TTS-2000A

TETRA
Site Survey Test Set
V 3.10, April 2019

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Content

1 INTRODUCTION 4

1.1 Overview 4
1.2 Safety Precautions 4
1.3 Disclaimer 4
1.4 Software Versions 4
1.5 Functions and Features 5
1.5.1 Use of the TTS-2000A in Air-Interface-Encrypted Networks 5
1.6 Scope of delivery 6
1.7 Antenna data 6

2 CONNECTIONS AND HARDWARE INSTALLATION 7

2.1 Mechanical Details 7
2.2 Dimensions 7
2.3 Power Supply Input and Battery Charging 8

3 TTS-2000A QUICK SETUP GUIDE 9

4 STARTING PROCEDURES 10

4.1 Preparing the Set 10
4.2 Powering the Set 10
4.3 Connecting the WiFi to the TTS-2000A 11
4.4 Switching off 11
4.5 iPad (iCloud) account settings and app updates 12

5 TTS-2000A C-APP FUNCTIONS 13

5.1 iPad screens 13
5.1.1 The main screen / Main 13
5.1.2 Status line 15
5.2 The network neighbor cell display/ Neighbors 16
5.3 Network Information 17
5.3.1 Serving Cell Information 18
5.3.2 Network Information 19
5.4 The TETRA parameters and antenna setting screen 20
5.4.1 TETRA Scan Parameters 21
5.5 The Map View 22
5.7 The Calibration Screen 23
5.8 Update 24
5.9 Saving data for further processing 25
5.10 TTS-2000A Data import 26
5.11 TTS-2000A basic configuration 27

6 INSTALLING THE PC BASED MAIL SERVER 31

6.1 Introduction 31
6.2 Start the server 31
6.3 Setting up the server in the iPad 32

7 COVERMAP PC TOOL 34

7.1 Base station coverage analysis/ RSSI Level 34
7.2 RSSI analysis/ RSSI good/bad 36

7.3 Cell change analysis/ Show change of serving LAC 37
7.3.1 Cell Reselection Decisions 38
7.4 Show difference between best cell and serving cell/ RSSIdelta 39
7.5 Base Stations 40

8 TTS-2000S SCANNER APP FUNCTIONS 42

8.1 iPad screens 42
8.1.1 The main screen / Scan 42
8.1.2 The Monitor screen / Monitor 46
8.1.3 The network parameter screen / Network Information 47
8.1.4 TETRA Scan Parameters and Antenna Gain / TETRA Settings 48
8.1.5 Recording Screen / Monitor Data 48

9 TTS-2000M MANUAL APP FUNCTIONS 49

9.1 iPad screens 49
9.1.1 The project screen / Home 50
9.1.2 The main screen / Manual 51

10 SPARE PARTS AND FOLLOW UP ORDERS 54

11 SPECIFICATIONS 57

1 Introduction

1.1 Overview

This document contains information about the installation, settings, and operation of the TTS-2000A TETRA Site Survey Test Set. Additional information is also available in the Internet, on the website www.TetraModem.com.

1.2 Safety Precautions

It is essential to ensure that the radio and antenna systems are installed and commissioned by trained personnel only.

This radio equipment should not be used in life-support systems or in safety systems without our prior written permission.

It is not permitted to interact with the TTS application while driving a vehicle. Please contact local jurisdictions for further information.

1.3 Disclaimer

We, Funk-Electronic Piciorgros GmbH, have carefully checked the contents of this document and the hardware and software described in it for compatibility. However, we cannot exclude possibilities of deviations and cannot guarantee complete conformity of the document with the equipment it describes. If any corrections or improvements are to be made, they will be taken into consideration in the next version of this document.

Important instructions are marked by the expressions "Important", "Note" or “Caution!”. These should be carefully observed. Explanations regarding these precautions can be found on the website www.TetraModem.com, in the login area.

1.4 Software Versions

The software (firmware) versions and document editions history is listed below:

Firmware Version	Document Version	Comments / Changes
1.0	1.0	First Release
1.0	1.1	Added Mail Server description
2.92	1.2	Finalizing of features Map View added TTS-2000A does no active registration or transmit actions
3.15	1.3	Documentation update

1.5 Functions and Features

The TTS-2000A is a portable test device, which helps the user to monitor and, with the information gathered, understand and improve the performance of their TETRA network. It is an instrument to visualize the RF field strength, the bit error rate and network specific information like the neighbor report (including their RSSI) or broadcast messages at any location within the network.

This set is a “ready to go” TETRA site survey test set that can be used to measure up to 32 reported neighbor cells simultaneously.

It is built into a small Pelicase enclosure and can be operated stand alone, without the requirement of an external PC. The data acquisition and display is performed by an iPad Mini (included). Power is provided to the unit using either an in-car cigarette lighter lead or optionally with a 12 to 24 Volt power supply.

With a built-in rechargeable battery the TTS-2000A can be operated up to four hours without any external power attached, which makes it ideal for walk-around tests in areas that are not accessible by a vehicle.

A number of accessories, such as cigarette lighter cable, wall plug charger/power cable, magnetic antenna and analysis software are part of the package.

After the TTS-2000A has been powered up, the TETRA network parameters and the operating modes can be configured in the iPad app. This includes the TETRA scan frequency range, MCC and MNC. It should be noted that the TTS is never registered to a TETRA network. It only simulated the registration meaning that no ISSIs are needed for the analysis.

As the measurement is not only taken from the base station the device is logged into, also from all reported neighbor cells, the cell overlap can be easily checked. Once the measurement has been started, the GPS coordinates, the received field strength, radio channel and the LAC code of the registered cell and the number of reported neighboring base stations are displayed.

After completion of the survey, a simple touch gesture generates an email on the iPad, including a .csv file with all the data for later analysis on a computer using any spreadsheet program, or the data can be converted into a graphical site survey map based on Google Maps (included in package).

1.5.1 Use of the TTS-2000A in Air-Interface-Encrypted Networks

As the TTS-2000 is not actively registering to the TETRA network, it cannot decode messages, which are Air-Interface-Encrypted. For a full functionality it needs the Neighborhood Broadcast Messages from the network, hence this broadcast information must be sent in clear to fully use the TTS-2000A.

In most networks these broadcast messages are always sent unencrypted, in others there is an option to configure this. If the TETRA network uses AIE, please check with the network operator if the NBCells broadcasts are sent in clear.

1.6 Scope of delivery

The TTS-2000A package contains:

- TTS-2000A
- iPad Mini including charger
- Power supply / charger for the TTS-2000A (100-240V AC)
- Car power supply / charger cable for the TTS-2000A
- Magnetic Antenna including 5m cable
- Whip antenna for walk test
- USB Stick with:
  - This documentation
  - CoverMap PC software
  - TTS mail server application

1.7 Antenna data

The included magnetic antenna has 0dB gain, the 5m RG58 cable including connectors has an attenuation of 1dB.

By using the magnetic antenna including the 5m cable the setting “Antenna Gain” in the TETRA Parameters tab should be set to a loss of 1dB.

2 Connections and Hardware Installation

2.1 Mechanical Details

The TTS-2000A housing is built into a compact crushproof and dustproof Pelicase.

Inside the case is an aluminum panel including the on/off-switch and 4 LED, displaying the power status, the operation display, a blue "TETRA"-LED, which shows the registration to the TETRA network and a “Charge”-LED, which is off when not charging and red when charging.

The power / charger plug and the TNC antenna plug are located on the front of the Pelicase. The power supply can range from 12 to 24 VDC with a tolerance of about +/- 20%. Once power is provided, the TTS-2000A will charge its internal battery in both cases: if operating or turned off.

2.2 Dimensions

The dimensions of the TTS-2000A are as follows:
232mm x 192mm x 111mm

2.3 Power Supply Input and Battery Charging

The required supply voltage (12-24 VDC +/-20%) is connected either by the wall plug power supply or by the car charger. Both cables are included in the package.

Once power is applied, the TTS-2000A can be operated. Also the internal battery will be charged and keeps being charged.

The "Charge" LED will indicate whether the battery is charging (continuously on) or is fully charged / kept in standby (off or flashing).

If you connect the power source with a full battery the "Charge" LED will stay off.

3 TTS-2000A Quick Setup Guide

1) Set up an Apple iTunes Account on the iPad Mini
2) Set up a valid Email address on the iPad Mini. You will need it to send the data to you PC/Mac later
3) Download the App(s) from the App Store. When you type in “Piciorgros” into the search field, you will find all Piciorgros applications.
4) Turn on the TTS-2000A. Ensure that you have an antenna connected to it
5) On the iPad Mini go to Settings -> WiFi and select the TTS-2000A WiFi. (The WiFi name depends on the Serial Number of the TTS-2000A in case you have more than one)
6) Once selected, click on the little information “i” on the right side and choose “Static” under the tab “Configure IP”. Here change the IP-address to 192.168.0.100 and the sub net mask to 255.255.255.0.
7) Open the TTS-2000 App (C-app). “TTS-2000” should be red for a few seconds, then turn green and eventually black. That means that the iPad is connected to the WiFi of the TTS-2000A. Please be aware that the WiFi Symbol will not be visible in the top left corner at any time.
8) Now click on the “TETRA Settings” Tab in the bottom menu. Here you can see your purchased TETRA frequencies. Note that additional frequencies can be purchased at a later point in time.
9) You will now have to fill in the MCC (Mobile Country Code) and MNC (Mobile Network Code), the Frequency at which the TTS should start scanning and the Scan Range in Channels (The max amount of scan channels in 400). When entering the Start Scan frequency, ensure that you mind the **offset**! Find out if your network has an offset and either type in the right start frequency or let the TTS-2000A do the work for you by clicking on the right offset underneath the Scan Range.
10) The TTS-2000A now has to restart so please wait up to 60 seconds for it to “register” to the given network. Of course the TTS never really registers to the network (the reason why you do not need an ISSI) but it has to simulate a registration and that takes up to one minute.

    Please note:
    Always do updates when they appear (both iPad and TTS-2000A). Especially for the TTS, there could be a critical Stack, DSP, MMI or Firmware update that could either fix a bug or simply enhance your TTS experience. Always download the latest versions from the App Store and after restarting the App, check for the “update” Tab on the bottom of the Screen and update accordingly. You will have to have the TTS-2000A connected to power when you do the updates. NEVER unplug it before the updates are done.

    If you have purchased more than one application: **Only one application can run at a time**. So always close all unused applications to avoid confusion. To close Apps on the iPad Mini, double click on the home button and swipe the App towards the top of the screen.
    Always double check if you are connected to the right WiFi. The TTS App will let you know if you are not connected to the required WiFi.

4 Starting Procedures

4.1 Preparing the Set

Before the set is ready to operate, some preparation has to be made. This preparation is mainly the installation of the antenna.

The antenna must be connected to the TNC connector located at the front of the Pelicase. Any antenna, which is connected to the TTS-2000A, needs to match the operating frequency range of the network that will be monitored.
In case of usage in a car it is recommended to select an antenna with a magnetic foot to fix it on the car's roof. A magnetic antenna is included in the package.

Once the set is used in an environment where power supply is available you may connect the power to the TTS-2000A to ensure the seamless operation and keep your battery charged.

Also ensure that the iPad Mini is charged or that a power supply/charger is attached to it.

4.2 Powering the Set

To supply the TTS-2000A with power there are two methods available:

1. Use the in-car cigarette lighter lead adapter to power the case while driving in a vehicle. Plug the connector into the intended jack at the front of the Pelicase.

2. To use a common AC power supply an additional adapter is provided. The device facing connector must be plugged into the intended jack at the front of the Pelicase.

Ensure that your iPad is properly charged or connect a power supply to the iPad.

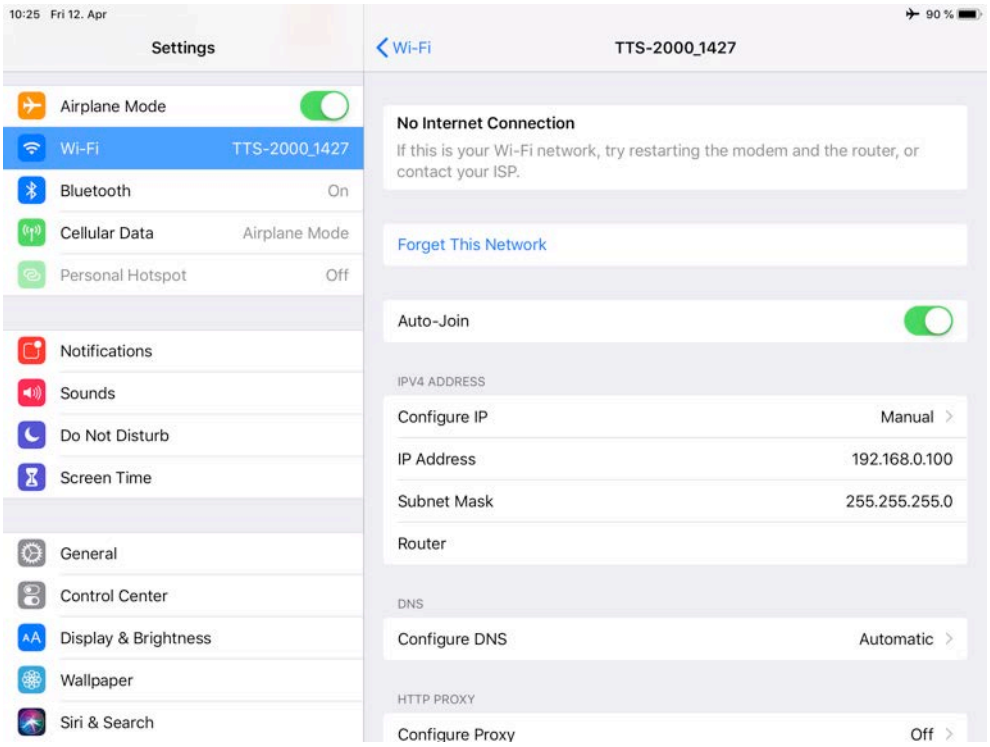
A short (about one second) press on the "On/Off" button on the front panel switches on the TTS-2000A. Once the TTS-2000A is turned on, the "Pwr"-LED and the "OK"-Led will light up. The TTS-2000A needs some seconds to start the internal WiFi access point to connect to the iPad.
One can see that the TTS-2000A is connected to the iPad in the main screen of the TTS app.

4.3 Connecting the WiFi to the TTS-2000A

Once the TTS-2000A is switched on, it will provide a WiFi access point with the name "TTS-2000_xxxx", whereas "xxxx" is the serial number of the TTS-2000A.

The iPad must be connected to this Access point. The password is "picologo" by default.

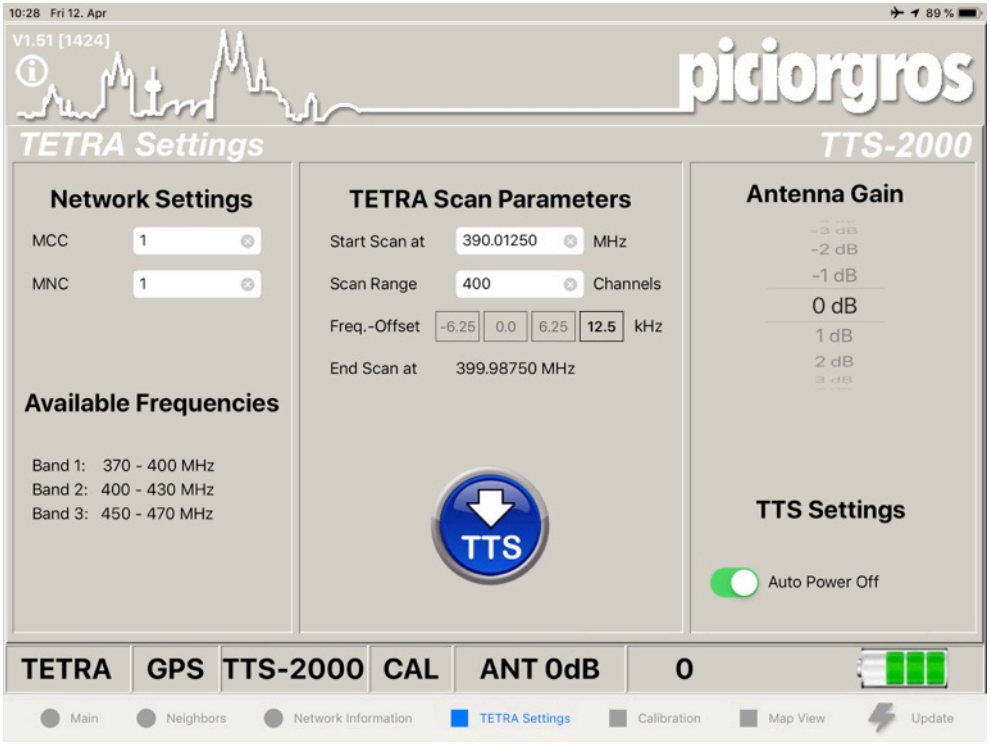
Once the TTS-WiFi is selected, the IP data must be entered statically. Click on the blue information “i” next to the Access Point Wifi to get to the screen below. Ensure that you click on the “Configure IP” tab and choose “Static”. We recommend setting the iPad to the IP address 192.168.0.100 with net mask 255.255.255.0. If leaving the "Router" entry empty, you will be able to use the Internet in parallel with the link to the TTS-2000A if a SIM card with a data plan is inserted (SIM card is not included in the package).



