Willtek

User's Guide

2303 Stabilock

TETRA Mobile Station Tester

Firmware version 1.50

boosting wireless efficiency

Notice

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Ordering information

This guide is issued as part of the 2303 Stabilock. The ordering number for a published guide is M 290 002. The ordering number for the product is M 100 203.

For remote control of the 2303 Stabilock, please also refer to the SCPI Reference Manual, ordering number M 293 002.

Table of Contents

About This Guide

Purpose and scope

The purpose of this guide is to help you successfully use the 2303 Stabilock features and capabilities. This guide includes task-based instructions that describe how to configure, use, and troubleshoot the 2303 Stabilock. Additionally, this guide provides a description of Willtek's warranty, services, and repair information, including terms and conditions of the licensing agreement.

Assumptions

This guide is intended for novice, intermediate, and experienced users who want to use the 2303 Stabilock effectively and efficiently. We are assuming that you have basic computer and mouse/track ball experience and are familiar with basic telecommunication concepts and terminology.

Related information

Use this guide in conjunction with the following information:

2303 Stabilock getting started manual, ordering number M 295 002

2303 Stabilock SCPI reference manual, ordering number M 293 002

Technical assistance

If you need assistance or have questions related to the use of this product, call Willtek's support. You can also contact Willtek by e-mail at customer.support@willtek.com.

Table 1 Technical support contact

Region	Phone number	Fax number
Europe, Middle East, Asia, Africa	+49 (0)89 99641 311	+49 (0)89 99641 440
Americas	+1 973 386 9696	+1 973 386 9191
China	+86 21 5836 6669	+86 21 5835 5238

Conventions

This guide uses naming conventions and symbols, as described in the following tables.

Table 2 Typographical conventions

Description	Example
User interface actions appear in this **typeface**.	On the Status bar, click **Start**.
Buttons or switches that you press on a unit appear in this **TYPEFACE**.	Press the **ON** switch.
Code and output messages appear in this `typeface`.	`All results okay`
Text you must type exactly as shown appears in this **`type-face`**.	Type: **`a:\set.exe`** in the dialog box.
Variables appear in this <type-face>.	Type the new <hostname>.
Book references appear in this typeface.	Refer to Newton's Telecom Dictionary
A vertical bar | means "or": only one option can appear in a single command.	`platform [a|b|e]`
Square brackets [ ] indicate an optional argument.	`login [platform name]`
Slanted brackets < > group required arguments.	<`password`>

Table 3 Keyboard and menu conventions

Description	Example
A plus sign + indicates simultaneous keystrokes.	Press **Ctrl+s**
A comma indicates consecutive keystrokes.	Press **Alt+f,s**
A slanted bracket indicates choosing a submenu from menu.	On the menu bar, click **Start > Program Files**.

Table 4 Symbol conventions

This symbol represents a general hazard.

This symbol represents a risk of electrical shock.

NOTE

This symbol represents a note indicating related information or tip.

Table 5 Safety definitions

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Safety Notes

This chapter provides the safety notes for the 2303 Stabilock. Topics discussed in this chapter include the following:

Safety class

For the safety class of your 2303 Stabilock, please refer to the Getting Started Manual that was delivered with your 2303 both as a hardcopy and as a PDF file on a CD.

Safety warnings

This product is designed for indoor use. As exposure to water may damage the instrument it has to be protected against moisture when used outdoors.

WARNING

Only use a 50 Ω N-type connector to connect to the RF IN/OUT port of the 2303 Stabilock. Use of any other connector may result in damage of the instrument.

WARNING

Do not cover the ventilation slits (on the left and right-hand side of the instrument). Covering them may result in serious damage and fire.

WARNING

The maximum input power level at the RF IN/OUT connector is 10 W continuous level, or 20 W burst TETRA signal. Higher input levels may result in serious damage of the instrument.

WARNING

Operate the instrument within the temperature range from 5°C (40°F) to 45°C (110°F) only. Operation outside this range will lead to invalid results.

Safety advice for the battery module

Do not crush. Do not heat or incinerate. Do not short-circuit. Do not dismantle. Do not immerse in any liquid, it may vent or rupture! Do not charge below 0°C (32°F) nor above 45°C (110°F).

Battery module usage

The battery module is for use with the 2303 Stabilock and the 9100 Handheld Spectrum Analyzer Series only. Willtek does not accept any liability for damage of the battery or other equipment if the battery module is used with other electric or electronic equipment.

Overview

1

This chapter provides a general description of the 2303 Stabilock. Topics discussed in this chapter include the following:

About the 2303 Stabilock

Regular testing of TETRA phones ensures safe and reliable communication: In critical situations, users in the public safety and security sector fully rely on their communication devices. To help organizations such as police, firefighters and paramedics provide maximum safety and reliability to their users, Willtek designed the 2303 Stabilock. It is the first TETRA mobile station tester which is specifically made for testing TETRA mobile stations in a service environment. Service managers can now use the affordable instrument to ensure that the radios are fully operational; this is particularly important for the police, firefighters and paramedics where lives may depend on proper communication tools!

The 2303 Stabilock delivers precise results the fast way. No matter if Trunked Mode or Direct Mode (optional), 400 or 800 MHz band: After setting up network parameters and frequency range the tester is ready for operation. The high contrast 6.5'' TFT color display is split into four sections for clear reading of test results in numeric or graphic format. All settings and commands are accessible via six softkeys or with one-hand operation using the turn-and-push dial. Reducing TETRA complexity to what is really needed in service – with this operational concept, users can operate the instrument easily with a few keypresses on the Stabilock's high-quality click-type keyboard.

