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TD230 Evaluation Kit User Guide

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This document contains instructions on how to get started with and how to operate the TD230 Evaluation Kit.

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DOCUMENT HISTORY

Rev. #	Notes	Date
1.09	Initial release	17.9.2012
1.10	Corrected DIO assignments	18.7.2012

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	TD230 Quick Start Guide Version 1, Revision 1
2	TD230 Rev D Hardware Technical Description, Version 1
3	Navigil Application Protocol Version 1, Revision 8
4	TG2 Geofence Database Format

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1   Evaluation kit package contents

The evaluation kit package contains the following items:

- TD230 unit
- Lithium battery
- External GPS/GLONASS antenna with MMCX connector
- USB cable
- Cigarette lighter adapter
- Main connector cable
- Account information for Navigil Track&Trace server

Optional additional accessories:

- RS-232 DSUB9 adapter
- Hands-free audio kit
- AC power supply wall adapter (12V)

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2   Setting up the unit

This section will guide you through basic steps of setting up a TD230 unit for reporting to Navigil Track&Trace evaluation server. A summarized short version of the setup can be found in Ref 1 [TD230 Quick Start Guide].

2.1   Insert SIM card and battery

Open the enclosure lid by sliding it to the direction of the arrow and insert a SIM card cut corner first so that the SIM contact surfaces are towards the 18-pin main connector.

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

SIM card holder
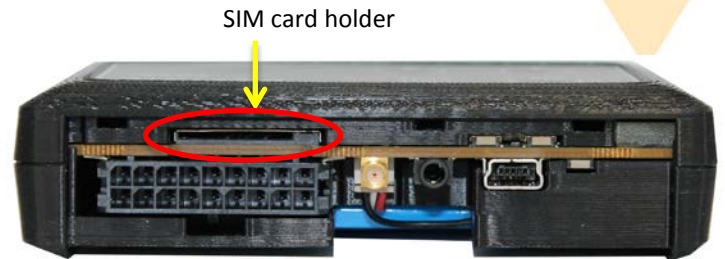
Insert the battery into the battery compartment. Install the battery cable into the battery connector as shown on the right:
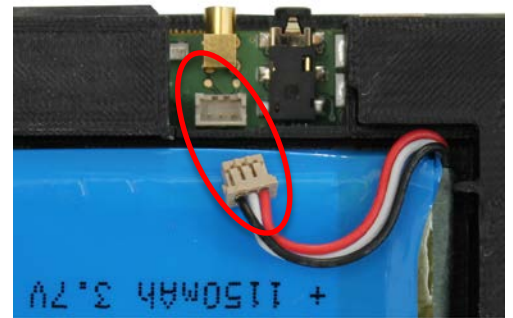
2.2   Configure phone number and APN

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://217.149.57.122/tracktrace.