Note that the WiFi symbol will not appear in the top status row of the iPad as the TTS-2000A does not provide Internet connectivity to the iPad.

4.4 Switching off

The TTS-2000A will automatically switch off once the iPad application is closed or if there is no connection to the iPad application for at least 5 minutes. However, if you want to avoid the auto power off, you can go to the “TETRA Settings” tab in the TTS applications and turn off the switch “Auto Power Off” in the right lower corner of the screen.



If the TTS-2000A is supposed to be switched off, press and hold the "On/Off" button until the green "OK" LED is off, then release it. All LED's should switch off after this.

4.5 iPad (iCloud) account settings and app updates

The TTS-2000A app has to be downloaded from the App Store before using the TTS-2000A. Please use an existing Apple Account or create a new one in order to be able to download the App(s).

Downloading the App from the AppStore also ensures that updates are delivered to the iPad automatically. Therefore the iPad should be connected to the Internet from time to time to check updates from the AppStore.

The TTS-2000 main app also carries possible firmware updates for the TTS-2000A and the TETRA radio core.

5 TTS-2000A C-App functions

5.1 iPad screens

There are seven screens available in the iPad app:

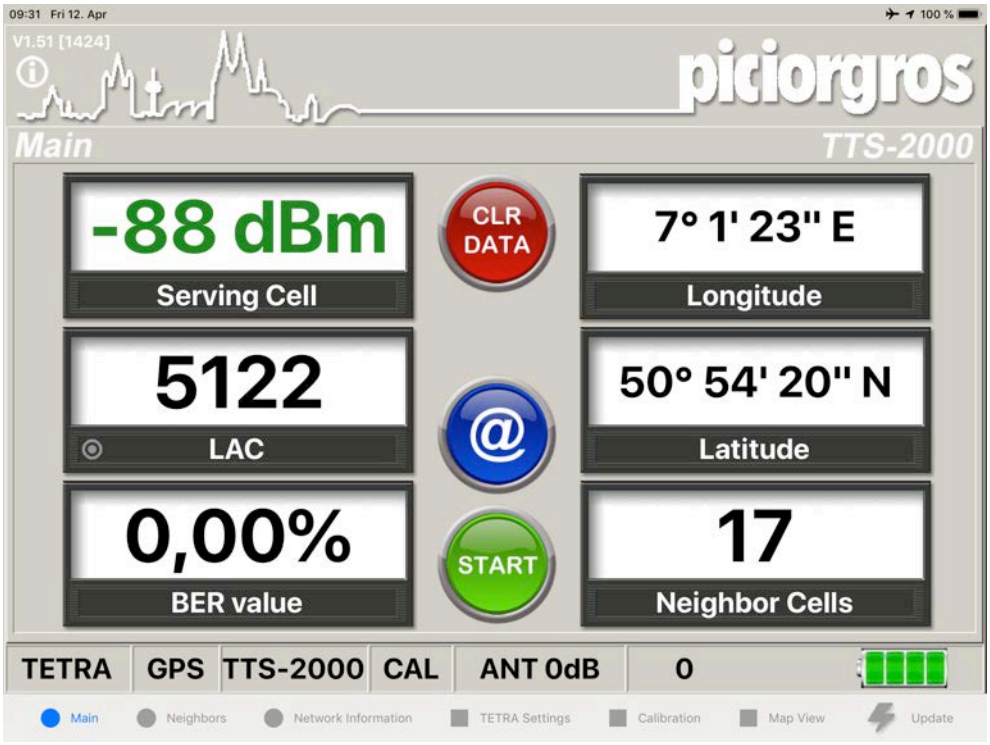
- The main screen / Main
- The network neighbor cell display screen / Neighbors
- The network Information Screen/ Network Information
- The network parameters and antenna setting screen / TETRA Settings
- The calibration screen / Calibration
- The map screen /Map View
- The Update of the TETRA Modem Screen/ Update

There is also a section in the iPad settings for the basic TTS-2000A app configuration.

5.1.1 The main screen / Main

The main screen is the operating screen for survey operations. Big symbols ensure that the most important data can easily be seen during a test drive in a car.

Important:
The street traffic must always focus your attention! If the drivers observe the iPad, they should only do so if the car is parked.
We, the Funk-Electronic Piciorgros GmbH are not responsible for any harm or damage caused by using the TTS-2000A in cars, in other vehicles or while walking.



Information “i” (upper left corner):
The user can tab and hold on the “i” to get the most important information on all the screens of this app.

RSSI (Serving Cell):
The RSSI display shows the current field strength of the serving cell the TTS-2000A is registered to. A basic colorization gives a rough overview if the reception is good (red), acceptable (yellow) or poor (green). (Color map is configurable in the main settings for the application)

Channel:
This number is the radio channel number of the cell the TTS-2000A is registered to. Next to the word channel, the user can see a “tab button”. Here one can click in order to change the Channel number to the Frequency of the serving cell.

LAC:
This is the LAC (Location Area Code) number of the cell the TTS-2000A is “registered” to.

Longitude / Latitude:
This is the GPS data of the actual position, provided by the iPad.
Therefore the iPad should be located at a position with good sky view and near to the TTS-2000A Pelicase to ensure accuracy of the position data (i.e. in the same car as the iPad, carried by the same person etc.).

BER value:
This value shows the calculated Block Error Rate in percent.

Neighbor Cells:
Shows the amount of neighbor cells reported for given serving LAC.

Start / Stop:
This button starts or stops the survey. A survey can be stopped anytime and continued later, even if the TTS-2000A and/or the iPad were switched off in the meantime.

Email (@):
Pressing this button generates an outgoing email on the iPad, containing the latest survey data in .csv format.

CLR DATA:
This button clears all the stored survey data in the iPad. A security pop-up dialog needs to be confirmed for additional security. Once the data is cleared, it cannot be restored.

Make sure that the data has been sent out and been received on the destination email account before clearing the stored data!

5.1.2 Status line

The status line at the bottom of the page displays the status of the most important features. All fields are color coded with red indicating a warning and black for normal operation.

TETRA:
This word will appear in black color when the TTS-2000A is registered to the TETRA network. It will appear in red color if the registration to the network is lost or not yet established.

GPS:
This reflects the availability of the GPS position information in the iPad. Once the word is red, there is no proper position information available. A yellow GPS indicates a low accuracy. If the GPS accuracy is not good enough for sufficient results, if possible change the location of the iPad to have a clear view to the sky.

TTS-2000:
This is the status of the WiFi link between the iPad and the TTS-2000A. If the word is in black color, the link is up and running. If the word is in red color, there is no WiFi link between the iPad and the TTS-2000A.
A green "TTS-2000" means that the WiFi connection has been established, but the data could not been retrieved from the TTS-2000A yet. This might happen if i.e. a second running TTS app is blocking the communication. Only one TTS app can be open at the same time. Always close unused applications.
Without an active link (i.e. if the app on the iPad has not been started, or has been turned off on purpose) the TTS-2000A will automatically switch off after five minutes to save power.

CAL:
One year after the last calibration this word turns red to remind the user to recalibrate the TTS-2000A.
The customer can do the calibration if a calibrated TETRA measurement device (like an Aeroflex TETRA test set) is available. As an alternative the TTS-2000A can also be sent to Piciorgros GmbH to let them do the calibration (please contact us for pricing and further information).
Even if the last calibration has exceeded a year and the status is shown red, measurements are possible. But to ensure the most accurate measurement values, the TTS-2000A should be recalibrated in time.

ANT:
The quality of the connected antenna influences the measurement values. The gain or loss can be defined at the parameters page.

Counter:
The amount of currently measured values is displayed at this location.

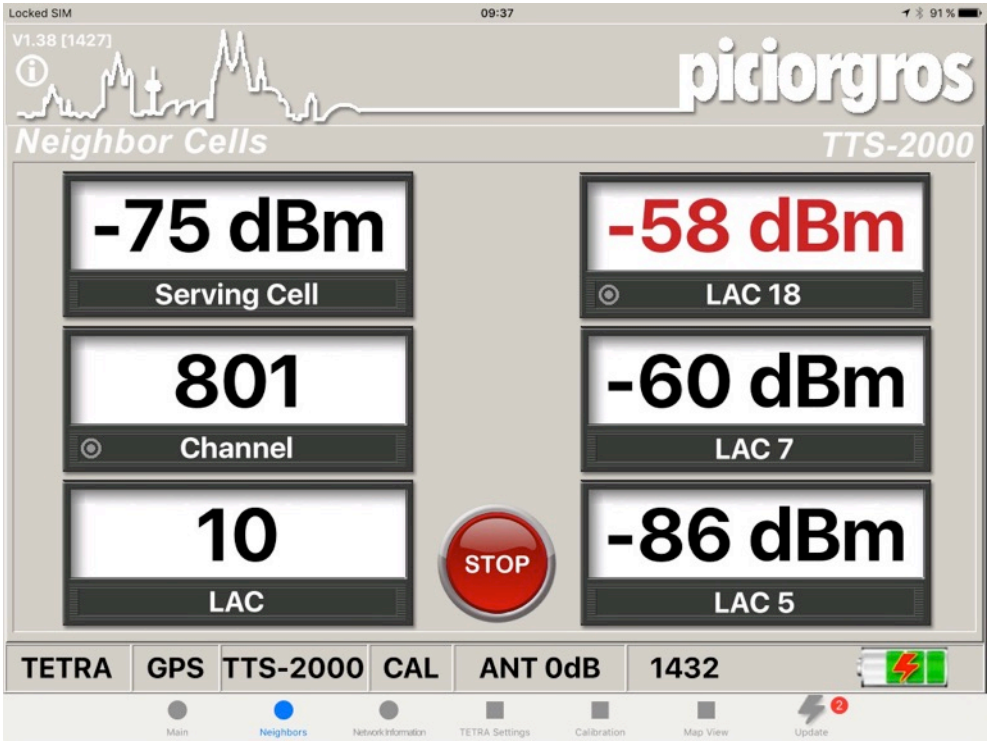
Battery Level:
Battery level of the TTS-2000A, a red lightning symbol indicates connected external power supply and charging of the battery. Each green bar indicates approximately one hour of operations (operating time highly depends on individual battery handling and environmental influences). If you tab on the battery symbol in the right lower conrner, you can also view the voltage left over in the battery. However, once the TTS is fully charged the lightning symbol will disappear and the charge LED on the TTS will go and stay off as long as the charger is connected to the TTS.

5.2 The network neighbor cell display/ Neighbors

This view can be used to observe the neighbor cells during the test drive. On the left side the serving cell is displayed as it is in the main view. On the right hand side the three strongest neighbor cells are displayed.

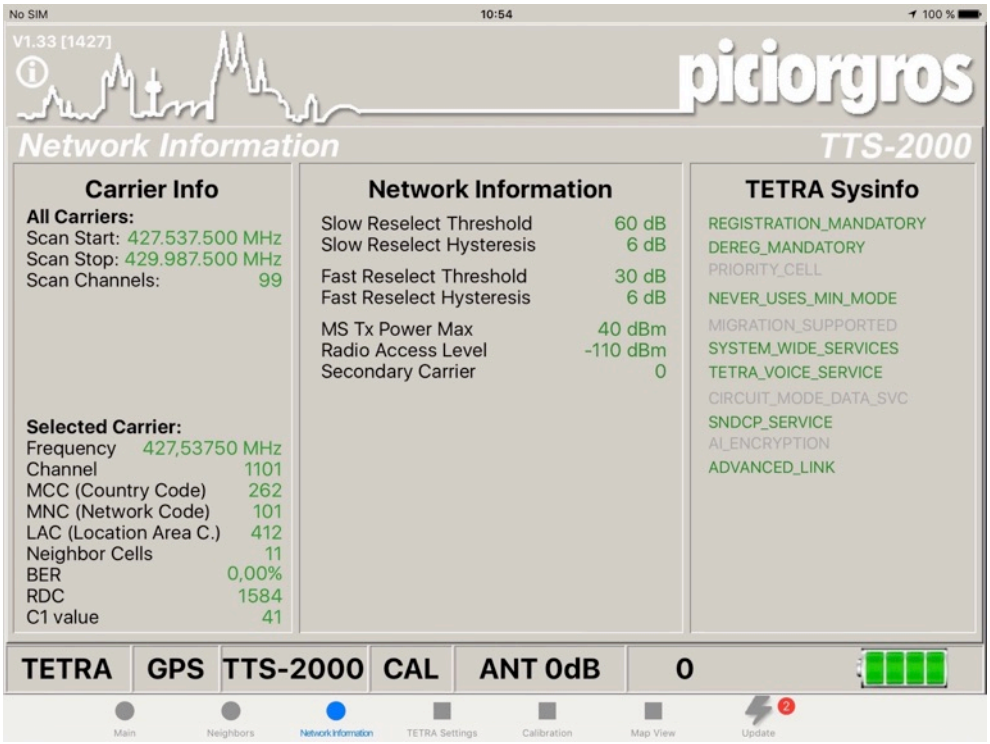
The user can click on the “tab” button next to the upper neighbor to change the LA to the channel number or frequency of that given neighbor.

Here one can see that always the strongest cell is colored, even if it is not the serving cell as can be seen in the example below. If this is the case, one can assume that most likely a cell reselection will take place soon.



5.3 Network Information

On the left hand side of the screenshot below one can see the information entered prior to the simulated registration process. Below this information the latest reported information from the selected carrier (serving cell) are listed.
In the middle column one can see some basic networks information and settings broadcasted from the serving base station.
On the right hand side, the user can see the TETRA SYSINFO reported from the serving cell. All supported features are shown in green color whereas unsupported features are displayed in grey.
For a more detailed explanation and definitions, see below the image.



5.3.1 Serving Cell Information

RDC
RDC = Radio Downlink Counter. When a radio is attached to a serving cell it is continuously monitoring the quality of the downlink signal it is receiving from the base station. When doing this it maintains the Radio Downlink Counter. The starting value for this counter is announced by the cell in the RADIO_DOWNLINK_TIMEOUT field of the cells SYSINFO messages.

If the radio is unable to decode the Access Assignment Channel (AACH) in a downlink message, the RDC is decreased by N × N.210 (where N.210 is a constant which defines the quality threshold for the MS which in the case of the TTS is set always 4, and N is equal to the number of successive timeslots the radio is receiving and decoding, so in the TTS this is always 1).
If the radio successfully receives and decodes the AACH in a message, the RDC shall be increased by N but shall not be increased above the value of the announced RADIO_DOWNLINK_TIMEOUT.
Radio downlink failure is declared when the RDC falls below 0. If this happens, the radio will perform an immediate a cell reselection. The value of N.210 controls the AACH message error rate threshold at which radio downlink failure occurs, so for example, in the TTS N.210 = 4, so there is a ratio of 4 to 1 between failure and success counting to give a decreasing RDC. This will occur when the message error rate exceeds 20 %. Therefore, a continuous message error rate greater than 20 % will cause a radio downlink time-out and a cell reselection.

C1 value
The C1 value is known as the Pathloss and is calculated for the serving cell by the following formula,

C1 = RSSI – RXLEV_ACCESS_MIN - Max(0, MS_TXPWR_MAX_CELL - P_{ms})
where:
RSSI = the averaged receive signal level at the MS
RXLEV_ACCESS_MIN = the minimum permissible receive level allowed at the MS (announced in the cells SYSINFO message, and displayed as ‘Radio Access Level’ under Network Information by the TTS)
MS_TXPWR_MAX_CELL = the maximum MS transmit power permissible in this cell (announced in the SYSINFO message from the cell and displayed under Network Information by the TTS)
Pms = the maximum transmit power of the radio. Since the TTS does not transmit, this value is always assumed to be the same as the MS_TXPWR_MAX_CELL being announced by the cell. All parameters are in dB.