Features and capabilities

General features

- Supports TETRA mobile station tests relevant for service
- Intuitive and failsafe user interface
- Made for the PMR service environment
- Bright screen and robust case
- Portable, lightweight and compact
- Optional battery operation
- Proven Stabilock® quality and precision with a 50-year tradition

Transmitter measurements

- RF power
- Carrier frequency offset
- Burst power profile over time
- Timing error
- Residual carrier power
- Unwanted output power
- Error vector magnitude (RMS, peak)
- Modulation spectrum
- Constellation diagram

Receiver measurements

- Single ended BER (bit error rate)
- Loopback BER
- Paging sensitivity

Options and accessories

2330 DMO Option: Expand testing capabilities to TETRA Direct Mode Operation

With the 2330 DMO Option installed, the 2303 Stabilock also understands and analyzes the TETRA DMO protocol for direct communication between two TETRA mobile stations.

2331 Autotest Option: Efficient and time-saving checks through automated tests

Willtek offers a set of automatic test capabilities for the 2303 Stabilock. The 2331 Autotest Option allows to run typical test sequences automatically on the instrument. So you can run tests with the mere push of a button!

2360 OCXO Option: Increasing frequency accuracy

TETRA mobile stations are usually running a reliable AFC (Automatic Frequency Correction) to match frequency offset to the base station. For tests on mobile stations which do not have this feature, Willtek offers the 2360 OCXO Option to make the reference frequency of the 2303 Stabilock ten times more accurate.

2361 Battery Option: Becoming independent from mains power

No need to spend time dismounting mobile stations installed into vehicles: Take the tester on the road with the 2361 Battery Option! Using the high-capacity Li-Ion type battery, the 2303 Stabilock becomes independent from

other power sources for about two hours. And with accessories like the desk charger and extra batteries, engineers are always prepared for a quick emergency mission.

1500 Battery Charger

The desktop charger allows you to recharge a battery while operating the 2303 Stabilock with another battery. This way, your 2303 will always be ready for use in the field!

4914 Antenna Coupler

The Willtek 4914 Antenna Coupler makes testing of TETRA terminals easier. Where technicians previously had to move around many RF adapters (radio frequency adapters) for different types of TETRA mobile stations, they now can simply place the unit under test on the 4914 Antenna Coupler, adjust the shuttle to a predefined position and start the test. Using a coupling device with an antenna has the additional advantage of including the antenna in the test whereas individual adapters are often connected in place of the antenna or with a connector that bypasses the antenna. The 4914 is designed for the frequency range from 350 to 495 MHz. For higher frequencies, the 4916 Antenna Coupler is the right choice.

Instrument Setup and General Operation

2

This chapter describes how the instrument and measurement parameters are set up. Topics discussed in this chapter are as follows:

Starting the instrument

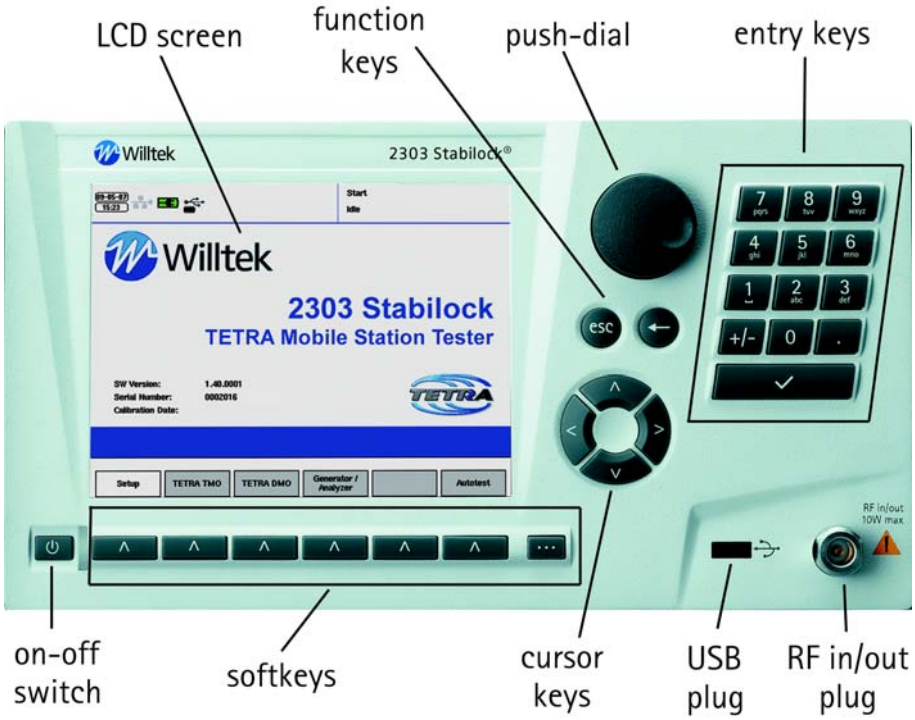
Please read the Getting Started manual for the 2303 Stabilock to learn how to power up the 2303. Once the firmware is booted, the Welcome menu appears (see below). Explanations in this user's guide typically start from this Welcome menu.

For a general description of the front panel elements and how to navigate the menus, see section "Basic concepts of operation" below. See also "Connecting the device under test" on page 11 to learn different possibilities how to connect TETRA mobile stations to the 2303 Stabilock.

Basic concepts of operation

The 2303 Stabilock can be operated either through the front panel or via remote control. The latter allows automation of test sequences and is explained in more detail in Chapter 6 "Automation Through Remote Control".

In manual mode, the 2303 Stabilock is operated through the front panel elements. The basic elements and functions are explained in the Getting Started Manual.



Menus and softkeys

The most important elements are the menus displayed on the LCD screen, and the six softkeys below the screen. The screen always displays a menu with either input fields or results or both, and a description of the current functions of each of the six softkeys.

Depending on the current description of the softkeys, each softkey starts or stops a function, provides access to parameters or changes to a new menu.

While you can go to a new menu level by pressing a softkey, you can return to the next lower menu level with the **ESC** function key.

Some menus contain more than six softkey functions. In such a case, the right-most one displays "1/2" or "2/2" on top of the softkey description. Press the **...** key to move to get access to the remaining softkey functions.