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.
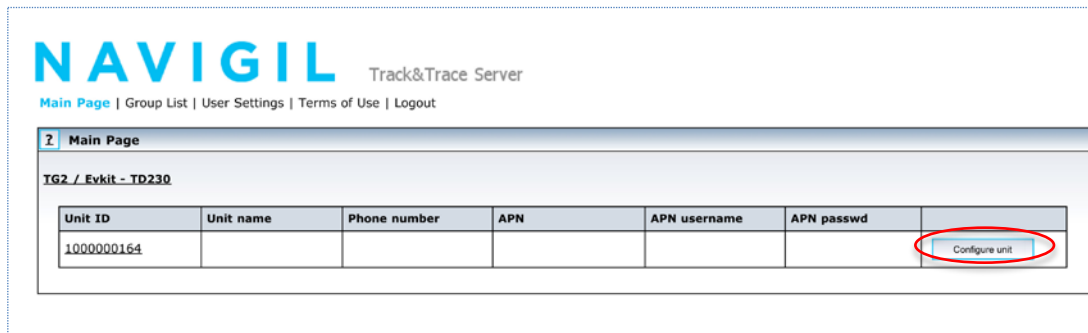
When logging in for the first time, you are asked to agree with the terms of use. Upon accepting them a main page will open, showing all units to which the account has access to. To configure a unit, click "Configure unit" button.
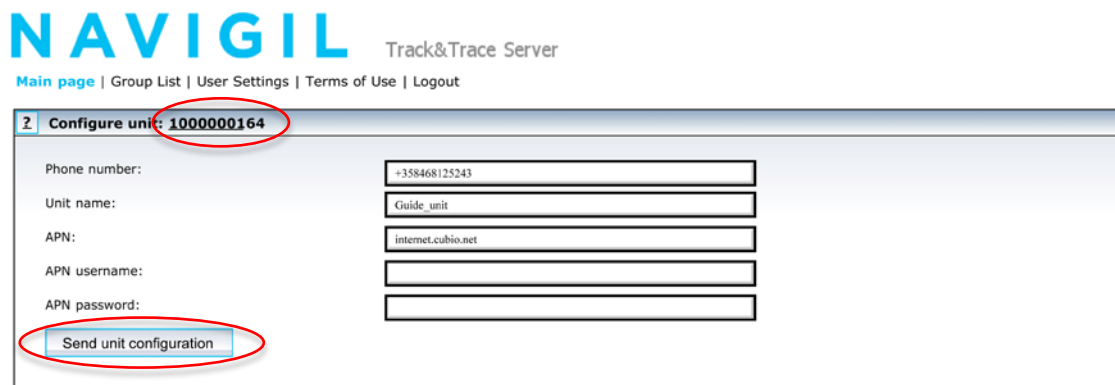
Enter phone number and APN information into the corresponding fields. You can also give a name to the unit by typing it into the Unit name field. After clicking "Send unit configuration", the Track&Trace server will send the information in a SMS message using the given phone number.

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.

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

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3   TD230 unit interfaces

This section presents the TD230 interfaces available in the evaluation kit.

3.1   User interface

User interface is implemented as a re-brandable membrane at the top of the enclosure. The membrane contains 3 buttons and 3 LEDs, which can easily be customized for different purposes. This section presents the default led and button behavior.

3.1.1   Status LEDs

The TD230 evaluation kit contains 3 red LEDs, labeled STAT1, STAT2 and STAT3. In the default configuration they are assigned to indicate the following information:

- STAT1 – power supply status
- STAT2 – GPS status
- STAT3 – 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**
STAT1 (power)	Blink once	Running on internal battery
	Blink twice	Battery full
	ON 3 sec OFF 200 ms	Charging
	Rapid blinking	Battery charging error
	ON (up to 2 sec)	Power button pressed down
STAT2 (GPS)	OFF	Valid GPS fix available
	ON	GPS fix not available
	Rapid blinking	Time not available
STAT3 (network)	ON	GSM registration not available
	OFF	Server connection available
	Blink once	GSM registration ok, no server connection
	Blink twice	Server connection error
	Rapid blink	SIM card not inserted

3.1.2 Buttons

The TD230 evaluation kit membrane has three buttons, one having a power switch symbol, the other two labeled as "1" and "2".

Buttons 1 and 2 can be used for triggering certain application functionalities as described in the table below. The TD230 can be turned on by briefly pressing the power button. Please note that the TD230 will be automatically turned on when the battery connected as described in section 2.1. TD230 can be turned off by pressing the power button for 2 seconds or more. While the power button is pressed down the STAT1 LED is lit. Once the power button has been continuously pressed down for 2 seconds the STAT1 LED (and any other STAT LED that is on) is turned off to indicate that the power down cycle has been initiated. Please note that it will take the TD230 up to several seconds to complete the power down cycle. The button disabled during the power down cycle. If the power button is released prior to the end of the 2 second period the TD230 will continue its operation.

User interface buttons	
Button	Function
1	Send a snapshot report to the server
2	Send a snapshot SMS report (if a SMS contact has been defined)
Power	Turn on / off the TD230

3.2 External interfaces

This section describes the interfaces for connecting external equipment to TD230. All external interface connectors are located at the back of the evaluation kit. Some interfaces are accessible with the cover closed, others requiring removal of the battery lid / back panel part.

3.2.1 Main connector

The main external connector is an 18-pin connector designed to contain most of signals generally required in vehicle operation. The main connector contains the following signals.