5.3.2 Network Information

Secondary Carrier
This parameter display the number of Secondary Control Channels (SCCH) which are being announced by the current serving cell.

Radio Access Level
This parameter displays the RXLEV_ACCESS_MIN value being announced in the current serving cell in its SYSINFO messages. It is the minimum permissible receive level allowed at the MS and is used in the C1 calculation

MS Tx Power Max
This parameter displays the MS_TXPWR_MAX_CELL being announced by the current serving cell in its SYSINFO messages. It is the maximum MS transmit power permissible in this cell and is used in the C1 calculation.

Slow Reselect Threshold/Hysteresis and Fast Reselect Threshold/Hysteresis
These parameters are all announced by the current serving cell in its Neighbour Cell broadcast messages and are used by an MS during cell reselection decisions. The decisions taken by the TTS during cell reselection are described in the next section.

5.4 The TETRA parameters and antenna setting screen

The TETRA parameters screen allows the configuration of the parameters necessary to simulate the registration to the TETRA network. As the TTS-2000A does not need to be registered to the network, there is no need for an ISSI to be provided for the device. The TTS-2000A does not transmit meaning it does not generate any traffic in the network.

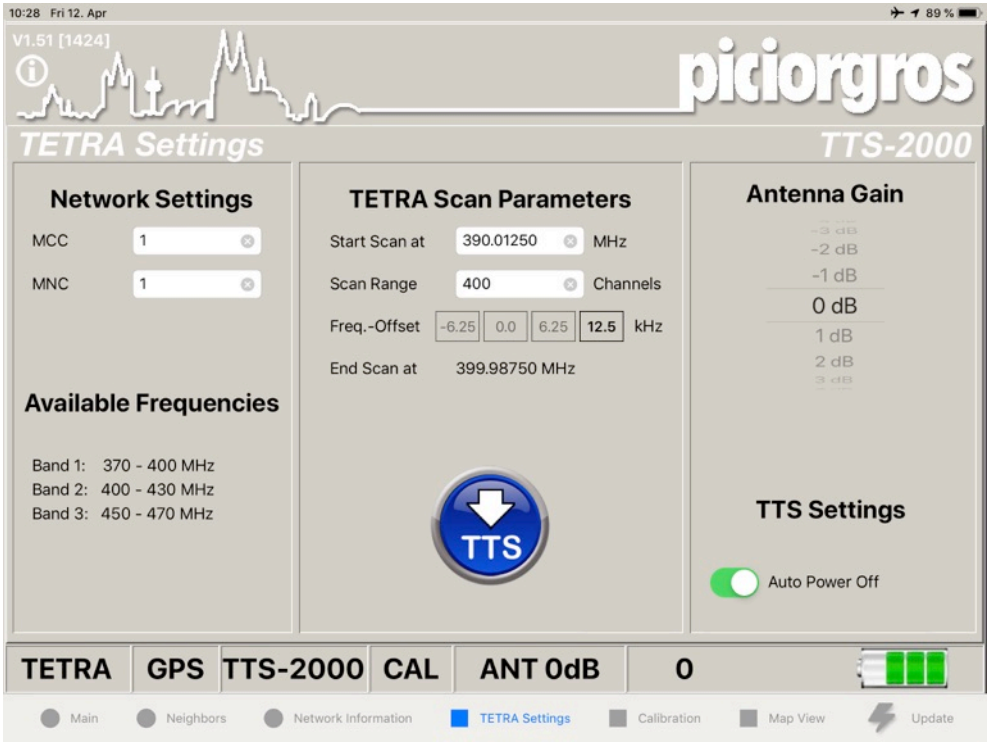
IN order for the TTS to start the simulated registration process the user has to enter the MCC (Mobile Country Code), the MNC (Mobile Network Code) and the start frequency with a scan range (amount of channels that should be scanned). After the user has entered the frequency, they can see if they have entered an offset or not in the Freq.-Offset field. Here the bold field will be the one calculated by the TTS due to the entered information. However, one can also go vice versa. If the user is not sure about their exact start frequency, but knows which offset they are using, they can simply enter a frequency without an offset and then click on the correct offset field, which will lead to a calculation of the iPad for the correct start scan frequency.
As soon as a value is changed, the TTS-button underneath the TETRA Scan Parameters will be activated and clickable to re-program the TTS (modem) with the new settings.

In the Available Frequencies section, one can see which TETRA frequency bands have been activated for this given TTS. The purchased/activated frequencies are shown in black color, the ones that have not been activated but can be purchased at a later point in time are greyed out. The user can always add new frequencies after receiving the TTS. They will be sent an activation code, which they will have to enter in the settings section of the iPad (see Settings for more info). To see all activated features and applications, please go to the Update tab in the Application. Here the user can see which features have been bought and which ones are still available for purchase.

In the Antenna section, the gain or loss of the used antenna can be selected in 1dB steps. On the gain side there may be a possible gain of the used antenna, on the loss side will be the used antenna cable. This enables the user to match the receiving conditions of the TTS with a given handset.
The total sum of gain and loss should be entered on this page to ensure correct measurement values.

If you close the app or turn off the TTS, and restart them both later, the TTS will remember the last settings (MNC, MCC, Start Frequency and Scan Range) and automatically reconnect to the last network it was connected to.

In case you do not want the TTS to automatically turn off after five minutes, when not connected to the iPad, you may switch off the “Auto Power Off” button. Please be aware that the TTS-2000A will then stay on until the battery dies completely. Piciorgros is not responsible for lost data.



5.4.1 TETRA Scan Parameters

Start Scan at
This is the value for the start frequency for scanning the network. If the network uses a **frequency offset**, this must be included within the value or added by tapping on the equivalent offset as explained above.

Scan Range
This is the value for the amount of channels that should be scanned starting at the Start frequency. The End Frequency will be displayed below the Offset section.

Freq.-Offset:
Here the user can pick their offset if their network has one.

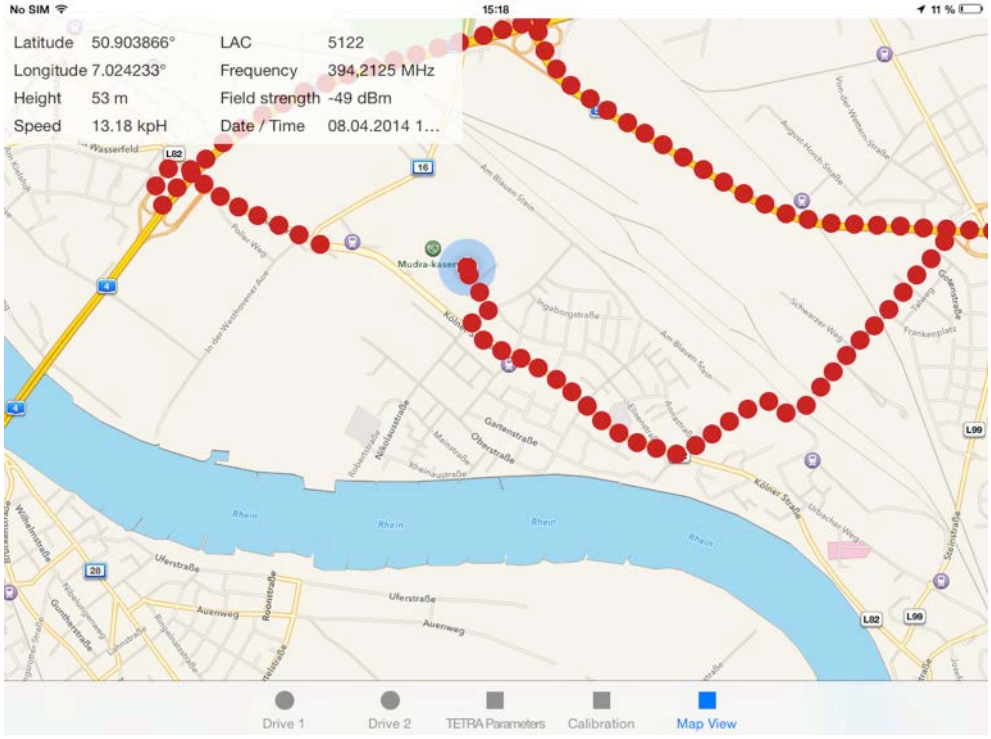
Network Settings
MCC
This is the value of the TETRA network's Mobile Country Code.

MNC
This is the value of the TETRA network's Mobile Network Code.

As soon as one of the network parameters (Frequencies, MCC, MNC) is changed, the blue TTS button will be activated to start the transfer of the new parameter to the Modem.

IMPORTANT: After the transfer the TTS-2000A automatically power cycles to activate these entries. Started again the internal TMO-100 will need some time to program the internal modem and register in the network, depending of the scanning range and the coverage at the location. If all values are set correctly, the TTS-2000A will be ready again for usage without the need of user interaction (TETRA in the lower bar will be black again).

5.5 The Map View



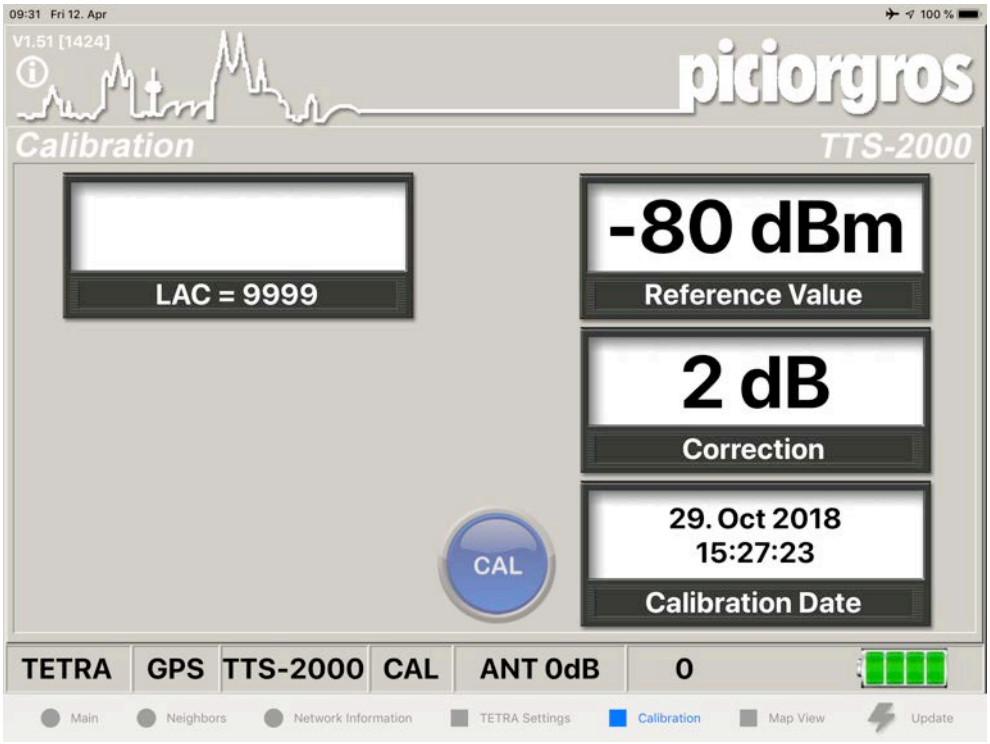
In the Map View screen the recorded data can be viewed. Please note that the iPad needs Internet connection to load the map data, so either it must be logged into a WiFi network with Internet connectivity for viewing the data, or a SIM card with a data plan must be inserted into the iPad.

The map can be zoomed and rotated as used in other map applications. Furthermore any dot can be touched and additional information for this measurement point will be displayed as seen in the screenshot above.

For more detailed analysis and the view of the coverage for a single LAC or any combinations of LACs', the PC based software CoverMap should be used.

5.7 The Calibration Screen

The calibration screen allows the calibration of the TTS-2000A.



The user can do the calibration in case that they have a calibrated TETRA test set in combination with base station simulator mode (like the Aeroflex IFR3901).

To calibrate the TTS-2000A, the test set must be set to provide its RF output with a reference value of -80dBm. Also the test equipment must identify itself with the same LAC number as written below the RSSI display field. This LAC can be changed in the setting of the TTS-2000A app.
The last calibration date is shown in the field "Calibration Date".

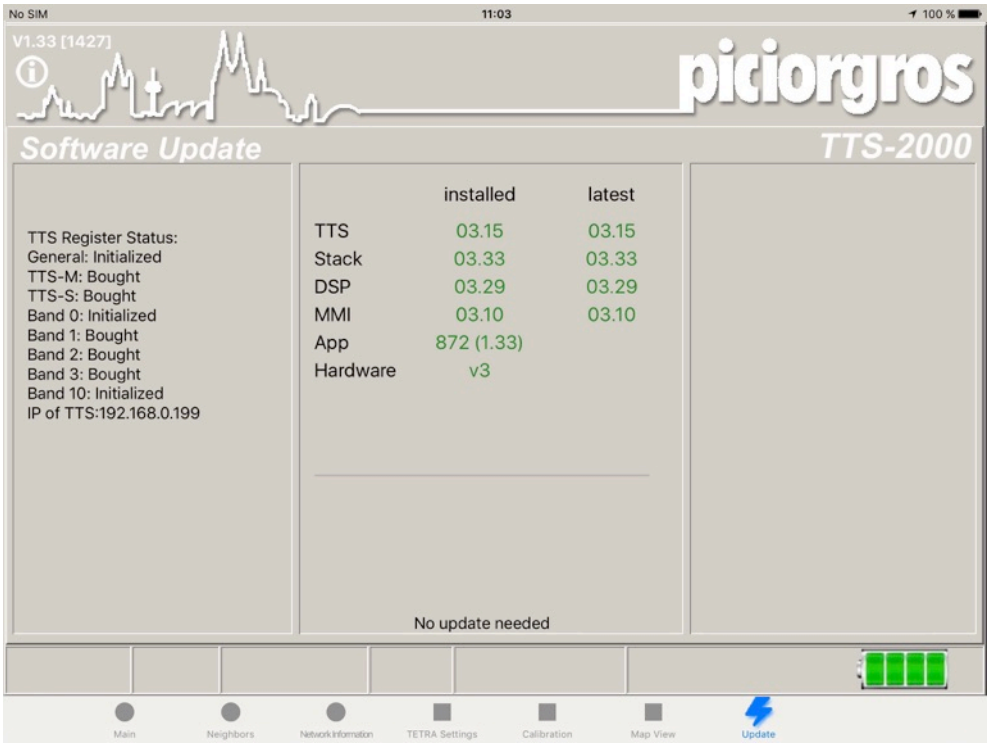
Ensure to use short cables and a proper RF connection between the test set and the TTS-2000A for the calibration.

Once the connection is made and the TTS-2000A has "registered" to the test set, the current field strength is displayed in the RSSI field.

When pressing the "CAL" button a correction factor is stored in the TTS, which equalizes the real calibrated input field strength to the value measured by the TTS-2000A. The calibration date is updated as well.

In case of lack of calibration equipment, the TTS-2000A can be also sent to Piciorgros GmbH for a recalibration (contact us for price information).

5.8 Update



On this screen, the user can find updates, if any are available. If there are updates for their TTS, they can see a red number next to the “updates” tab in the lower menu bar, indicating the number of updates that are available. Updates are always free and should be downloaded and installed right away as they can enhance the TTS experience or fix bugs.

On the left hand side of this screen the user can see the purchased frequency bands and applications. Additional frequency bands and applications can be purchased at a later time also. A key will be generated and sent to the user and the TTS does not have to be sent back in order to add bands or apps.