Entry fields

Most menus contain one or more entry fields where you can change test or control parameters. At any stage, the 2303 Stabilock is in one of two modes: the menu mode (where you can select an entry field or move to a different menu) and the entry mode (where the 2303 Stabilock is ready to accept your input for a parameter field).

In menu mode, you can move between the entry fields with the cursor keys (**RIGHT** or **DOWN** key to jump to the next entry field, or **LEFT** or **UP** key to jump to the previous entry field). The entry field currently selected is high-lighted.

NOTE

The softkeys are also treated as entry fields, i.e. a softkey may be highlighted and selected instead of a normal entry field.

Entry mode is selected by either pressing the **ENTER** key [✓] or the push-dial, or by pressing one of the entry keys directly.

In entry mode, you can either enter numerical values or alphanumerical values, or select an entry from a defined list (list field). What you can actually enter here, depends on the type of input field.

- Numerical input fields allow you to enter a new numerical value using the entry keys, or change the value currently displayed with the cursor keys or the push-dial.
- Alphanumerical input fields allow you to enter new text using the entry keys. Press an entry key repeatedly to select the desired letter. Alternatively, you can use the push-dial to enter text. While in entry mode, turning the push-dial results in a vertical list of characters appearing on the right-hand side. Scroll up or down with the push-dial to select a character, then wait three seconds to accept the selection. The **...** key allows you to toggle between lowercase, uppercase and additional symbols.
- List fields allow you to scroll through the list with either the cursor keys or the push-dial.

A numerical or alphanumerical input can be undone by pressing the **BACKSPACE** key [←]. The character before the current cursor position is deleted.

To close an input field and accept the selected input, press the **ENTER** key or the push-dial.

To close an input field and return to the previous input, press the **ESC** key.

Symbols used on the display

In the top-left corner, there are one or more symbols displaying the current instrument status. The symbols and their meaning are as follows:

Table 1 Symbols used in the 2303 menus

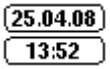
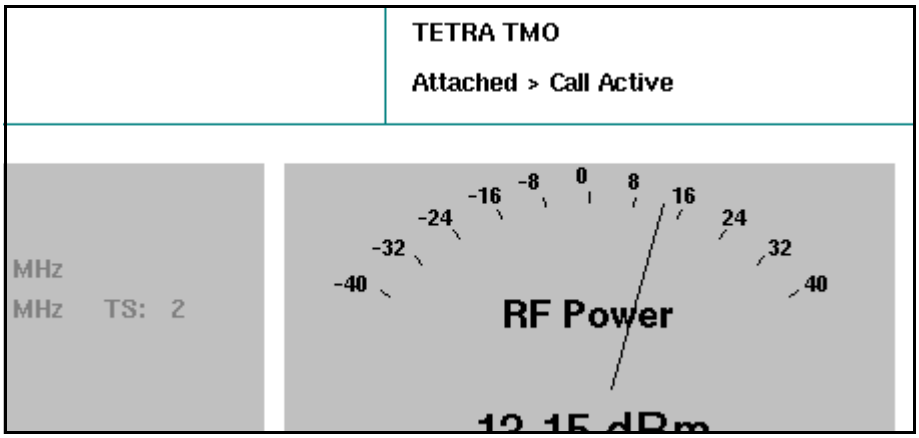
	Time and date. For date format and the displayed date and time, see sections "Setting the date format" on page 33 and "Setting the date and time" on page 34.
	Not connected to LAN. See section "Connecting the instrument to the LAN" on page 26 for more details.
	Connected to LAN. See section "Connecting the instrument to the LAN" on page 26 for more details.

Table 1 Symbols used in the 2303 menus (Continued)

	Operating from the battery, with indication of charging level.
	
	Connected to external power supply, battery fully loaded.
	Connected to external power supply, loading battery.
	Connected to external power supply, no battery installed.
	The mobile station is probably coupled with the test instrument via an antenna (a TX coupling factor of more than 3 dB has been set).
	USB flash drive connected. If there is more than one USB flash drive connected, the symbol will also indicate the number. See section "Connecting and using a flash drive" on page 26 for more details.
	NFS drive connected over LAN. See section "Connecting the instrument to the LAN" on page 26 for more details.
	A duplex call has been set up and is currently active.
	A simplex call has been originated by the TETRA radio and is currently active.
	A simplex call has been originated by the tester and is currently active.
	Warning: External synchronization is switched on, but PLL is not locked. This means that the transmit and receive frequencies of the 2303 are not accurate.
	Warning: There is a shortcircuit at the USB port at the front panel – remove the device from the USB port on the front! The USB port will be operational again after a short while.
	Warning: There is a shortcircuit at the USB port at the back panel – remove the device from the USB port on the rear! The USB port will be operational again after a short while.

In the top-right corner, the 2303 Stabilock displays the name of the menu and the current signaling status. Example:



Connecting the device under test

General observations

There are two ways of connecting the 2303 Stabilock with the TETRA radio device (mobile station): either with a proper RF cable or with an antenna coupler. Both methods have their advantages, but a cable connection is not always possible because some TETRA mobile stations are lacking an RF connector or because there is no RF cable with an appropriate connector available.

If you connect the TETRA device under test with the 2303 Stabilock using a double-shielded RF cable you can test the transmitter and receiver with the most accurate results. This is because the connection is least affected by loss of signal strength or distortion through other radiated signals. The drawback of this method is that one component of the TETRA mobile station (MS) is not included in the tests, and that is the antenna and in some cases even the antenna connector.

If you use an antenna coupler to connect the TETRA MS with the instrument, you will be able to test the complete TETRA device including the antenna. Also you do not need different RF cables for various types of TETRA mobiles in store, so testing over an antenna coupler eases test handling.
On the other hand, only a small fraction of the signal transmitted from both sides reaches the other end, and this small fraction may be distorted by other signals on the air as long you do not take any precautions. If you use an RF shielding device such as Willtek's 4921 RF Shield, the problem of signal distortion can be avoided. With the knowledge of the exact attenuation of the signal in a given shielding solution and at a specified position relative to the antenna coupler, the signal attenuation at the antenna coupler can be compensated.