- Two power supply inputs, tolerant with 12V and 24V vehicle systems
- 2 digital inputs
- 2 digital outputs
- 2 analog inputs, capable of measuring a voltage range of 0-36V
- High current load switch (open drain)
- 3V regulated power output, maximum current 150 mA
- RS232 RX and TX
- CANBUS 2.0

A cable for accessing all main connector signals is delivered with the evaluation kit. The pinout of the connector is presented below.

Main connector pin out			
Pin	Signal	Description	Specification
1	GND	PCB ground	
2	VSAUT1	Automotive power input 1	8 – 36V
3	ADC0	Analog input	0 – 36V
4	ADC1	Analog input	0 – 36V
5	RS232_TX	RS232 Tx line	
6	GND	PCB ground	
7	DIO1	Digital I/O	Configured as input
8	DIO3	Digital I/O	Configured as output
9	GND	PCB ground	
10	NC	Not connected	Must be left floating
11	VSAUT2	Automotive power input 2	8 – 36V
12	CAN HI	CANBUS HI line	
13	CAN LO	CANBUS LO line	
14	RS232_RX	RS232 Rx line	
15	HCURR	High current load switch	
16	VEXTOUT	Regulated 3.0V output	up to 150 mA
17	DIO2	Digital I/O	Configured as input
18	DIO4	Digital I/O	Configured as output
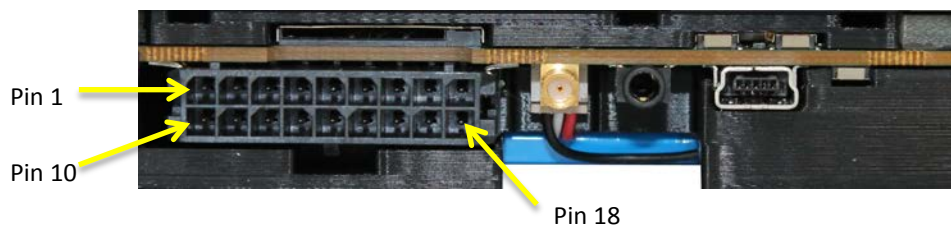
For detailed electrical specifications of the main connector signals, refer to Ref 2 [TD230 Rev D Hardware Technical Description].

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3.2.2 External GNSS antenna

For covert installations and other scenarios where the evaluation kit does not have a clear view to the sky, an external GNSS antenna can be connected using the external antenna connector. A magnet-mount external antenna has been delivered in the evaluation kit package.

TD230 contains automatic detection and switching logic for the external antenna. Once connected, the external antenna will automatically be taken into use.

3.2.3 Audio

The audio connector can be used for connecting a standard cell phone hands free with differential input and output signals. For detailed electrical specifications, refer to Ref 2 [TD230 Rev D Hardware Technical Description].

A hands free kit to be used with the audio connector has been delivered in the evaluation kit package.

3.2.4 USB

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

The current TD230 firmware does not support data connection with a computer over USB.

External GNSS antenna

Audio

BOOT0

USB

BOOT1

Reset

3.2.5 Reset and boot select buttons

TD230 contains 3 user accessible buttons, one reset button and two boot select buttons. The reset button is accessible with the back cover closed, by pressing it with a sharp object through the reset button hole.

Boot select buttons are only accessible by removing the back cover. Boot select buttons are used for selecting the mode to which TD230 enters when released from the reset state. To select a boot mode, press and hold the boot select button, then press and release the reset button. After releasing the reset button, the boot select button can also be released.

BOOT0 button is only used for initial configuration / factory resetting of the unit. This button should not be used by an evaluation kit user.

NOTE: Depending on the PCB revision of TD230, BOOT0 button may not be assembled at all.

BOOT1 is used for selecting a firmware/configuration programing mode for cases where automatic reprogramming cannot be used. A typical situation is that a custom software or configuration prevents normal communication of the programmer application and TD230.