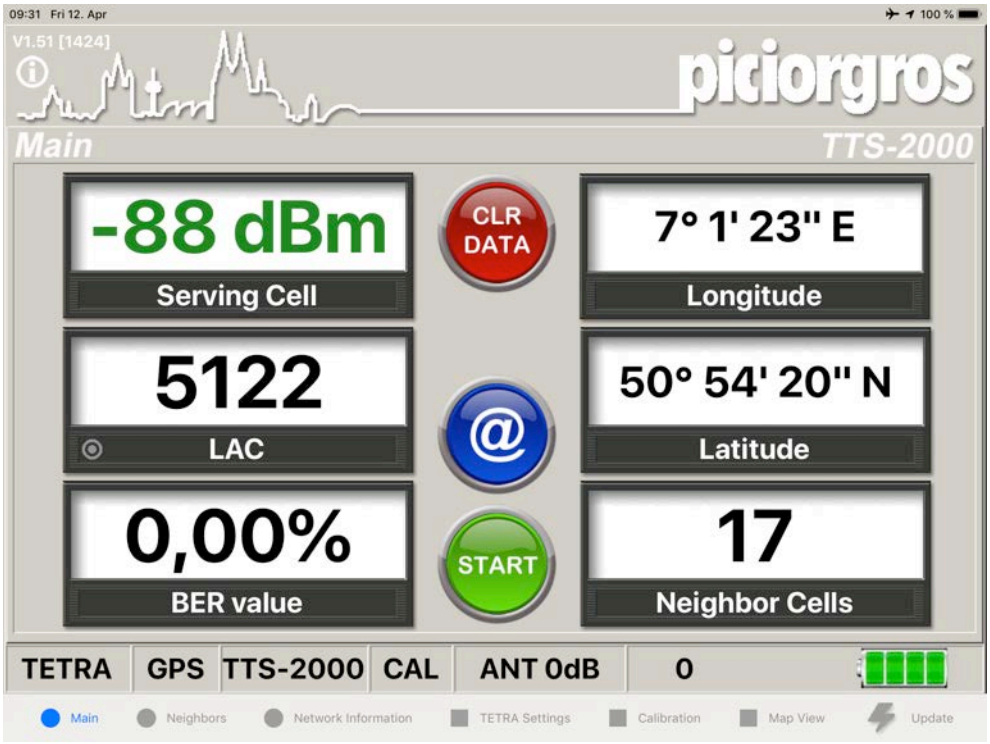
To perform the updates ensure that the TTS-2000A is plugged into a power source (wall plug charger or car charger) and the battery is fully charged. Also the iPad should have a proper battery percentage (>20%).

Although security measures are built in it might happen that a power loss during the update procedure can render the TTS-2000A unusable so that it needs to be sent to service. Please contact sp@piciorgros.com for further information if this is the case.

5.9 Saving data for further processing

When the survey is completed, the data needs to be saved for further processing. This is done in the main screen by a press on the "@" button.

Attention! A valid mail account has to be installed on the iPad in advance. Please refer to chapter 6 for further information about setting up the included PC based mail server and connecting the iPad to it.



This will generate an email, message or Airdrop with a .csv file attached to it. The .csv file contains all measurements since the last data erase, which can be open with Excel. The data can also be processed by the CoverMap software (included) to be displayed on Google maps or by any other customer specific solution.

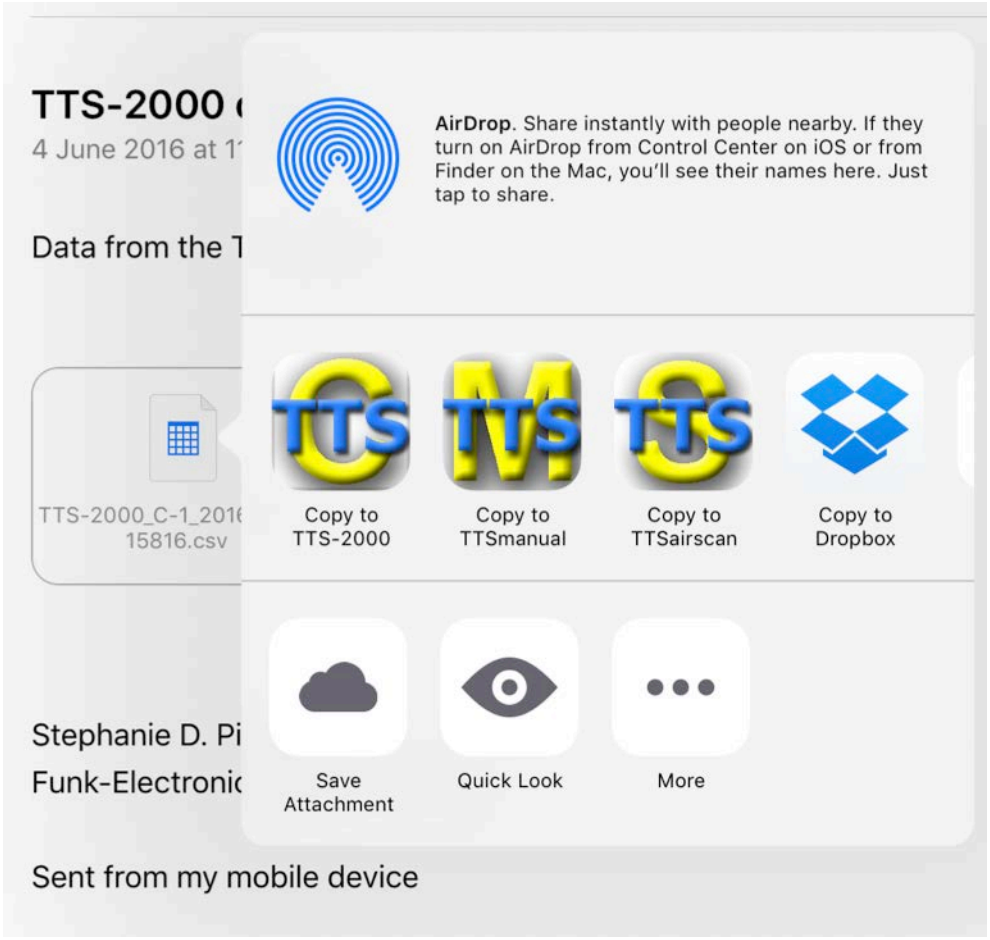
After the data has been transmitted, the data in the iPad can be erased with a press on the "CLR DATA" button. A security pop-up will ask for an additional confirmation. If it is not deleted the test drive will simply continue whether it was sent or not.

Attention:
Always make sure that the email with the data was received on the destination side before erasing the data in the iPad. Once the data was erased there is no way to restore it!

5.10 TTS-2000A Data import

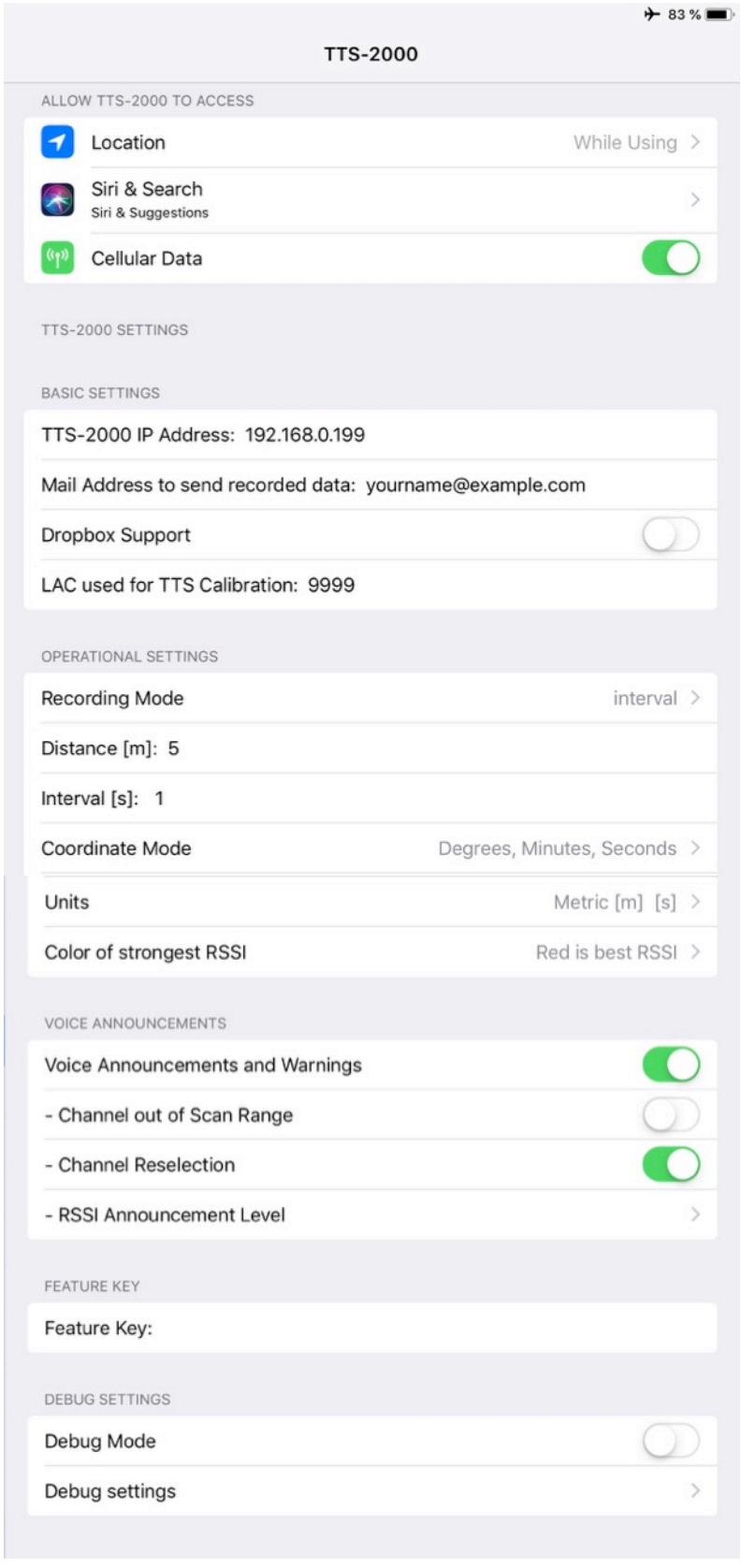
The TTS-2000A can import data from emails. This enables the transfer of results from one app to another. Also, additional configuration files can be opened using this kind of data transfer.

To import data, please send the file(s) via email to the TTS-2000A iPad. Press and hold the file you want to open and choose the appropriate app.



5.11 TTS-2000A basic configuration

The application can be individualized via the main settings page of the iPad. A change of these settings is immediately realized by the application without restarting it.



ALLOW TTS-2000 TO ACCESS:
- Location (at least “while using”, or if preferred “always”)
- Cellular Data should be turned on if SIM card is inserted

The named resources need to be enabled to guarantee the full TTS functionality.

BASIC SETTINGS:
TTS-2000 IP Address:
Is the internal IP address for the TTS-2000A.

Mail address to send recorded data:
Is the pre-set email address that will be used to send all the recorded data to. The data will be sent as a csv file.

Dropbox Support
If this is enabled, the data can be stored in a Dropbox folder rather than sending it to an email address. After the user has enabled this feature, the TTS application has to be restarted in order for it to work properly. The user can then see a little export button in between the CLR DATA and the “@” button.

LAC used for TTS Calibration:
The TTS-2000A can only be calibrated using a carrier with this LAC value. This should be an unused LAC.

OPERATIONAL SETTINGS:
Recording Mode:
This entry defines the mode of measuring. The mode can be distance or interval. In distance mode a measurement is recorded after the TTS has moved the configured distance (i.e. every 100m, feet). In interval mode a measurement is taken each x seconds, independent of the distance of the movement in this time frame. The minimum distance is 1m, the minimum interval is 1 second.

Distance [m]:
This indicates the distance in meters between measurement points. Only has to be filled out if the user chose “Distance” as their “recording mode”.

Interval [s]:
This indicates the interval in seconds between measurement points. Only has to be filled out if the user chose “Interval” as their “recording mode”.

Coordinate Mode:
The user can chose whether the TTS should show Coordinates as degrees, Minutes and seconds or as degrees decimal.

Units:
The users can decide if they want to use the metric or imperial system.

Color of Strongest RSSI:
The user can choose red as the best RSSI (red as in hot = good RSSI, blue as in cold = bad RSSI) or green as the best RSSI.

Voice Announcements:
Voice Announcements and Warnings:
This feature should be enabled if the user wants to have the iPad warn them about certain anomalies:

Channel out of Scan Range
The iPad will warn the user every time a cell, which is outside of the scan range, is selected as the serving cell.

Cell Reselection
An audio signal is played during a cell change. A single beep indicates a connection to a cell and a double beep indicates the beginning of a cell change. The iPad will also announce the new selected LA and the reason for the cell reselection.

RSSI Announcement Level
Definition of thresholds for coverage warnings (for “RSSI Level Below/above”). The user can set their preferences here. The iPad will always make a voice announcement if the RSSI is below or above a certain preset RSSI.

FEATURE KEY
The feature key field is only used if an additional frequency band or application has been purchased. The user will be sent a key that has to be copied and pasted into this field in order for the TTS to activate it. Please be advise that every time you enter a new frequency band, you have to restart the TTS Application before it actually activates it.

If the feature key was correctly applied, it will be "eaten" by the application, leaving the feature key field blank again. If a key is not correct, a popup message in the app will give information about this.

DEBUG SETTINGS

Debug Settings

Enhanced configuration for the debug mode.

Debug Mode

This switch enables the debug mode for the app. In debug mode, an enhanced debug log is written and can be exported via email after a measurement. Do not enable debug mode without requested by the support team. The files will be very large and the TTS will slow down drastically after about 4000 measurements. Please contact sp@piciorgros.com for further information.

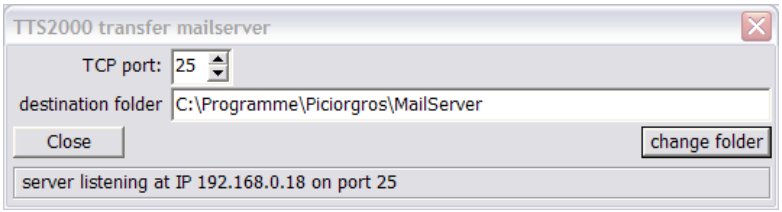
6 Installing the PC based Mail Server

6.1 Introduction

In some circumstances it is not possible to connect the iPad with an email server within a secured network. Also it might not be possible or allowed to install and use iTunes for data transfer.
In this case a minimal mail server is provided by Piciorgros to enable the data transfer to any windows based PC in the network.

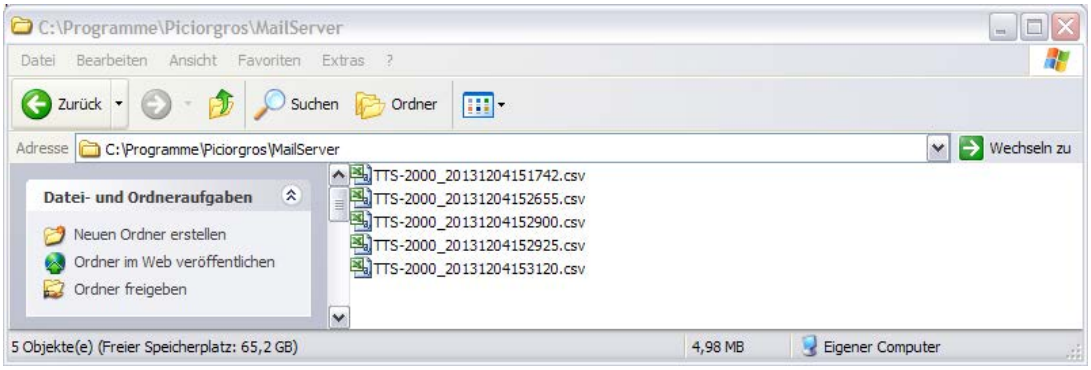
6.2 Start the server

The server is realized as a smart application that can run on any PC. It is started by a double click on “MailTTS2000.exe”.