Using a cable connection

1 Use a double-shielded RF cable with an N-type connector at one end and the appropriate connector for the TETRA MS under test at the other end.

2 Plug the N-type connector into the N-type jack **RF IN/OUT** at the 2303 Stabilock.

3 Plug the other end of the cable into the RF jack of the MS.

4 In the **Setup > Definitions** menu, ensure that the RF pre-attenuation is properly set. If you do not know the exact attenuation of the cable, set both the RX Pre-Attenuation and the TX Pre-Attenuation to 0 dB.

Note

The Definitions menu can also be called up directly from measurement menus by selecting **...** > **Definitions**. By returning from the Definitions menu to the measurement menu, the measurements will be reset and started with the new averaging and pre-attenuation values.

Using an antenna coupler

1 Connect the 2303 Stabilock with the coupler using a double-shielded RF cable with appropriate connectors:

   a Plug the N-type connector into the N-type jack **RF IN/OUT** at the 2303 Stabilock.

   b The next step depends on whether or not you want to use an RF shielding device:

   – If you are not using an RF shielding device, plug the other end of the cable into the RF plug of the antenna coupler.

   – If you are using an RF shielding device, plug the other end of the cable into the external RF plug of the shielding device. Use another cable to connect the RF plug inside the shielding device with the antenna coupler inside the shielding device.

2 Mount the TETRA MS on the antenna coupler.

3 If you are using an RF shielding device: Once a connection has been set up, close the shielding device to avoid the RF signals to be distorted by other signals in the environment.

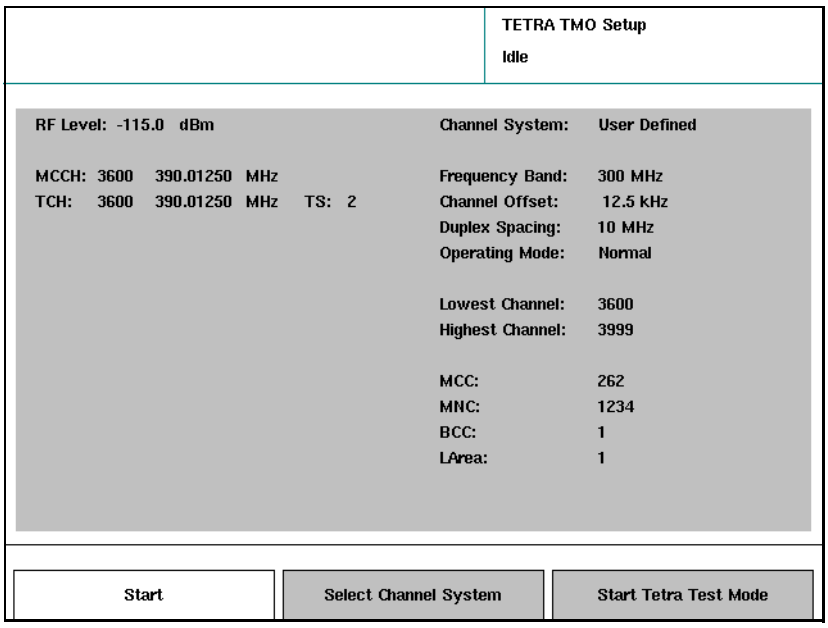
4 In the **Setup > Definitions** menu, ensure that the RF pre-attenuation is properly set so that the 2303 Stabilock can compensate the signal loss.

Note

See "Determining the RF Coupling Factors" on page 119 to learn how to obtain the pre-attenuation for a particular type of TETRA MS.

Setting up the network parameters

The following parameters should be carefully selected so that the TETRA mobile station can successfully synchronize with the 2303 simulating a base station. The parameters are all accessible on a single menu:
From the Welcome menu, press the **TETRA TMO** softkey to enter the TETRA TMO Setup menu.



RF Level

This is the RF power level that the 2303 Stabilock transmits to TETRA MS. Valid entries are in the range from –120 to –40 dBm if no pre-attenuation is set (see "Connecting the device under test" on page 11).

NOTE

TETRA mobiles typically receive signals well above –104 dBm.

MCCH

This is the channel number and frequency (in megahertz) of the Main Control Channel (MCCH) that the network simulated by the 2303 Stabilock is using. See Appendix A section "Calculating channel numbers and frequencies" on page 110 for the proper selection of channels and frequencies. The range for valid entries may be restricted by the Lowest Channel and Highest Channels on the right-hand side of the menu.
Once that the 2303 has started the base station simulation, the MCCH cannot be changed anymore.
If you change the channel number (on the left-hand side), the change will automatically be translated into the associated new frequency (on the right-hand side), and vice versa. The 2303 Stabilock uses the channel parameters on the bottom right (channel offset, duplex spacing, frequency band) to calculate channel numbers and frequencies.

TCH

This is the channel number and frequency (in megahertz) of the Traffic Channel (TCH) that the network simulated by the 2303 Stabilock is using. See Appendix A section "Calculating channel numbers and frequencies" on page 110 for the proper selection of channels and frequencies. The range for valid entries may be restricted by the Lowest Channel and Highest Channels on the right-hand side of the menu.

TS

In this input field, you can select the time slot (TS) used for the traffic channel. Possible entries are from 2 to 4. Time slot 1 is reserved for the MCCH.

Channel System

The base station and network parameters on the right-hand side can be either user-defined or predefined. See "Setting up a predefined channel setup" on page 24 to learn how to create a predefined base station parameter set.

Push the **Select Channel System** softkey to select a different (predefined) parameter set or to edit the parameters in the user-defined mode.