3.2.6 SIM card holder

SIM card holder is located above the main connector. Insert the SIM card the wedged end first and SIM card contacts facing the main connector. Press the card inwards until you hear a "click" sound.
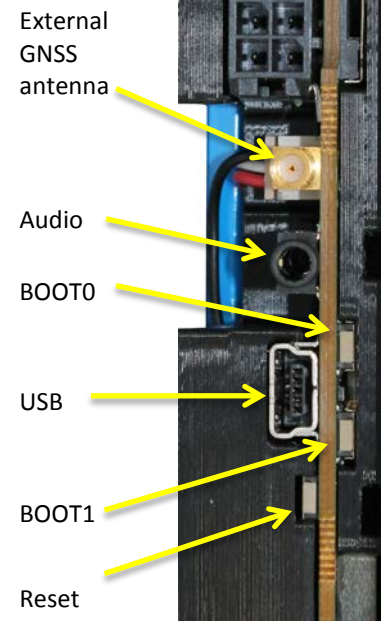
4 Navigil Track&Trace server

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 TD230 hardware performance and key firmware features. It is not available as a commercial service for larger unit fleets.

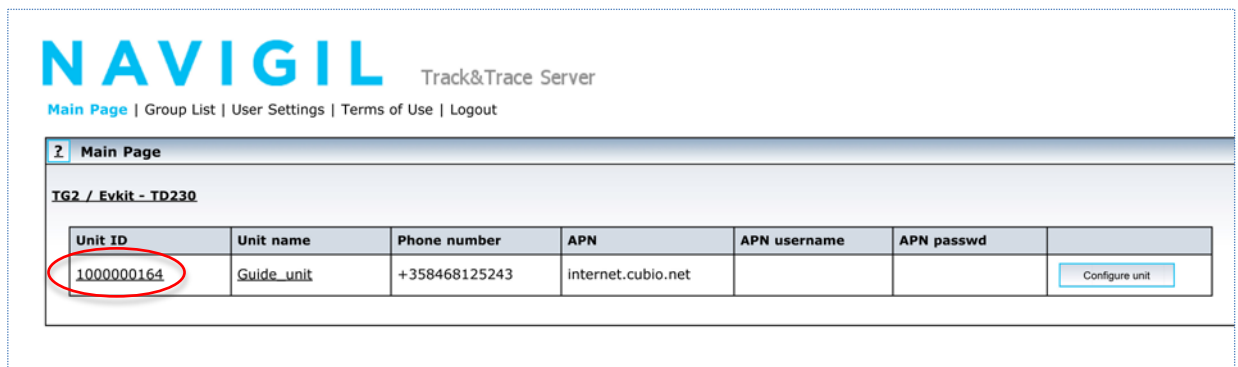For the commercial use, a suitable server system must be utilized. Contact sales@navigil.com for references to external fleet management systems supporting TD230 units.

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 unit 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. TD230 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 (3b9acaa4 in 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.

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 TD230 via SMS. The SMS template pull down menu provides templates for frequently used commands. You can use this tool to read and write TD230 parameters, to read/set/clear system registers and send other useful commands to TD230.

The message log shows recent messages sent by the TD230 to the Track&trace server.

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4.2.1.1 Unit ID Info

The unit info view shows the configuration used by the TD230 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 TD230 and any responses sent back by the TD230. 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 TD230 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.

4.2.1.4 Message Log

The message log area show the recent message sent by the TD230 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 TD230 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 TD230 generation time they appear in message sequence order. Please note that not all messages sent by the TD230 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 TD230. Please see Ref. 3 [Navigil Application Protocol Version 1, Revision 8] for further details on messages sent by the TD230.
- Fifth column [Msg seq #] shows the sequence number generated by the TD230. 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 TD230 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 TD230 has entered a geofence/geofence group. OUT denotes that the TD230 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).

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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 TD230 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 TD230 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.

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Navigation bar

Unit ID info

Send SMS to Unit tool

Switch to unit

SMS log

OTA update

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 TD230 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 TD230 and any responses sent back by the TD230. 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 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 TD230 with the reporting of TD230 thus making sure that the TD230 is in active mode when the update command is sent.

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

4.2.3.6 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.

4.2.3.7 Current location

The map area shows the last known location of the TD230. You can use the zoon in (+) and out (-) buttons to adjust the magnification of the map. Additionally you choose to show the location in map, satellite or hybrid view.