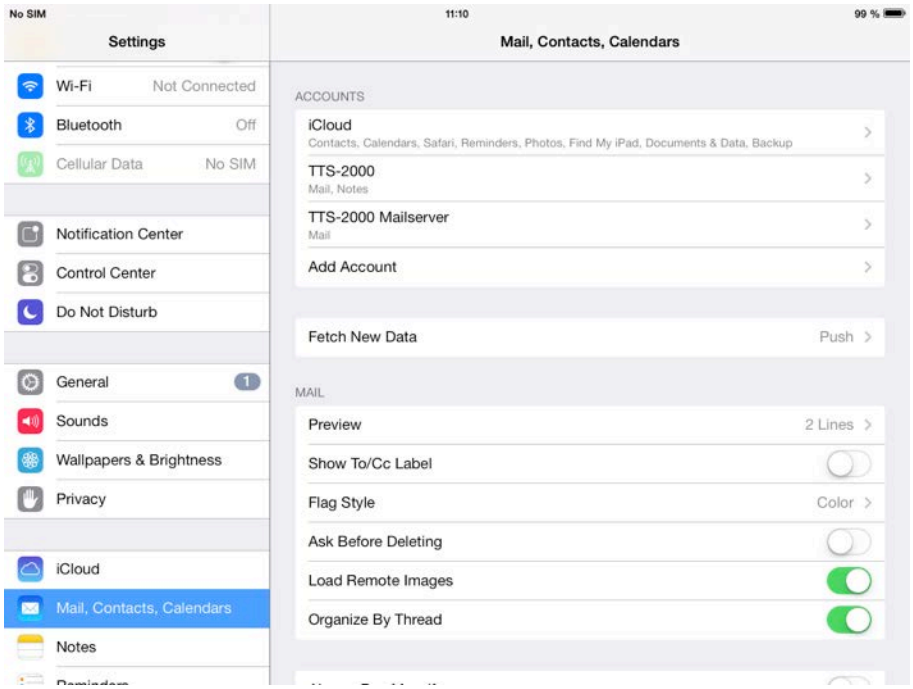
The server immediately starts listening on the selected port, which can be changed in the upper input field.

As soon as the TTS-2000A sends its data using the PC as mail server, the application receives the mail and processes it and the data is pushed to the destination folder in csv-format.

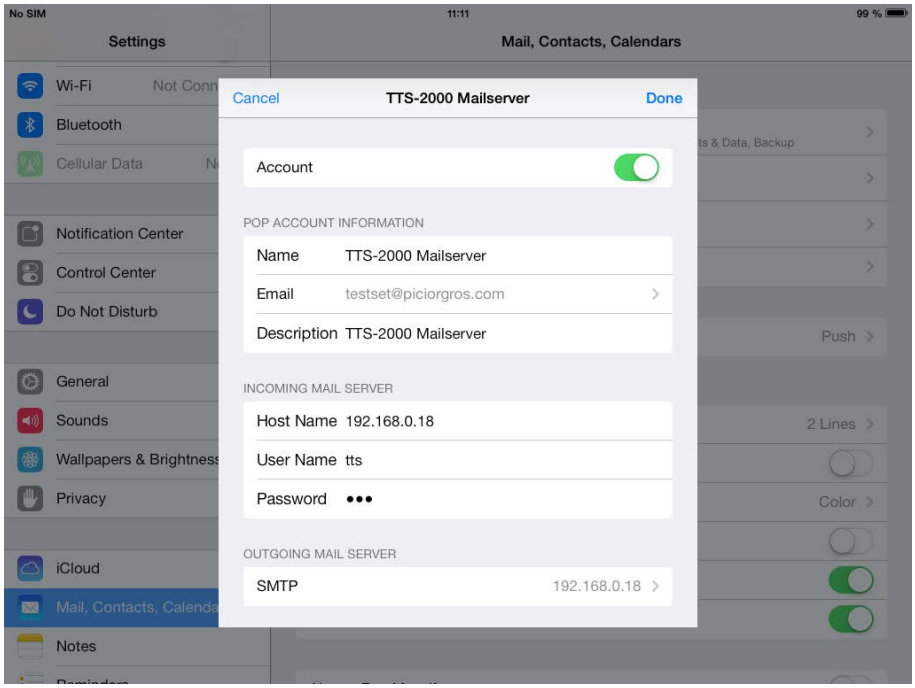


6.3 Setting up the server in the iPad

The server must be installed in the main settings of the iPad. As default the account is installed as “TTS-2000A Mailserver”. The settings can be edited at “Settings >> Mail, Contacts, Calendars”.

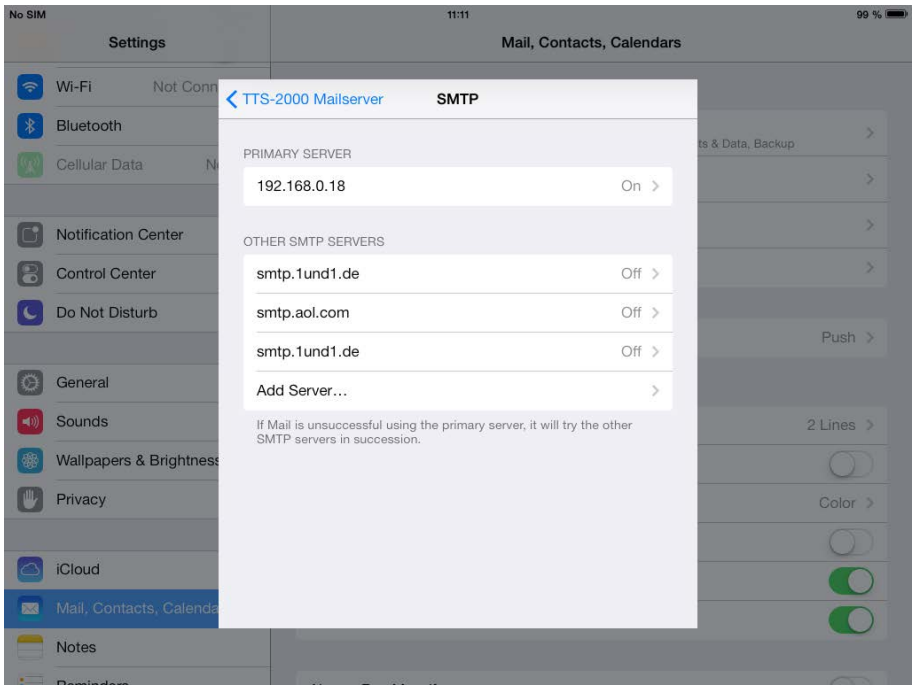


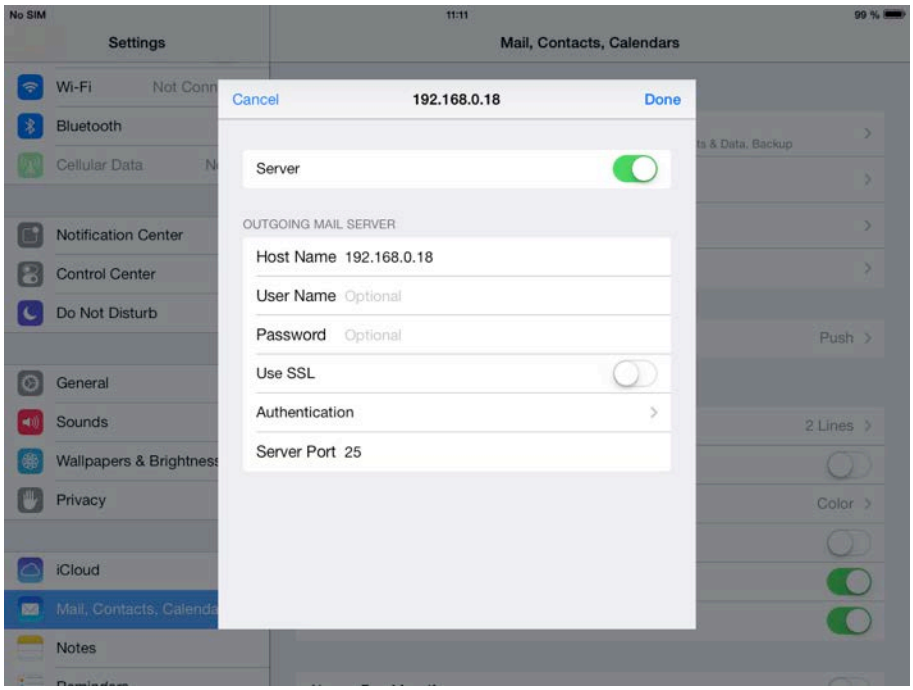
At the settings page, the entry for “Host Name” at “INCOMMING MAIL SERVER” must be set to the IP address of the PC that is running the mail server (192.168.0.18 in this case). “User Name” and “Password” are both set to “tts” by default but can be ignored when using the PC based mail server.



Next are the SMPT settings for outgoing mails. Please make sure that all other servers are deactivated and the settings for the primary server fit to the configuration of the PC and the mail server running on it.

The following two pictures show how the PC with IP address 192.168.0.18 and the mail server listening on port 25 is set up.





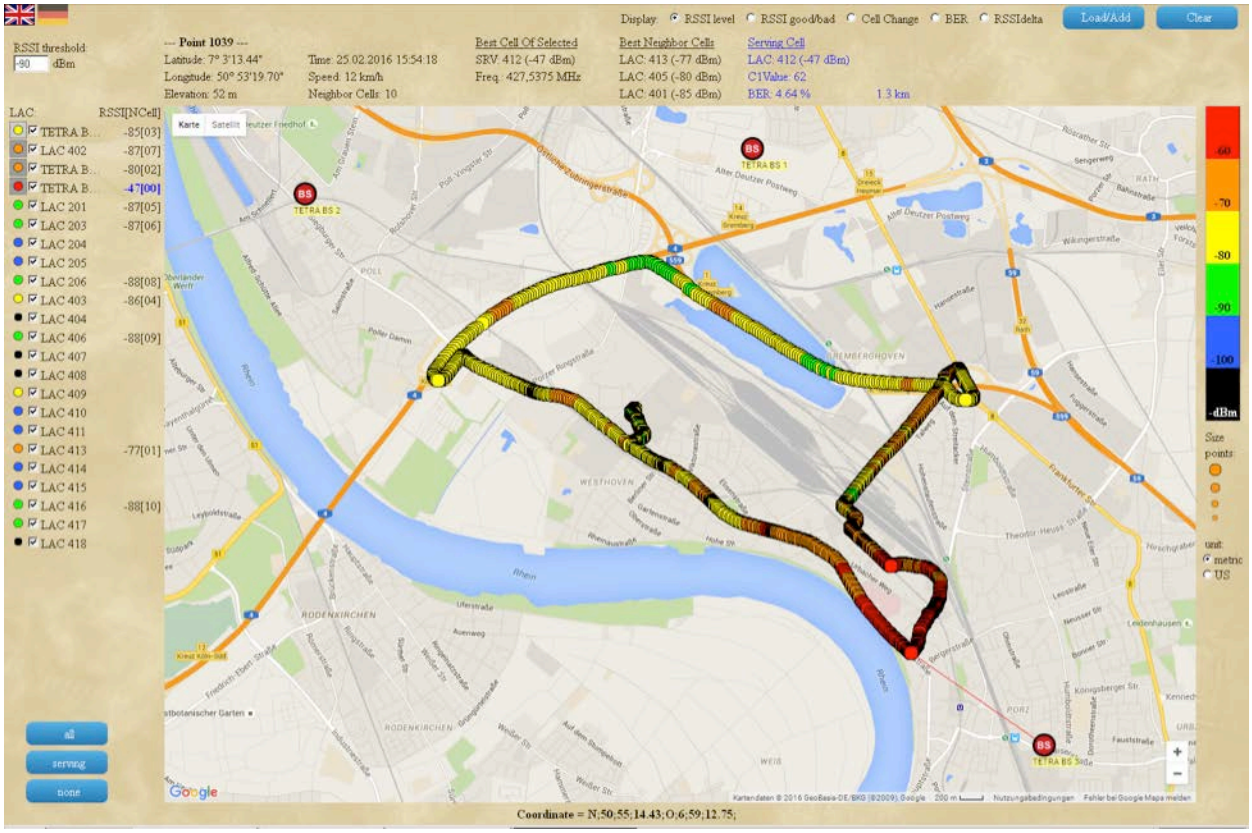
7 CoverMap PC Tool

The visualization of the acquired data is done by separate software. The TTS-2000A package includes the tool “CoverMap”. This opens a web browser and enables the user to load data sets from the CSV-files. Please ensure that you click on “allow blocked content” in the popup in case you have any sort of blocker enabled after loading the data.
Also always ensure that you have the latest CoverMap Version installed. After opening up CoverMap a popup will show you if there are any newer versions including their features. Please always click on “ok” to guarantee the full CoverMap experience.

IMPORTANT: For working with the web-based application, it is recommended to use Firefox.

7.1 Base station coverage analysis/ RSSI Level

Based on this data, each measurement location is displayed as a colored dot. Its color represents the range of field strength that the TTS-2000A evaluated for this location.

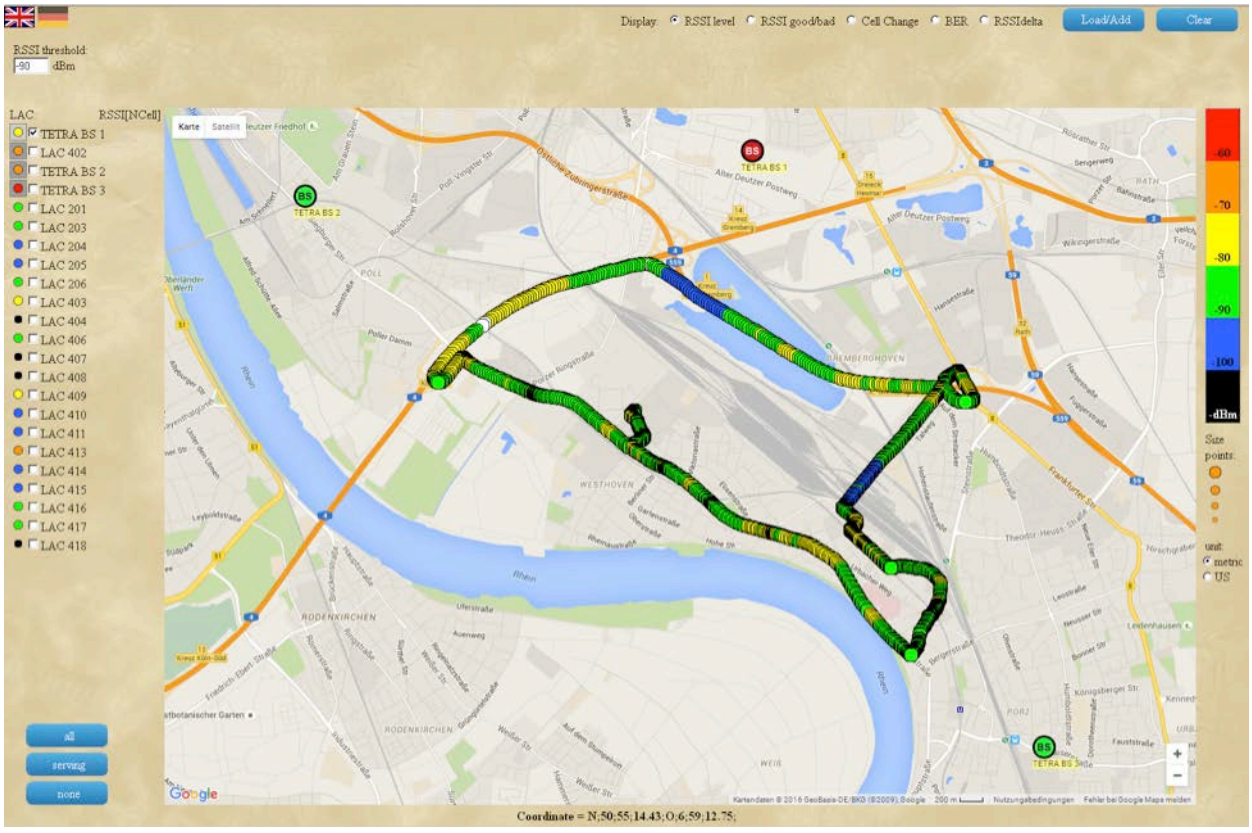


In the picture a real life measurement can be seen. The values were evaluated driving on different kinds of roads with a once per second measurement interval. The different colors correspond to the bar on the right (double click on bar to change from best RSSI red, to best RSSI green) and show the field strength along the track.

If the cursor is moved over a point on the map, all information of this measurement point is shown on top of the map. The user can see a lot of information including a time stamp (which can be very useful when comparing measurements with others), the serving cell including RSSI, BER and C1 Value, the 3 best neighbors including RSSI and also the strongest cell at given point, as the serving cell does not necessarily have to be the strongest cell.