Note

If a predefined set of parameters is selected, the individual parameters cannot be changed. You can, however, change to user-defined settings; the current settings (from the predefined parameter set) remain on the screen and can be edited.

Frequency Band

The frequency band is a multiple of 100 MHz specifying the frequency range in which the mobile phone can operate. One of the following values can be selected from a list: 300 MHz, 400 MHz, 800 MHz, 900 MHz.

Channel Offset

The channel offset is the offset of the carrier frequency relative to a multiple of 25 kHz. One of the following values can be chosen from a list: 0 kHz, 12.5 kHz, +6.25 kHz, –6.25 kHz.
Ensure that the correct channel offset is selected. If the 2303 is not set to the same channel offset as the network for which the TETRA MS is programmed, the MS might not communicate with the 2303.

Duplex Spacing

The duplex spacing is the difference between the uplink (base station transmit) frequency and the downlink (mobile station transmit) frequency. One of the following values can be selected from a list: 0 MHz, 10 MHz, 45 MHz. Most networks transmitting in the 300 and 400 MHz range are applying a duplex spacing of 10 MHz while networks operating in the 800 and 900 MHz bands typically apply 45 MHz duplex spacing.

Operating Mode Select **Normal** if the base station transmits at the higher frequency. Otherwise, if the base station transmits in the lower band, select **Reverse**.

Lowest Channel In this input field you can enter the lowest channel number that the MS supports. This helps to ensure that only valid MCCH and TCH channel numbers are entered.

Highest Channel In this input field you can enter the highest channel number that the TETRA MS supports. This helps to ensure that only valid MCCH and TCH channel numbers are entered.

MCC The Mobile Country Code (MCC) is a three-digit number identifying the country. See ''Mobile Country Code MCC'' on page 115 for more information. The combination of MCC and MNC as entered in the 2303 must match that in the TETRA MS for a connection to be established successfully.

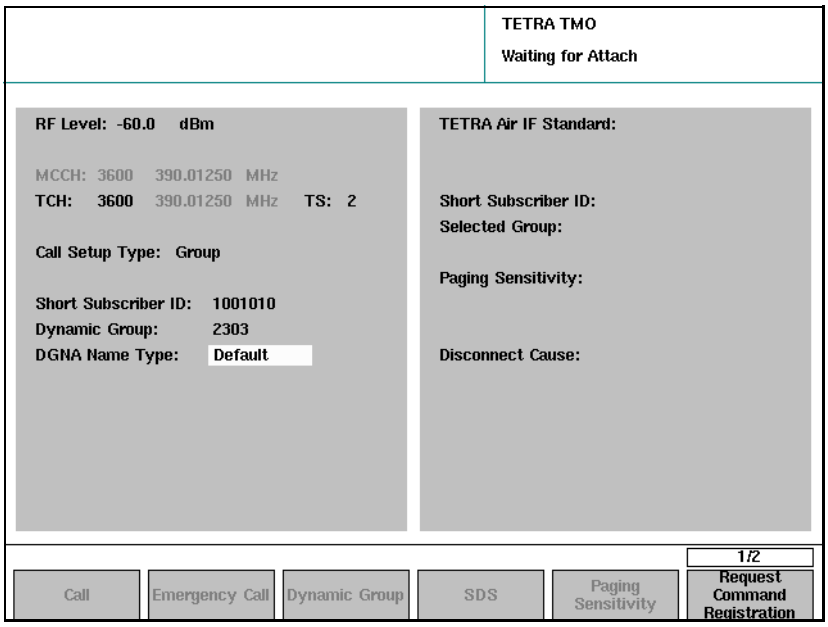
MNC The Mobile Network Code (MNC) is a number in the range from 0 to 16,383 identifying the network within a given country. The combination of MCC and MNC as entered in the 2303 must match that in the MS for a connection to be successfully established.

BCC The Base station Color Code (BCC) is a number in the range from 0 to 63 identifying a scrambling code that is used on all channels of the base station. The scrambling code can be chosen randomly.

LArea The Location Area (LArea) code is a number in the range from 0 to 16,383 identifying the cell. For TETRA mobile stations not restricted to a certain area, the location area can be chosen freely.

Setting up the call parameters

These parameters determine the type of call and the addresses that should be used. You can access the parameters in the TETRA TMO menu by selecting **TETRA TMO > Start**.



Call Setup Type

This field specifies the type of call that the 2303 Stabilock shall use when it sets up a call with the TETRA MS. One of the following call types can be selected from a list: Individual Simplex, Individual Duplex, Group, Phone, Ambient Listening.

NOTE

Depending on the capabilities of the MS, one or the other call setup type may not be available. The setup types actually available are shown once the MS is attached, i.e. when it has registered with the network simulated by the 2303 Stabilock.

The Individual Simplex setting means that a call is set up where only one party can talk at any one time. In order for the MS under test to transmit, the PTT (push-to-talk) button must be pressed.
Individual Duplex means that a call from one MS to another is set up, and both parties can talk and listen at the same time.
Group means that the TETRA MS is called under one of its group numbers. At any time during the call, you can either talk or listen, but not both at the same time. Note that you may need to assign a group number before you can actually perform a group call (see "Testing the incoming group call" on page 47).
With the Phone setting, a call from or into the public telephone network can be simulated. When the 2303 receives a call setup request into the public telephone network, it displays an appropriate symbol. Phone calls are duplex calls by nature.

With the Ambient Listening setting, the TETRA MS is automatically set into call mode without the need to answer the call (i.e. without pushing a button). The MS will transmit, but not receive any voice data.

Which call setup type do I need?

For standard MS transmitter and receiver tests, select Individual Duplex or, if not available, Individual Simplex.

If you want to ensure that the TETRA mobile station is programmed correctly, select

- ''Group'' to check the pre-programmed group number (TETRA MS must ring when called).
- ''Individual Duplex'' or ''Individual Simplex'' to check the programmed emergency call number. The number called by the MS will appear with a symbol indicating an emergency call.
- ''Phone'' to test the capability to initiate or receive calls into or from the public telephone network.
- ''Ambient Listening'' to verify this feature.