4.2.3.8 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. By default reports while moving are triggered by heading change, distance (default every 2 km on odometer) and time (default 120 seconds). Please note that by default a SNAPSHOT4 (or other message containing location information) message sent by the TD230 will reset distance and time values to zero. Thus the unit will only trigger timer and distance messages when selected time or distance from last SNAPSHOT4 message has elapsed.

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	
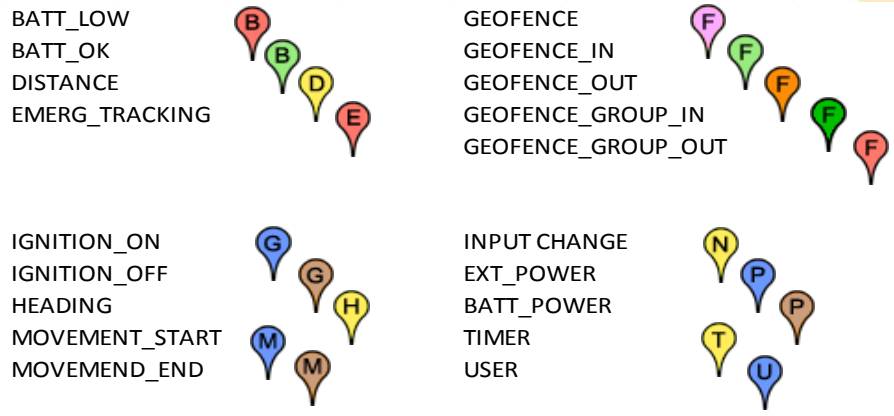
4.2.3.9 Draw plot

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 TD230 tracking device. The TD230 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 TD230 system console using the Send SMS to unit tool or via serial 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.

5.1 Reporting

Whenever the unit is awake, 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). TD230 uses the Navigil Application Protocol to communicate with the server, see Ref. 3 [Navigil Application Protocol Version 1, Revision 8].

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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 TD230 software. If the TD230 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 TD230. 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, error reports and geofence alarms.

Most of the reporting triggers represent changes in the movement of the unit (such as power input changes, turns and distance). While the unit is stationary only few triggers generate reports, the most prominent are the TIMER trigger (parameter keys 300 and 304) and distance (parameter key 210). Timer reporting is generated by a system timer, which creates periodic timer alarms in the system, which in turn are captured by the protocol engine and server report messages are created. Distance reporting is triggered by distance from last report containing position.

The default settings for the reports are optimized for a good balance between number of messages (transmission cost / power consumption) and sufficient granularity of the reports to be able to determine the actual route traveled. The settings are a compromise for urban and highway use. If the unit is mainly used in urban environment it is recommended that the distance parameter is set a much lower value than the default 2.000 metres. Alternatively the timer parameter can be adjusted to a much lower value, the downside of this is that while stationary the system will keep on sending messaging with no additional information. A good parameter compromise for highway use would be a distance interval of 10.000 metres and timer interval of 180 seconds. In order to set these values issue following commands at system console: param,write,300,180 and param,write,210,10000. They can be sent also in a single SMS message using the Send SMS to unit tool. Please separate commands with a semicolon (;) when sending more than on command in a single SMS.

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 TD230 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 TD230 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 TD230. Please see section 7 for further details.

5.2 Power management

There are two primary power modes in the TD230 software: active mode and power saving mode. In the active mode all functionality is enabled. This mode is generally used when the unit is externally powered and therefore it is not necessary to operate in low power consumption modes. In addition to external power supply, there are also several conditions that can set the unit into active mode.

Power saving mode is entered when no active mode conditions are present. During the power saving mode the unit is in low power sleep mode for most of the time and only wakes up at defined intervals based on the reporting timer (parameter key 304). There are also other triggers for waking up from sleep, such as mechanical motion and power supply change.

Please see section 7 for further details on how to customize the TD230 sleep mode behavior.

5.2.1 Entering power saving mode

A central element in the power mode control is a power saving mode counter. This counter is managed by the power saving module and is continuously decremented when the unit is awake. When the counter reaches zero, power saving mode is entered and the unit subsequently goes to low-power sleep.