On the left, a list of all base stations measured is presented in the LAC column.
The RSSI[NCell] column shows the RSSI of a selected measurement point in blue and all its neighbors in black. However, if the strongest cell is NOT the serving cell, the user can easily find it, as its RSSI will be visualized in **bold**. The number next to the RSSI level indicates the ranking from best to worst neighbor cell, whereas [00] is always the serving cell and [01-X] are its neighbors.

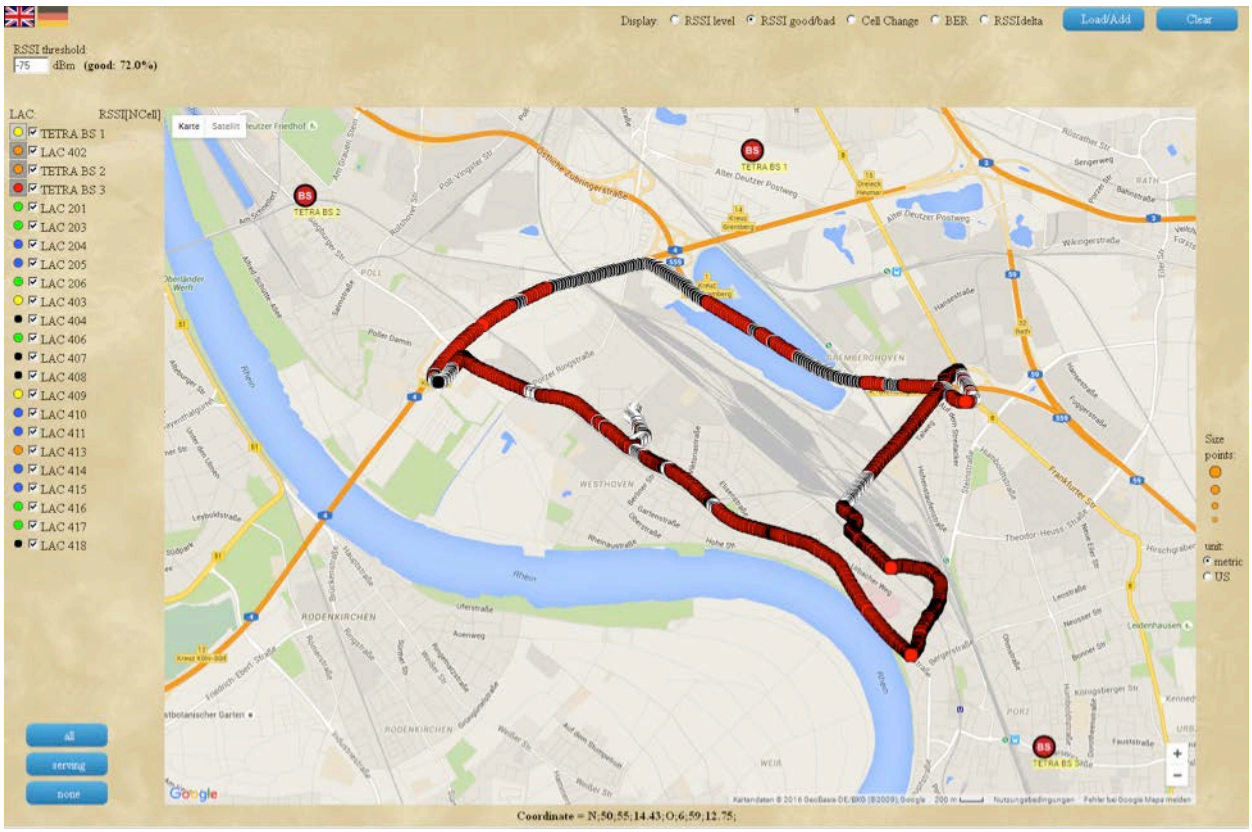
There are 3 different types of squares that could be seen on the left side of the LA (hover over the square with your cursor to get more information on neighbors). A dark grey square (as seen in the picture above) indicates that all neighbor cells were gathered properly. A light grey square indicates that there may be some missing neighbor cells. This usually means that the TTS was not “registered” to that given serving cell long enough to gather all its neighbors. And there is also a red square. This means that there is a cross-check error. A cross-check error shows the user, that there is a certain cell (e.g. LA 1) that does report another cell (e.g. LA 2) but not vice versa. This can lead to problems with cell reselections and should be fixed immediately.
On the right the actual color scheme (double click on it to change from best RSSI red to best RSSI green), the size of the measurement points’ and the used unit system can be found and changed.



A very powerful feature of CoverMap is the possibility of “turning off” Base Stations, by simply unchecking the check box next to the LA one wants to turn off (or click on “none” or “all” to enable or disable all LAs). This means that the user can find out, what would happen to their network, if one or even multiple base stations would fail. Redundancy is of utmost importance in TETRA and the TETRA user should ensure that even if one base station fails, the RSSI and reach of the neighbor base stations is strong enough to cover that area in case of loss. In the picture and example below only one LA is active. This is also an interesting feature to see the reach of each single base station individually.

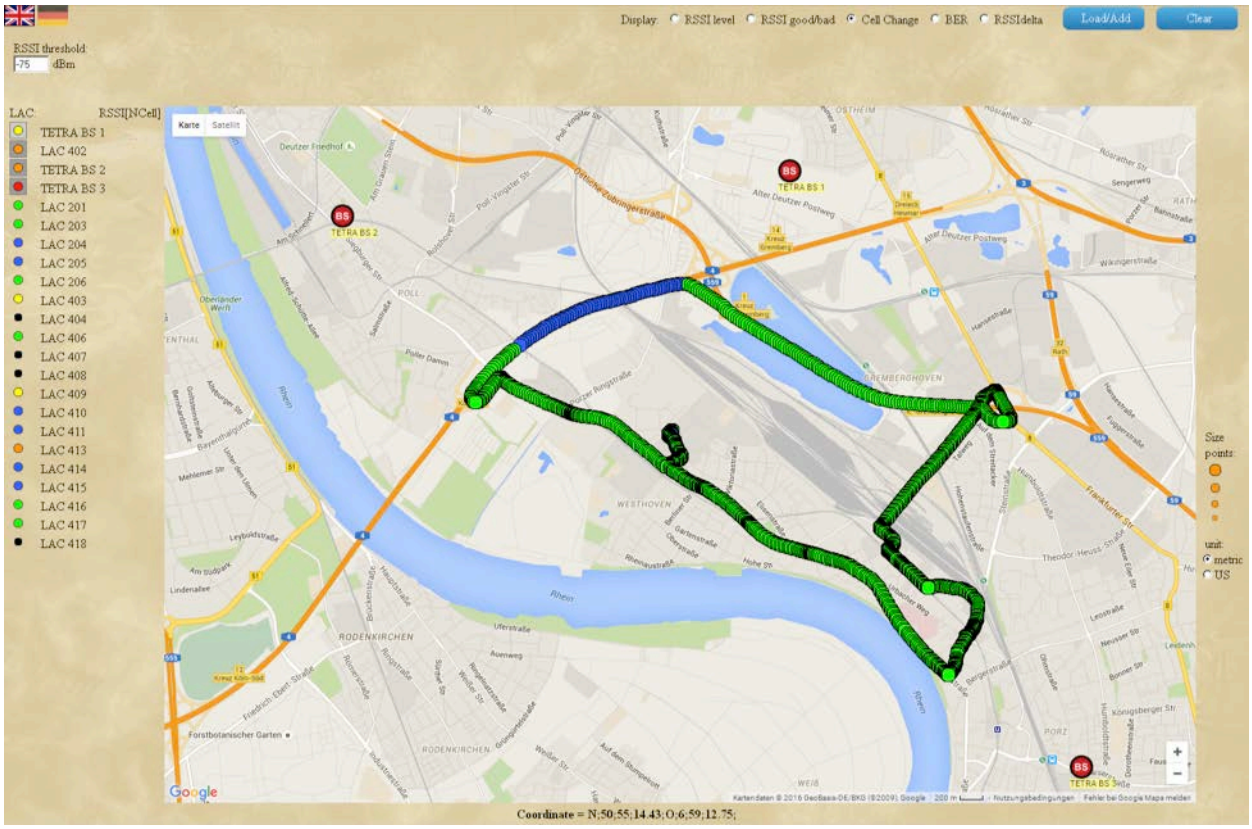
7.2 RSSI analysis/ RSSI good/bad

Another powerful feature of CoverMap is the “RSSI good/bad” feature. Once the user has chosen the tick box next to this feature (in the top menu), the “RSSI threshold” field in the top left corner will appear. Here the user can decide on an RSSI level, which they find acceptable as the worst RSSI in their network and activate it. Once activated CoverMap will evaluate the % of measurement points that were of equal or better value than the chosen RSSI level, and will give the user a good clue on the average field strength in their network. It will also change the color of the measurement points to either red (equal or better value than the threshold) or white (worse than the threshold).



7.3 Cell change analysis/ Show change of serving LAC

A large number of cell changes decreases the performance of the whole network. In the following picture one can see an example for a test drive. The dots are colored in blue and green only. Every time the color of the dots changes, a cell change was performed. If the cell change was not due to a normal cause, a red dot will be displayed. If the cursor is placed over one of these red dots, one can see the cell reselection cause on the upper right side next to the Serving Cell ("reason cell change"). See below for explanation of the different cell changes.



7.3.1 Cell Reselection Decisions

The TTS behaves like a normal TETRA radio in the network and runs the standard TETRA cell reselection decisions. Since it does not transmit then it considers its own maximum transmit power to be the MS Tx Power Max being announced by the current serving cell. This value is used to calculate the C1 value of the serving cell.
The TTS calculates a C2 pathloss value for each of the neighbor cells it is monitoring, this is calculated in a very similar way to C1,
$C2 = RSSI_n – RXLEV\_ACCESS\_MIN\_MCELL - Max(0, MS\_TXPWR\_MAX\_MCELL - P_{ms})$
where:
$RSSI_n$ = the averaged receive signal level at the MS for the neighbor cell
RXLEV_ACCESS_MIN_MCELL = the minimum permissible receive level allowed at the MS in this cell
MS_TXPWR_MAX_MCELL = the maximum MS transmit power permissible in this cell
P_{ms} = the maximum transmit power of the radio. Since the TTS does not normally transmit this value is always assumed to be the same as the MS_TXPWR_MAX_MCELL.

All parameters are in dB.

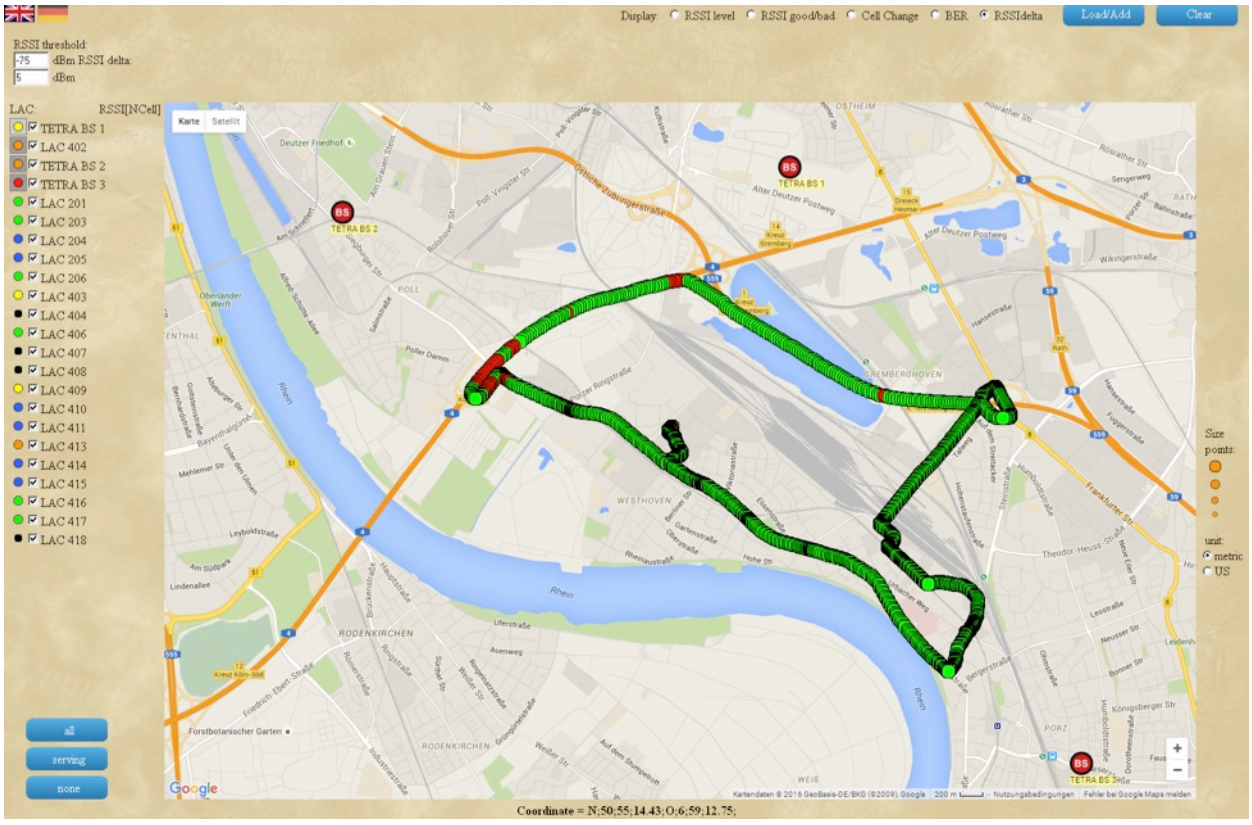
RXLEV_ACCESS_MIN_MCELL and MS_TXPWR_MAX_MCELL for the neighbor cell can be announced in the Neighbor Cell broadcast messages of the current serving cell, but including this information in the messages is optional (and not usual in most TETRA networks). If the TTS does not know these values for each of its neighbor cells the values from the current serving cell (announced in the SYSINFO message) are used in the calculation.
Firstly if the TTS detects a Radio Link Failure condition due to the RDC value going below zero it will immediately perform a cell reselection. It will also immediately perform a cell reselection if the C1 value of the serving cell drops below 0 (i.e. the RSSI has fallen below the RXLEV_ACCESS_MIN allowed by the cell.)
The TTS will only ever perform normal cell reselections using the Slow Reselect Threshold and Slow Reselect Hysteresis parameters since it is never involved in TETRA voice calls and remains in ‘idle’ mode all of the time. This also means it will only ever perform an ‘Undeclared’ cell reselection. A normal TETRA radio would use both the Slow and the Fast parameters, the Fast parameters being used when the radio is in an active voice call.
So in TETRA terms the TTS will perform a normal cell reselection when the serving cell is deemed to be ‘Radio Improvable’. This happens under the following conditions,

1. The serving cell pathloss parameter C1 falls below the Slow Reselect Threshold for a period of 5 seconds.
2. The pathloss parameter C2 of at least one of the neighboring cells being monitored by the TTS exceeds the pathloss parameter C1 of the serving cell by the Slow Reselect Hysteresis value.
3. No cell reselection has taken place within the previous 15 seconds.

If all of the above are true then the TTS will move to the new cell.

7.4 Show difference between best cell and serving cell/ RSSIdelta

The colored dots in CoverMap will always show the best RSSI at that given location. The color will refer to the strongest cell, which is not necessarily the serving cell. Sometimes the user may see that the TTS will not do a cell reselection even though the strongest neighbor has been a lot stronger for a while.
This behavior and the time when the TTS performs a cell reselection is not up to the TTS but to the TETRA network parameters (please see TETRA Network Information in the Main Application). However, users may want to know where in their network the cell reselection was not performed even though it should have performed one according to the network parameters. If so, the user can enter an RSSI delta in the upper left corner of the CoverMap Screen to enter a given value in dBm, which will reflect the difference between the serving cell and the strongest cell.
So if the user will enter 6 dBm in the RSSI Delta field, CoverMap will color all dots green, where the serving cell is stronger than its neighbors or less than 6 dBm weaker. It will color all dots red where the serving cell is more than 6 dBm weaker than its strongest neighbor.



7.5 Base Stations

To enable a more sophisticated network analysis, base stations can be included into CoverMap.
Therefore an additional configuration file needs to be included via the Load/Add button. The file should contain information about one base station in every line.