Short Subscriber ID

The short subscriber identity is a number in the range from 1 to 16,777,215 used to identify a TETRA MS in an individual call (Individual Duplex, Phone or Ambient Listening).
Enter a valid numer for the simulated MS that is virtually calling the MS under test. In an individual call to the MS under test, this number will likely be displayed on the TETRA MS as the calling party.

Dynamic Group

A group number or name is used to address the TETRA MS in a group call (Dynamic Group Number Assignment, DGNA). The number must be assigned to the MS under test before a group call can be performed; see ''Testing the incoming group call'' on page 47.

The group number should be in the range from 1 to 16,777,215.
Example: group number ''2303''.

DGNA Name Type

The TETRA radio can typically display a text with or instead of the group number. This can be controlled by the network, or the Stabilock in this case. The 2303 Stabilock can define it in three different ways.

During registration you will be asked if the 2303 Stabilock shall assign the dynamic group number permanently or temporarily. If you do not want the MS to keep the number used for test purposes, select ''Temporary''.

Effect on TETRA radio usability

When you assign a dynamic group with the 2303 Stabilock, dynamic groups with the same group identity previously stored in the radio are deleted. This means that they are not available anymore when you use the TETRA radio on a real network. Therefore, please check after your tests if

- the dynamic groups assigned during the test are deleted again in the TETRA radio.
- the main group is activated again when the radio leaves service.

Selecting a group number along with standard text

1 In the Dynamic Group input field, enter a number in the range from 1 to 16,777,215.

2 In the DGNA Name Type field, select ''Default''.
The group number will be displayed along with the text ''DGNA''.

Example: If the group number is set to 2303, the TETRA radio will display ''DGNA 2303''.

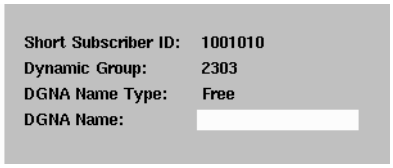
Selecting a freely selectable text

1 In the Dynamic Group input field, enter a number in the range from 1 to 16,777,215.

2 In the DGNA Name Type field, select ''Free''.
An additional input field DGNA Name is displayed.

3 In the DGNA Name field, enter the group name to be used. Up to 15 characters (including numbers) can be entered.
The resulting group name to be assigned will be the name entered.

Example: If the DGNA group name is set to ''Elephant 1'', the TETRA radio will display ''Elephant 1''.



Selecting a combination of name and group number

1 In the Dynamic Group input field, enter a number in the range from 1 to 16,777,215.

2 In the DGNA Name Type field, select ''Postnumber''.
An additional input field DGNA Name is displayed.

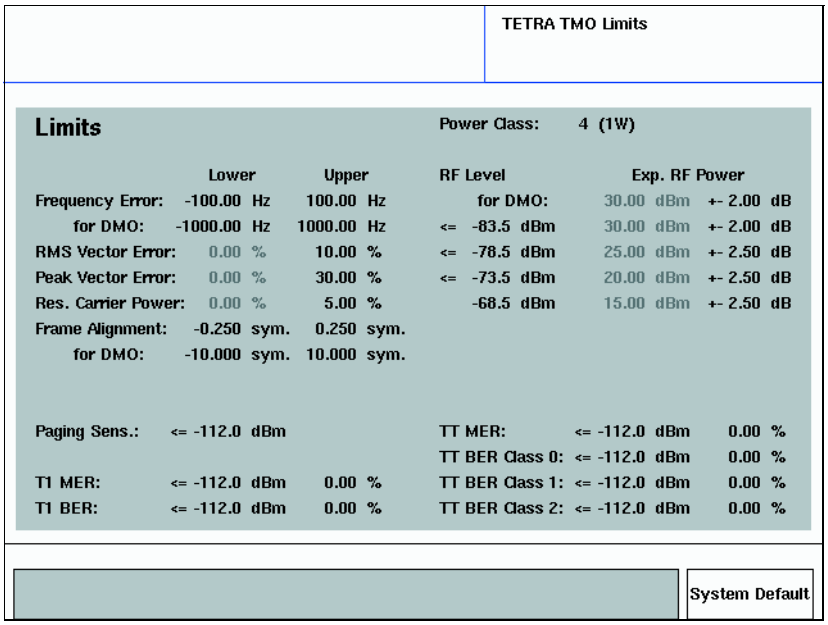
3 In the DGNA Name field, enter the group name to be used. Up to six characters can be entered.
The resulting group name to be assigned is the name entered + '' '' + the number.

Example: If the group number is set to 2303 and the DGNA group name is set to ''Sierra'', the TETRA radio will display ''Sierra 2303''.

Setting up test limits

The 2303 Stabilock indicates when a test result exceeds the limit. By default, the limits programmed into the 2303 are those defined in the TETRA specifications. You may, however, want to change the limits e.g. to take the measurement uncertainty or sharper, manufacturer-defined limits into account.

The test limits menu can be accessed from the Welcome menu by pressing **TETRA TMO > Start > ... > Limits**. The same menu is also available from various measurement menus directly, and from **TETRA DMO > Start > ... > Limits**. Please note that there are separate limits available for frequency error, frame alignment and RF level in direct mode (DMO).



Frequency Error

The frequency error is measured relative to the frequency of the base station (or the test instrument in this case). An upper and a lower limit can be defined here. The ETSI standard defines a tolerance range of ±100 Hz (see also page 55) in trunked mode and ±1000 Hz for direct mode.

Note

There are different limits for the frequency error in direct mode, therefore there is a second limit input field for the frequency error in DMO.

RMS Vector Error

The vector error is a measure of the modulation quality; only an upper limit can be defined here because the RMS vector error is an absolute value (the lowest value possible is 0%). The ETSI limit is 10%; see page 57 for more details.