To keep the unit in the active mode, the power saving mode counter must periodically be incremented to prevent it from reaching zero. By default all active mode conditions are periodically checked and if a certain condition is present, the counter is loaded upwards to a predefined value (power saving suspension time). Most active mode conditions have dedicated parameters to define the value for loading the counter. Please see section 7 for further details on how to adjust power saving parameters.

The counter can only be loaded upwards. If the counter is already at a value larger than the suspension time, the counter value is not changed.

This means that no particular active mode condition can independently define how long it takes to the TD230 to actually enter sleep mode. The basic design approach of the power control module is that each condition can only define that the unit must stay in active mode at least the time defined by the corresponding suspension time.

5.2.2 Waking up from sleep

When entering sleep, the unit can wake up on two primary triggers: timer and I/O. Timer wakeup is controlled by those system timers which have been allowed to wake up the unit from sleep. In the basic configuration the only system timer is the reporting timer.

For timer wakeups there is a special "wakeup advance"-parameter. This parameter defines how much earlier before the timer actually firing the unit should wake up. The wakeup advance allows the unit to establish the server connection and acquire GPS position by the time the timer triggers a report. This way the report has up-to-date information and the generated report can be delivered to the server without delay. By default the "wakeup advance"-parameter is set to 60 seconds.

On timer wakeups there are generally no active mode conditions and therefore the unit re-enters sleep after sending the report to the server.

I/O wakeups can come from several different sources, depending on enabled wakeup triggers. Possible I/O wakeup sources are power supply status changes, shock sensor input, external inputs and user interface buttons. Please see section 7 for further details on amending wakeup triggers.

5.2.3 Re-entering active mode

When the unit wakes up from sleep, the unit is still in power saving mode, regardless of the trigger. Whenever the unit is awake, all active mode conditions are checked. If any of the active mode conditions is present – resulting in the power saving mode counter to be loaded upwards – the unit goes directly into active mode, the most visible effect being the reporting timer to be changed back to its active mode interval.

5.2.4   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.

It is recommended that the under voltage shutdown parameter is left to the default 3.5V.

5.3   Progressive sleep modes

When the unit remains in power saving mode for a long time, it will decrease the server reporting frequency in two stages to further decrease its average power consumption. These stages are called progressive sleep modes.

There are 3 power saving stages. Each stage has dedicated timer intervals and wakeup triggers. Stages 1 and 2 also have configurable duration parameters to define how long the corresponding mode lasts before entering the next mode. Stage 3 has an infinite duration so the unit remains in power saving mode 3 until it goes back to active mode or enters under voltage shutdown. Please see section 7 for details on how to adjust the progressive sleep mode triggers.

5.4   Position handling

Position information is extracted from standard NMEA sentences received from the GPS module. A set a 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 TD230 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.

5.4.1   Fix post filtering

Fix post filtering generally tries to discard sequences of fixes, which cannot represent true movement of the vehicle (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 vehicle where the unit is installed. The post filtering contains several configurable parameters to define realistic limits for the vehicle movement. Setting these filtering parameters as tight as possible for the corresponding vehicle 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.

5.4.2 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 vehicle 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 vehicle has stopped. 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 shock sensor 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 vehicle 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 TD230 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 TD230. Should you wish to evaluate the raw performance of the TD230 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.

5.5 EPO Support

TD230 supports quick GPS start with long term predicted ephemeris. This allows the TD230 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. TD230 has by default the EPO (Extended Prediction Orbit) support turned on. The TD230 will download a fresh EPO file at defined intervals. The normal EPO download interval can be adjusted by using the param,write,171,<integer_value> command. The retry interval after a failed EPO download can be adjusted by using the param,write,172,<integer_value>. These values are defined in days. The default intervals are 1 and 1 day. The EPO files are stored on Navigil ftp-server. This server can be used only in conjunction with TD230 evaluation kits. Please contact sales@navigil.com for further information on arrangements for commercial use.

5.6 Geofences

TD230 firmware has industry benchmark embedded five dimensional geofence support. Up to 200 complex polygonal geofences or up to 5.000 circular 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 TD230 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 generating the geofence database file.

If you need assistance in generating sample geofence databases for TD230 evaluation please contact sales@navigil.com.