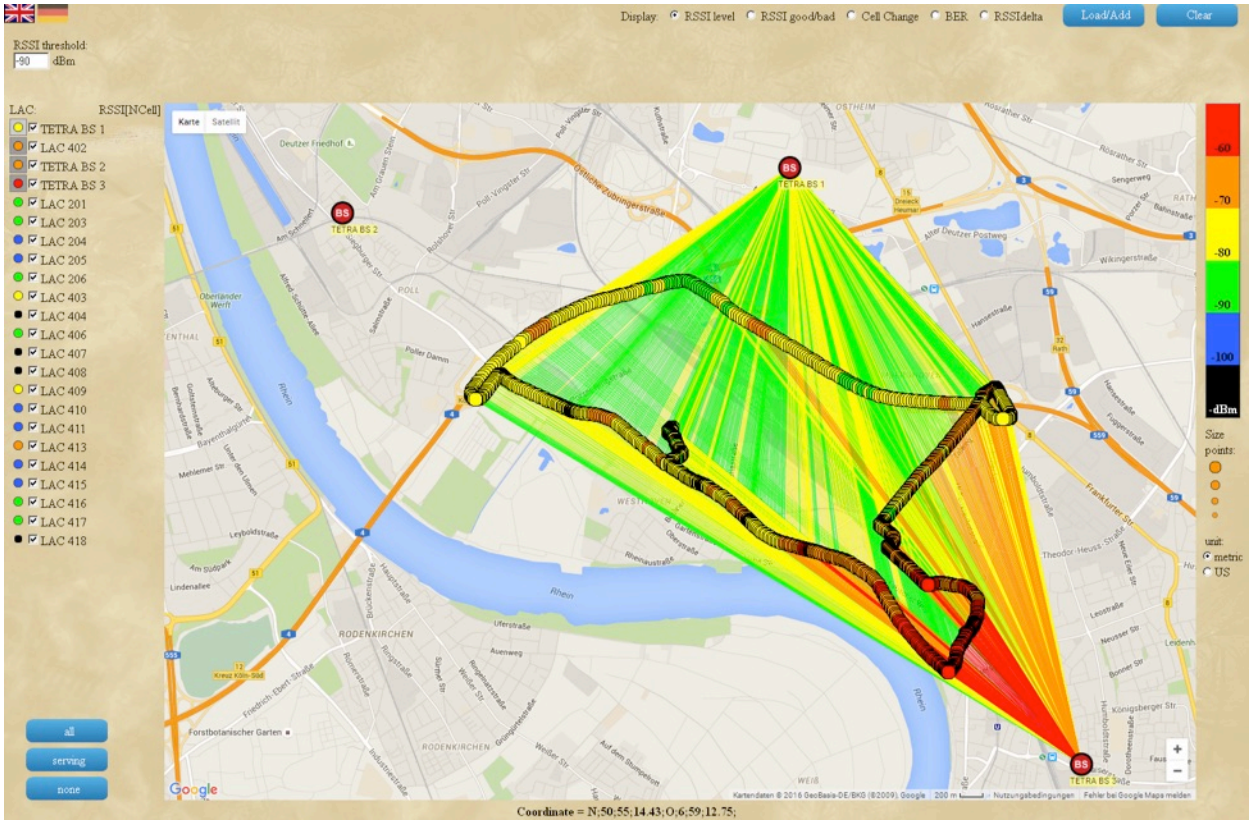
```
Sysinfo;Description;LAC;Frequency;N/S;NSDeg;NSMin;NSSec;E/W;EWDeg;EWMin;EWSec
0_01;My LAC;1234;420.0125;N;51;20;17.19;O;7;33;19.54;
```

Fieldname	Description	Example
Sysinfo	Internal version of the file	Always: 0_01
Description	A full text description of the base station	My LAC
LAC	The LAC number as an unsignd intener	1234
Frequency	The frequency of the base station as unsigned float	420.0125
N/S	Indication the orientation of the latitude	N
NSDeg	Degree of latitude	51
NSMin	Minutes of latitude	20
NSSec	Seconds of latitude as unsigned float	17.19
E/W;EWDeg;EWMin;EWSec;	Same as above for longitude	O;7;33;19.54

CoverMap can also help you to find the right corrodiantes for one of the LACs. Just right click on the desired location, then the coordinates are printed below the map for the user to copy and paste it in the right format.

If the base stations are loaded into CoverMap and the cursor is moved on a measurement point, a beam is shown to the best cell at that given location. If the cursor is moved on the base station, beams to all measurement points that were reported (either serving cell or neighbor) are plotted in the color of the points' RSSI for that base station.
The visualization of the beams can be enabled permanently by clicking on the base stations. It can either be deactivated by another click (for one base station) or by pressing ESC (for all base stations). Multiple base stations can be activted to see an overlay of these two base stations. This can be important when looking at redundancy in a certain area.


Display: RSSI level RSSI good/bad Cell Change BER RSSIdelta
Load/Add
Clear
RSSI threshold:
-90 dBm
LAC: RSSI[NCell]
TETRA BS 1
LAC 402
TETRA BS 2
TETRA BS 3
LAC 201
LAC 203
LAC 204
LAC 205
LAC 206
LAC 403
LAC 404
LAC 406
LAC 407
LAC 408
LAC 409
LAC 410
LAC 411
LAC 413
LAC 414
LAC 415
LAC 416
LAC 417
LAC 418
Karte Satellit
-60
-70
-80
-90
-100
-dBm
Size points:
unit: metric US
all
serving
none
Coordinate = N;50;55;14.43;O;6;59;12.75;


Display: RSSI level RSSI good/bad Cell Change BER RSSIdelta
Load/Add
Clear
RSSI threshold:
-90 dBm
LAC: RSSI[NCell]
TETRA BS 1
LAC 402
TETRA BS 2
TETRA BS 3
LAC 201
LAC 203
LAC 204
LAC 205
LAC 206
LAC 403
LAC 404
LAC 406
LAC 407
LAC 408
LAC 409
LAC 410
LAC 411
LAC 413
LAC 414
LAC 415
LAC 416
LAC 417
LAC 418
Karte Satellit
-60
-70
-80
-90
-100
-dBm
Size points:
unit: metric US
all
serving
none
Coordinate = N;50;55;14.43;O;6;59;12.75;

8 TTS-2000S Scanner App functions

8.1 iPad screens

The TTS-2000S app is a network scanner for TETRA networks. It is used to scan a whole band (or parts of it) for TETRA carriers and tries to identify them. Therefore the TTS tries to decode the SYSINFO message of every carrier to identify the network. If encrypted broadcasts are used, only the MNC, MCC and the frequencies can be evaluated. Human readable text can be imported into the app for a faster recognition of the carriers found. Different networks with be in different colors for easier recognition.
After startup, the app starts to scan the given band continuously and prints the results in the app instantly.

There are five screens available in the TTS-2000S App:

- The main screen / Scan
- The monitoring screen / Monitor
- The network parameters screen / Network Information
- TETRA Scan Parameters and Antenna Gain / TETRA Settings
- Recording Screen / Monitor Data

There is also a section in the iPad settings for the basic TTS-2000S app configuration.

The TTS-2000S app is not included in the standard delivery, please contact sp@piciorgros.com for more information and pricing.

8.1.1 The main screen / Scan

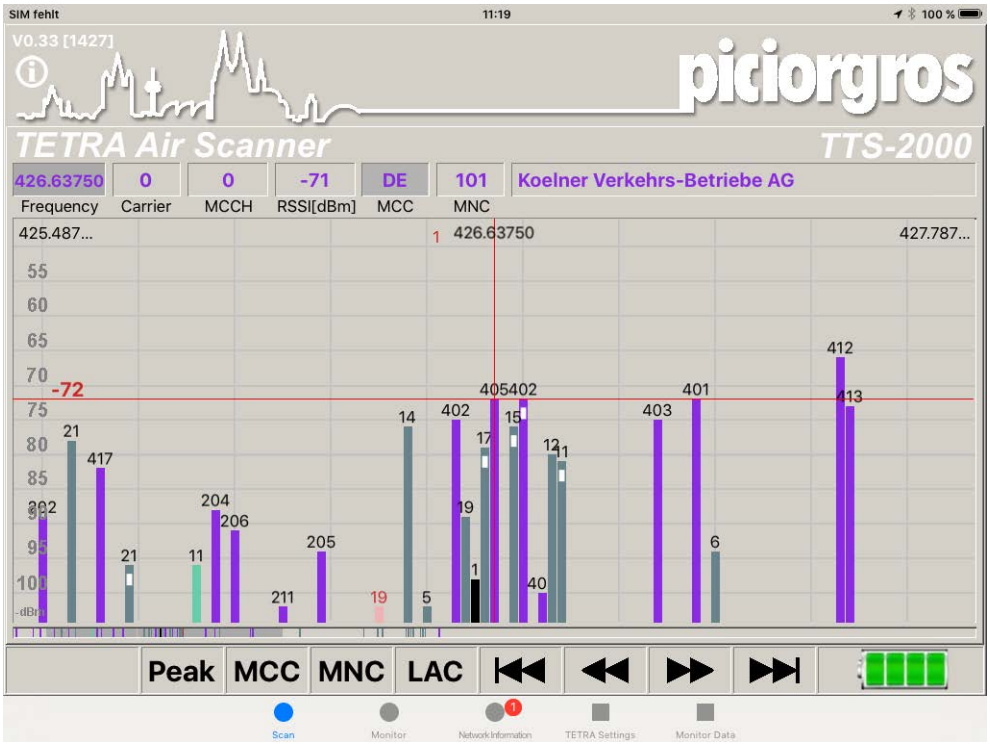
The main screen is the operating screen for scanning operations.

Important:
The street traffic must always focus your attention! If the driver observes the iPad, they should only do so if the car is parked.
We, the Funk-Electronic Piciorgros GmbH are not responsible for any harm or damage caused by using the TTS-2000A in cars, in other vehicles or while walking.

8.1.1.1 Head line

The headline contains detailed information about the results of the scan depending if a carrier is highlighted or not.

Channel/Frequency
If no carrier is selected this field indicated the channel at which the TTS is currently scanning the network. The user can click on the dark grey field to change the channel to the frequency.
If one carrier is selected, this field will show the channel number or frequency of this given carrier (see image below).



Carrier
This value indicates either all carriers found (if no carrier is selected) or the number of carriers of a given network (one carrier highlighted).

MCCH
This field shows the amount of MCCH (Main Control Channel) found during the entire search or (if one carrier is selected) of the selected network.

RSSI[dBm]
The receiving power of the highlighted carrier

MCC
This shows the mobile country code of the highlighted carrier. The user can click on this dark grey field to change the number into the country code as seen above. DE (for Germany) instead of 262.

MNC
The same as the MCC only for the Mobile Network Code. If a valid network file is loaded, a full name as well as the MNC is visualized.

The bar diagram visualizes all detected carriers. The displayed bandwidth can be moved from left to right (the lower to the upper bound of the band).
A thin red line indicates a highlighted channel/carrier. Touching them can highlight the carrier.

8.1.1.2 Bottom line

The buttons in this line can be used to navigate through the scanning results and to filter.

Peak
Center the screen on the best carrier, highlight it and draw a horizontal line indicating the strongest receiving power. The word Peak will turn green once selected.

MCC
If a carrier is highlighted, all carriers without this MCC can be dimmed (green) or all carriers with this MCC can be dimmed (red). The fields in the top menu bar will also change accordingly. They will only show the Carriers and MCCHs of the selected filter.

MNC
If a carrier is highlighted, all carriers with another MNC can be dimmed (green) or all carriers with this MNC can be dimmed (red). The fields in the top menu bar will also change accordingly. They will only show the Carriers and MCCHs of the selected filter.

LAC
If a carrier is highlighted, all carriers with another LA can be dimmed (green) or all carriers with this LA can be dimmed (red). This can show the user how many different carriers that one selected LA has. The fields in the top menu bar will also change accordingly. They will only show the Carriers and MCCHs of the selected filter.

The user can also select more than one of the mentioned filters. If MCC and MNC are selected for example, only the carriers with the same MCC AND MNC will be highlighted.

Navigation Buttons
The buttons can be used to navigate through the results, either step by step or jump to the beginning/end.

8.1.2 The Monitor screen / Monitor

The monitor screen is used to display the results of a long-term scan. For all carriers, the minimum and maximum signal strength is shown with the difference in red.

Channel/Frequency
If no carrier is selected nothing will be shown in this field. If one carrier is selected, this field will show the channel number or frequency of this given carrier (see image below). The user can click on the dark grey field to change the channel to the frequency.

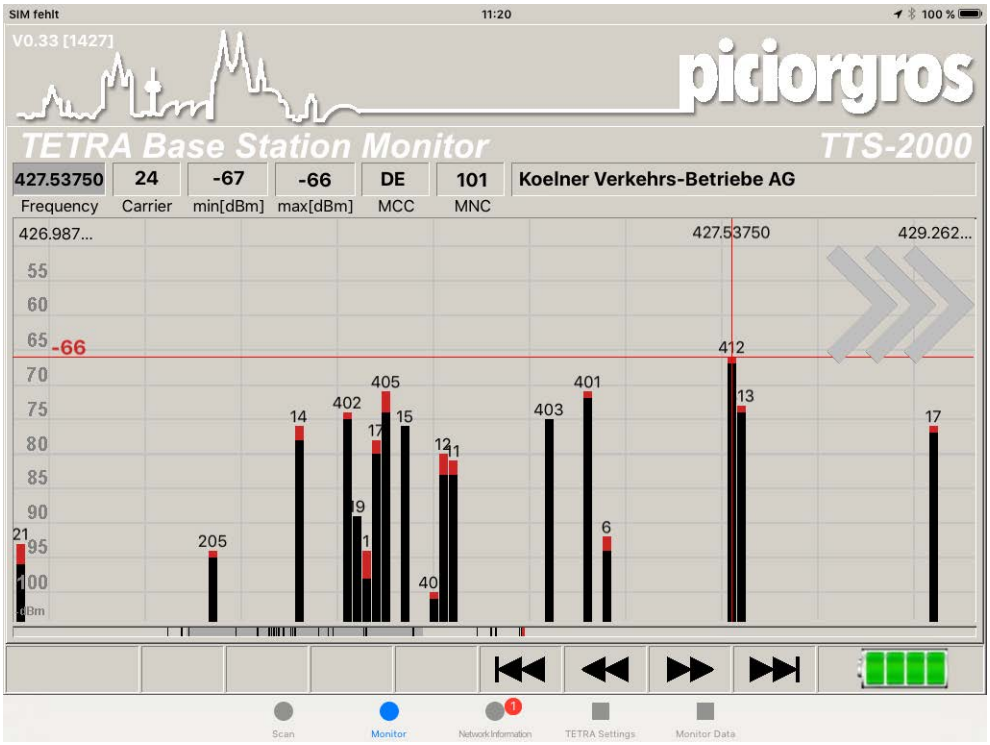
Carrier
This value indicates either all carriers found (if no carrier is selected) or the number of carriers of a given LA (one carrier highlighted).

Min[dBm]
The value in this field will show the minimum field strength recorded for the selected carrier over a period of time.

Max[dBm]
The value in this field will show the maximum field strength recorded for the selected carrier over a period of time.

MCC
This shows the mobile country code of the highlighted carrier.

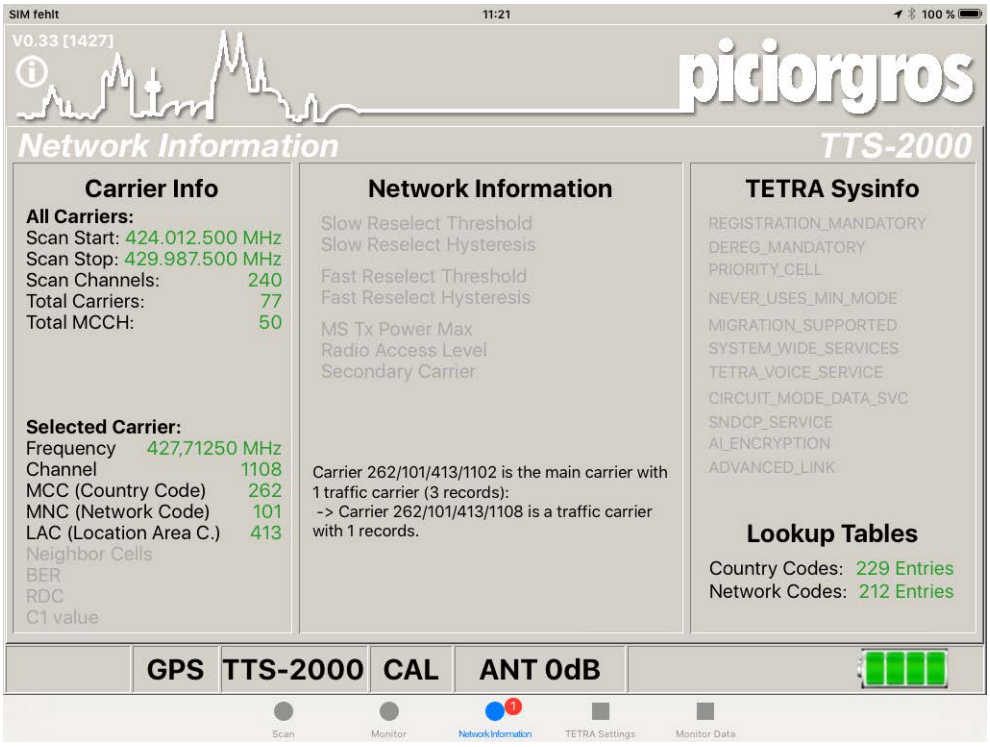
MNC
The same as the MCC only for the Mobile Network Code.