Peak Vector Error

The peak vector error is the maximum vector error within a burst. The ETSI limit for the peak value is 30%; see page 57 for more details.

Res. Carrier Power

The residual carrier power (residual carrier magnitude) is another measure of the modulation quality. The minimum value is 0; the maximum allowable value can be entered here. ETSI defines a limit of 5%; see page 59 for more details.

Frame Alignment

The Frame Alignment test determines the timing error of the burst in multiples of symbol periods. An upper and a lower limit can be entered here.

NOTE

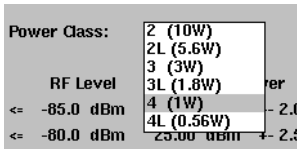
According to the TETRA specifications (EN 300 394-1), the burst timing error (frame alignment) should not exceed ±0.25 symbol periods in trunked mode.

Note

Due to the absense of a base station defining the system timing, the frame alignment measurement is not defined for direct mode. The measurement is anyway displayed in the 2303 to support fault finding when there are no measurement results; the 2303 takes measurements in a defined time window only.

Power Class

Set up the power class of the mobile station before entering the applicable power limits. This is necessary e.g. because there are typically narrower limits at the highest power level. See section "Power levels in TETRA" on page 113 for more details.



RF Level, Exp. RF Power

The TETRA TMO Limits menu displays a table of the nominal output power values (in the middle column) associated power limits (right-hand column) and associated receive power levels (left column).

RF Level	Exp. RF Power	
<= -85.0 dBm	30.00 dBm	+- 2.00 dB
<= -80.0 dBm	25.00 dBm	+- 2.50 dB
<= -75.0 dBm	20.00 dBm	+- 2.50 dB
<= -40.0 dBm	15.00 dBm	+- 2.50 dB

In the column on the right-hand side, you can adjust the symmetric power tolerance for each of the nominal power level steps.
Example: If you set the tolerance range for the nominal power of 20 dBm to ±2.5 dB, a measurement value of 17.5 dB will be within the limits, but 17.4 dB will be out of tolerance.

TETRA mobile stations only support open loop power control, i.e. the transmit power level is adjusted by the MS in 5-dB steps, depending on the received power level. You can impact the TETRA radio's transmit power level by increasing or decreasing its receive level, which is equivalent to the Stabilock's output power. The Stabilock assumes that when its output power level is equal or below the value in the left-hand column, the TETRA MS will try and transmit at the power level in the middle column. The associated tolerance range (in the right-hand column) will then be applied.

Paging Sens. The Paging Sensitivity test is a means of determining the receiver quality at low levels. The test is described in section "Paging Sensitivity test" on page 64.

The value entered here is the limit for the test, i.e. the TETRA radio must be able to receive and respond to paging messages at this receive level (and higher). If the TETRA radio does not respond to paging at this level, the test fails. This is a Willtek-defined test, there are no specified limits. Willtek recommends a limit of –112 dBm.

T1 MER The two input fields allow you to enter the maximum power level and the corresponding message erasure rate (MER) in the T1 loopback test (in asynchronous mode). The MER must not be exceeded at power levels above the given value.

T1 BER The two input fields allow you to enter the maximum power level and the corresponding bit error rate (BER) in the T1 loopback test (in asynchronous mode). The BER must not be exceeded at power levels above the given value.

TT MER The two input fields allow you to enter the maximum power level and the corresponding message erasure rate (MER) in the TETRA Test mode loopback test (in call mode). The MER must not be exceeded at power levels above the given value.

TT BER Class 0 The two input fields allow you to enter the maximum power level and the corresponding bit error rate (BER) of Class 0 bits in the TETRA Test mode loopback test (in call mode). The BER must not be exceeded at power levels above the given value.

TT BER Class 1 The two input fields allow you to enter the maximum power level and the corresponding bit error rate (BER) of Class 1 bits in the TETRA Test mode loopback test (in call mode). The BER must not be exceeded at power levels above the given value.

TT BER Class 2 The two input fields allow you to enter the maximum power level and the corresponding bit error rate (BER) of Class 2 bits in the TETRA Test mode loopback test (in call mode). The BER must not be exceeded at power levels above the given value.

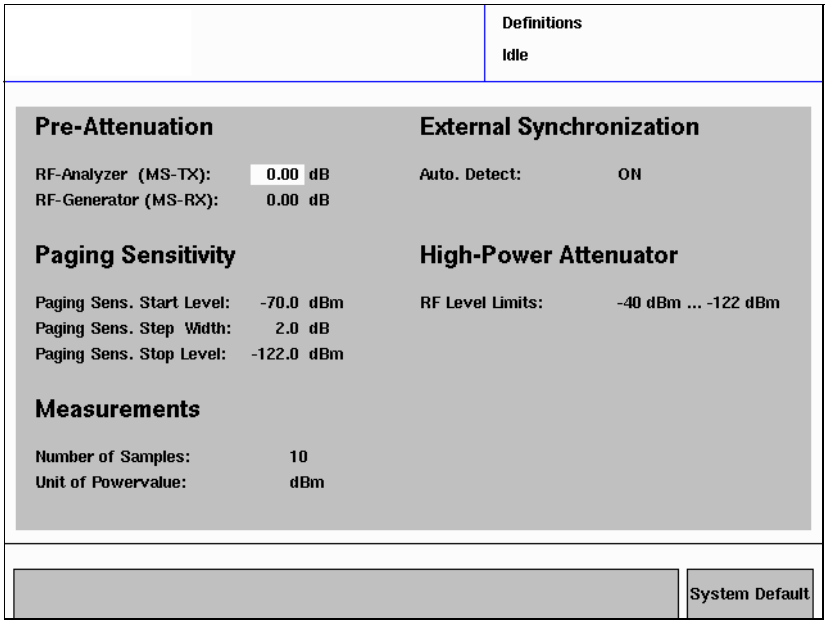
Adjusting the averaging

Graphical measurements in the 2303 Stabilock are displayed as an average of the last results if the **AVG** softkey is activated. The number of results affecting the displayed value can be changed in the range from 1 (no averaging) to 40 (i.e. 40 results are averaged to give one displayed value).