6   Default operational mode

The TD230 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 when external power is available (power via USB or VSAUT1 or VSAUT2) or movement is detected (accelerometer, shock sensor or GPS).

In active mode the TD230 will send messages to the server based on triggers. The key triggers are timer interval, distance interval and heading change. The default settings for these triggers are a compromise for both urban and highway use. If the unit is mainly used in urban conditions it is recommended that the distance parameter is reduced to 2000 meters.

Default server communication and reporting	
Server address	gw2.navigil.com:49304
Transport	UDP/IP
Server handshaking	Enabled
Acknowledgements	Enabled
Timer triggered report interval	120 seconds
Distance report interval	2.000 metres
Enabled reporting triggers	Timer
Distance
Heading change
Power supply change
Movement
UI button 1

Default power saving mode reporting intervals	
Stage 1 reporting interval	60 minutes
Stage 1 duration	24 hours
Stage 2 reporting interval	2 hours
Stage 2 duration	48 hours
Stage 3 reporting interval	24 hours

Default power management triggers	
Active mode conditions	VSAUT power supply USB power supply Movement
Wakeup triggers	Timer VSAUT power supply change USB power supply change Mechanical motion Input state change UI buttons
Under voltage shutdown limit	3.5V

7 Customizing unit configuration

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

7.1 TD230 system console overview

The simplest way to modify the unit configuration and to display status information is using the TD230 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 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 activate access control issue command sysreg,set,<register>,<bit>. In order to deactivate access control issue command sysreg,clear,<register>,<bit>.

7.1.2 Local cable connection

Another way to access the system console is a direct cable connection to the device RS232 port in the main connector. By default, the RS232 port is connected to the console. Serial port settings are 115200 baud, 8 data bits, 1 stop bit, no parity, no flow control.

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.

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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 TD230 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

In the default configuration following parameters are used. TD230 will report in active mode at least every 120 seconds, every 10.000 meters and when significant heading change has occurred. Additionally power status changes and GPRS connection open/close events will generate messages. Parameters can be changed using the param,write command and systems registers can be set/cleared using the sysreg,set / sysreg,clear commands.

The default location message is SNAPSHOT4.

Parameters

Key	Description	Default	Units
210	Distance reporting interval	2000	m
300	Timer reporting interval in active mode	120	sec
304	Timer reporting interval in sleep mode – Stage 1	3600 (1h)	sec
308	Timer reporting interval in sleep mode – Stage 2	7200 (2h)	sec
30C	Timer reporting interval in sleep mode – Stage 3	86400 (24 h)	sec
320	Wakeup advance	60	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

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7.4 Power management setup

In the default configuration the TD230 will remain in active mode when any of the following conditions is true: USB power is present, VSAUT1 or VSAUT2 power is present or movement is detected. The TD230 will wake up to power from any power source, motion, digital IO state change (DIO2 - main connect pin 8 and DIO4 - main connector pin 18) and UI keys 1 / 2. This configuration can be changed using the param,write and sysreg,set / sysreg,clear commands.

Parameters

Key	Description	Default	Units
310	Sleep mode – Stage 1 duration	24 (1 day)	hours
314	Sleep mode – Stage 2 duration	48 (2 days)	hours

System registers

Register	Bit	Description	Default
0	0	Enable power-saving mode	1
0	1	Stay awake when VSAUT1 is available	1
0	2	Stay awake when VSAUT2 is available	1
0	3	Stay awake when moving	1
0	4	Stay awake on mechanical motion	1
0	8	Stay awake when USB power is available	1
10	0	Wake up on button 1	1
10	1	Wake up on button 2	1
10	3	Wake up on DIN0 state change	1
10	4	Wake up on DIN1 state change	1
10	13	Wake up on USB power	1
10	14	Wake up on mechanical motion	1
10	15	Wake up on VSAUT power	1

7.5 Other useful parameters and registers

Parameters

Key	Description	Default	Units
171	EPO download interval	1	days
172	EPO download retry interval	1	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

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8 Troubleshooting

Problem	Possible causes	Action
Unit does not wake up	Battery is not connected	Check that battery is properly connected
	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.