Navigation Buttons
The buttons can be used to navigate through the results, either step by step or jump to the beginning/end.

8.1.3 The network parameter screen / Network Information

The network information screen is very similar to the network information screen of the Drive App. Please refer to **Chapter 5.3** for further information. The information that the scanner app can gather will be shown in green, the other information will be greyed out.



The Lookup Tables are used by the app to convert the numeric MCC and MNC values to human readable strings. They can be imported via email.
Format definition for MCC/MNC CSV lists:

MNC lists:
`MCC;MNC;Network;Color`
Each line contains the Mobile Country Code (unsigned integer), the Mobile Network code (unsigned integer), the human readable name of the network (string) and optional color code for the visualization (three hexadecimal bytes RGB).

Example:
`262;101;Koelner Verkehrs-Betriebe AG;8A2BE2`

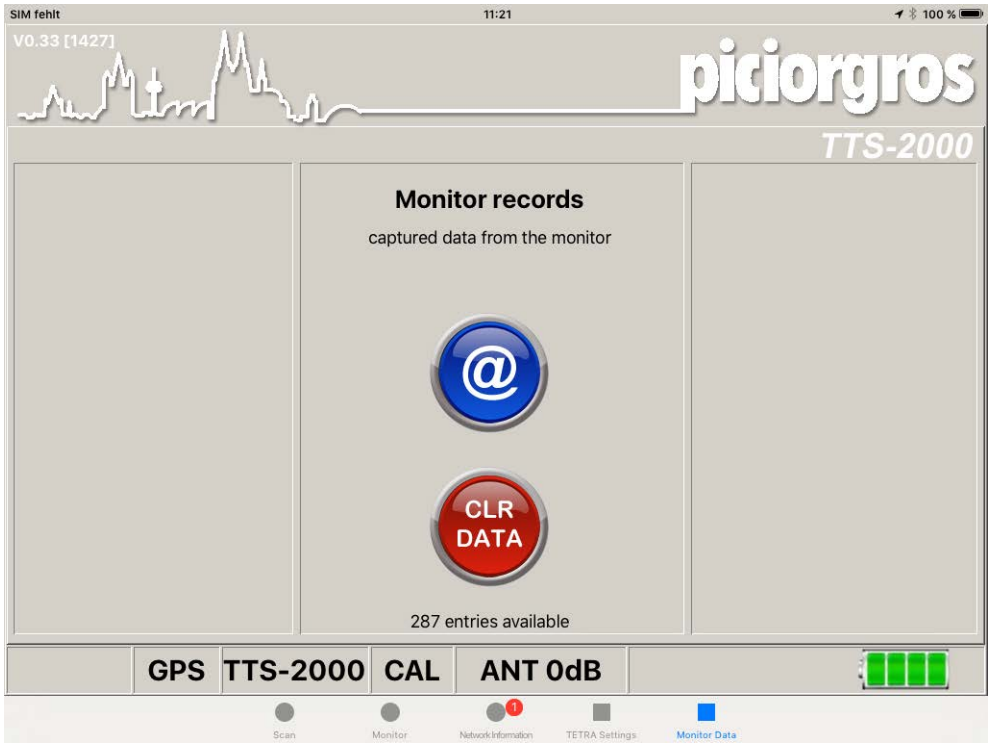
MCC lists:
`MCC;Country`
Each line contains the Mobile Country Code (unsigned integer) and the human readable name of the country (two character string).

Example
`262;DE`

8.1.4 TETRA Scan Parameters and Antenna Gain / TETRA Settings

Please refer to the TETRA Settings chapter for the Drive Application (**chapter 5.4**).

8.1.5 Recording Screen / Monitor Data



In this menu the user can record their data over time. They can leave the TTS-2000A at one location and send the data after a while. This could be interesting to see if there are major changes to the carriers' RSSIs over a day, week or even longer.

Please be aware that this data can only be viewed in a csv format and that there is no software like CoverMap to look at the data in the aftermath.

9 TTS-2000M Manual App functions

9.1 iPad screens

The TTS-2000M app is a manual coverage analyzer for TETRA networks. It is intended to be used in areas without GPS coverage (indoor) or in combination with self-created maps. The measurements are organized by projects. Each project contains of a picture or map and the manually added measurements.
The results can be exported as a screenshot with the underlying picture or as a csv file to open up with Excel or CoverMaps.

There are four screens available in the TTS-2000S App:

- The project screen /home
- The main screen / Manual
- The network parameters screen / Network Information (see **Chapter 5.3**)
- The TETRA Settings screen / TETRA Settings (See **Chapter 5.4**)

There is also a section in the iPad settings for the basic TTS-2000M app configuration.

The TTS-2000M app is not included in the standard package please contact sp@piciorgros.com for a quotation.

9.1.1 The project screen / Home

The home screen with the project selection is shown after start up. One can either open an existing project or add a new one.
Adding a new project requires the input of the project's name and the background image. Please ensure that the background image is part of your iPad's picture gallery before creating the project.

9.1.2 The main screen / Manual

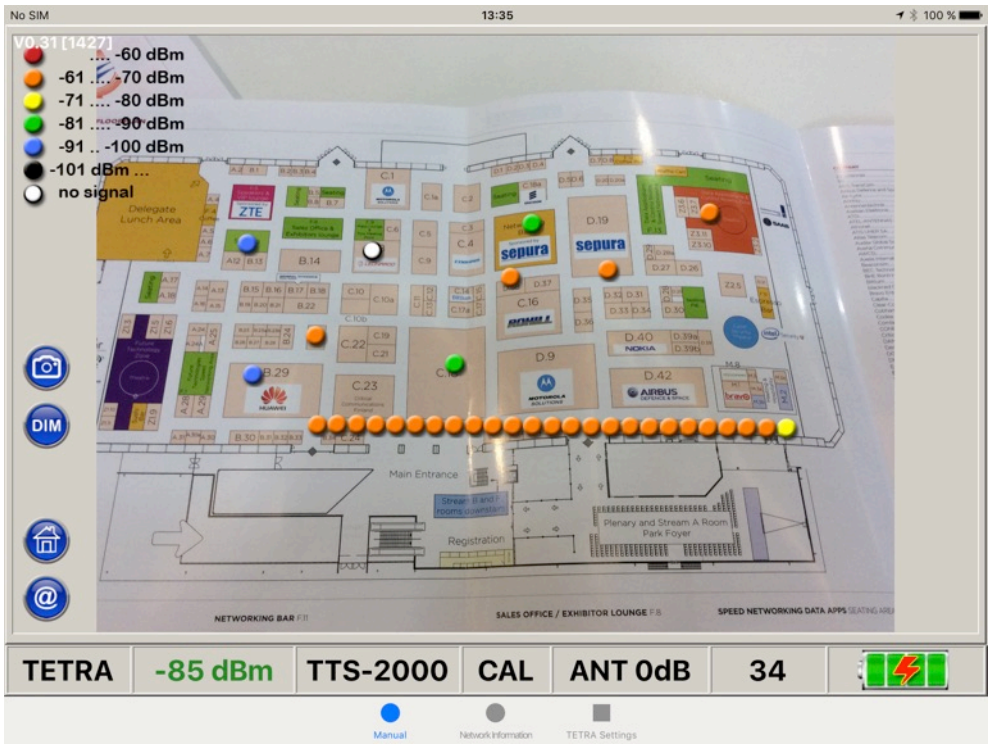
The main screen is the operating screen for manual operations.

Important:
The street traffic must always focus your attention! If the drivers observe the iPad, they should only do so if the car is parked.
We, the Funk-Electronic Piciorgros GmbH are not responsible for any harm or damage caused by using the TTS-2000A in cars, in other vehicles or while walking.

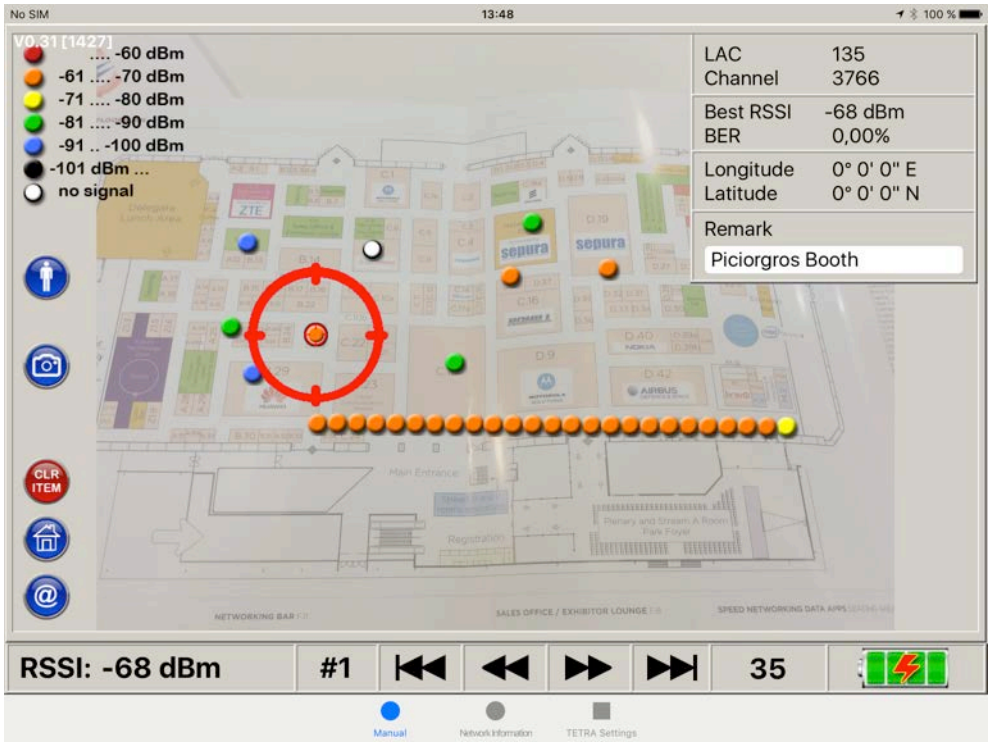
If the TTS is connected to the TETRA Network (indicated by a black word TETRA in the status line). The color scheme for the measurement points can be seen in the top left corner. A colored dot shows the position of the measurement. Touching the screen at the given location and holding it for one second create these dots. If the iPad is not muted, one can hear a "beep" tone once the measurement point has been placed. The background image can be zoomed to ensure a more accurate placement of measurement points. In case the user decides to take a longer walk with the TTS manual app, they do not have to click and place a dot every time, they can also start a series of measurements and start walking. To start this series, one has to place a measurement point at the starting position and keep their finger on the screen until a double beep can be heard and/or until the hairline cross turns red. The user can then walk a straight line in a steady pace until the ending pint of the series. They then have to touch the screen at the wanted ending point until the series is displayed on the screen. A point or series of points can be deleted by clicking on it/them and then clicking on the "CLR ITEM" button that will appear on the left side of the App.

On the left hand side, four icons are shown.

Camera Symbol	Export a screenshot of the current measurement to the iPad's Photos
DIM	Dimming of the background map to highlight the measurements
Home	Jump to the projects page
@	Export the data via eMail.



The status bar has the same functionality as in the TTS-2000C app, please refer to **chapter 5** for further details.



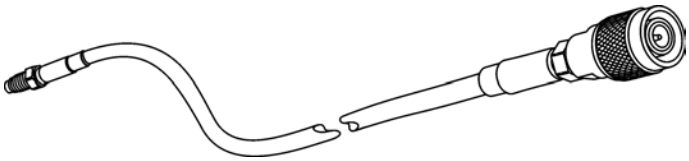
Once a measurement point has been selected, the user can also hop through the individual points by using the arrow buttons in the lower part of the app that will appear, once a point is selected. The user can also give individual points a remark or name, to make it easier to find them in a csv file later. In our case, the point was called “Piciorgros Booth”.

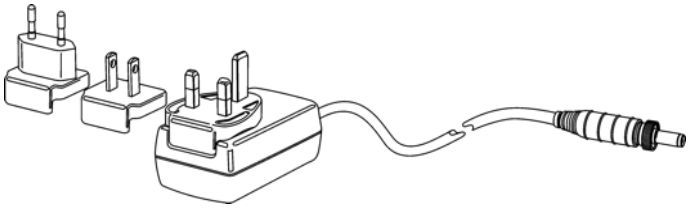
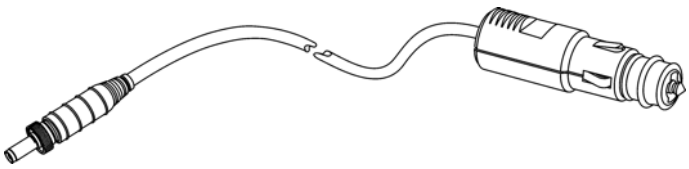
Once the user is done with their in-door measurements they can export the data by clicking on the “@” button. An Email will be created and sent including the initial image (map), an image of the screen last seen on the iPad before sending it out, and the csv File for further processing.

CoverMap can also be used to visualize the manual Measurements. However, as most of the time there was no GPS data where the Manual App was used, CoverMap needs the initial image to lead the measurement points into CoverMap into the image. That image has to be saved under c://Covermap where the Software will search for the background picture. Once it is placed and once the data was added to CoverMap the user can use almost all features as described in **chapter 7**.

10 Spare Parts and Follow Up Orders

Antenna only (without Magnetic Mount) Please make sure you specify the frequency band when ordering a new antenna Order Number: 3-100-200-98		
Magnetic Mount This order number is for the magnetic mount only Order Number: 3-100-200-99		
Antenna with Magnetic Mount 800MHz For the 800MHz frequency bands, you can only reorder the package of antenna and magnetic mount Order Number: 3-100-200-97		

Low Loss Antenna Cable including TNC Connector FME-RG58-TNC Length: 5m (Can be ordered in different lengths, please contact us for more information) Order Number: 3-100-200-70		
Low Loss Antenna Cable without TNC Connector FME-RG58-FME Length: 5m (Can be ordered in different lengths, please contact us for more information) Order Number: 3-100-200-95		
Antenna Connector TNC-FME Order Number: 3-600-550-02		

Power Supply Including plug for UK, US and EU Order Number: 3-100-200-60		
Power Supply for Car Cigarette Lighter Order Number: 3-100-200-50		

11 Specifications

Functions:	• Compact and mobile TETRA test set for analysis of TETRA network availability and coverage • Data display and acquisition using iPad Mini (included) • Data export to external applications in open .csv format (readable text)
Available frequency ranges:	Band 0: 350 MHz - 370 MHz Band 1: 370 MHz - 400 MHz Band 2: 400 MHz - 430 MHz Band 3: 450 MHz - 470 MHz Band 10: 806 MHz - 869 MHz
GPS receiver	Location and time based information, taken from the iPad
RF field strength indication:	RSSI value of the registered cell and neighbor cells on the iPad screen
RF Conformance EMC Conformance ESD Conformance	EN 300 394-1 EN 301 489-1 and -18 61000-4-2
Power supply voltage:	12-24 VDC +/- 20%
Duration of the built-in Battery	Up to 4 hours
Enclosure:	crushproof and dust proof PeliCase enclosure
Temperature:	0°C to +50°C (depending on the touch screen specifications)
Dimensions:	232mm x 192mm x 111mm