To change the number of bursts affecting the displayed measurement value:

1 Press **Setup > Definitions**.
The Definitions menu appears.

2 Go to the "Count of Avg" field and enter the required value.



Note

The Definitions menu can also be called up directly from measurement menus by selecting **...** > **Definitions**. By returning from the Definitions menu to the measurement menu, the measurements will be reset and started with the new averaging and pre-attenuation values.

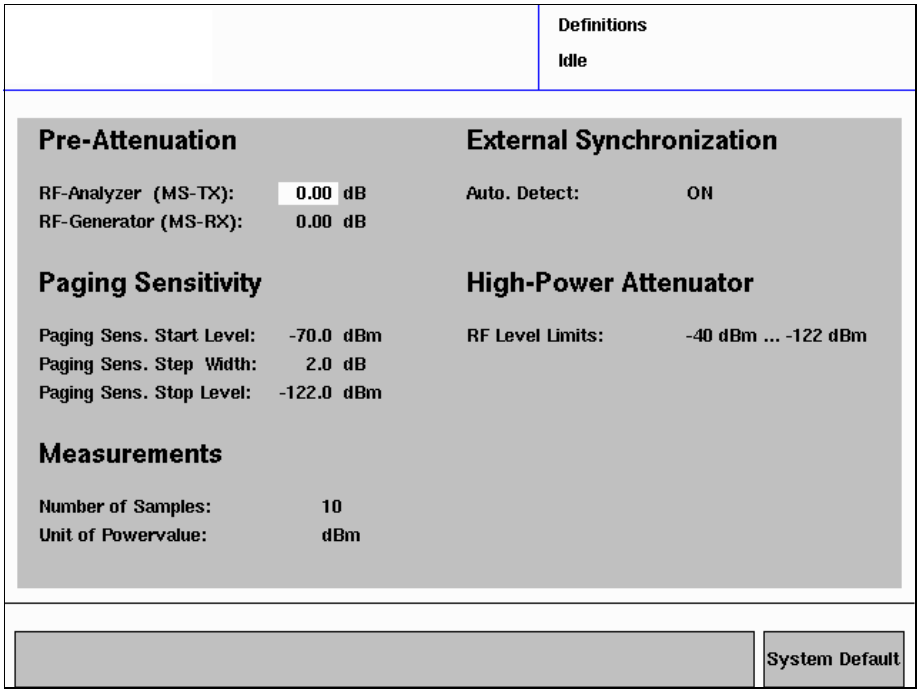
Changing the unit for power measurements

By default, the 2303 Stabilock displays powermeasurement resultsin dBm (decibel relative to one milliwatt); the TETRA specifications define power steps and limits in this unit.

If you prefer the results to be displayed in watt, you can change the displayed unit as follows:

1 Open the **Setup > Definitions** menu.

2 In the Measurements section, toggle the Unit of Power Value entry between **dBm** and **Watt**.
All subsequent measurements are shown with the power result in the selected unit.



Resetting parameters to factory settings

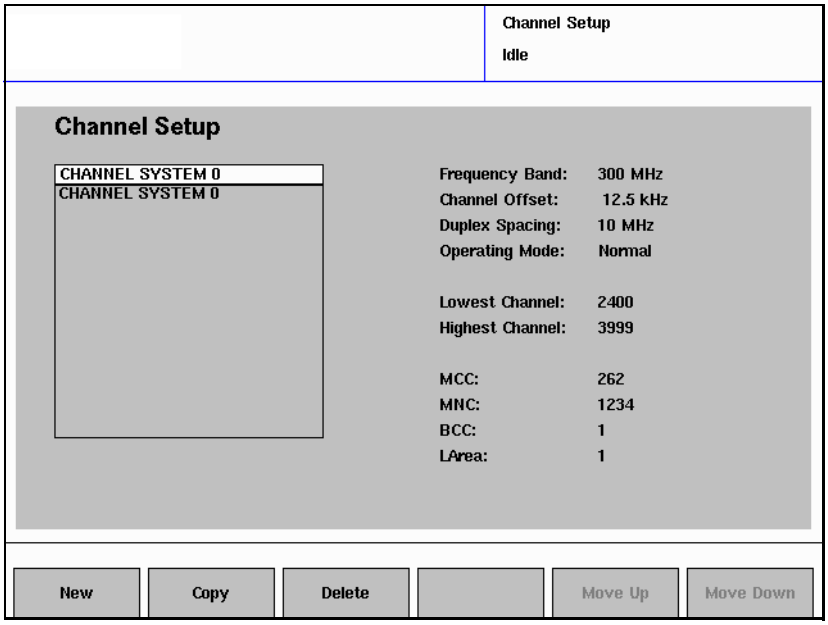
In the **Setup > Definitions** menu, there are general parameters that you can change at your descretion. If you want to return to the factory settings, push the **System Default** button to set all the parameters from this menu back to their defaults.

Similarly, a push on the **System Default** button in either **Setup > Limits** or **TETRA TMO > Start > ... > Limits** or **TETRA DMO > Start > ... > Limits** or **Generator/ Analyzer > Generator/ Analyzer > ... > Limits** returns the user-definable limit values to their respective default values.

Setting up a predefined channel setup

You can store and recall complete channel setups including channel numbers and base station details. Once a channel setup has been defined, it can be used in the setup for a manual test or an Autotest.

1 From the Welcome menu, select **Setup > Channel Setup**.
The Channel Setup menu appears.



2 From the scroll box on the left-hand side, select an existing channel setup that you want to change, or click **New** to create a new parameter set. (New parameter sets are automatically named, e.g. "Channel System 2".)

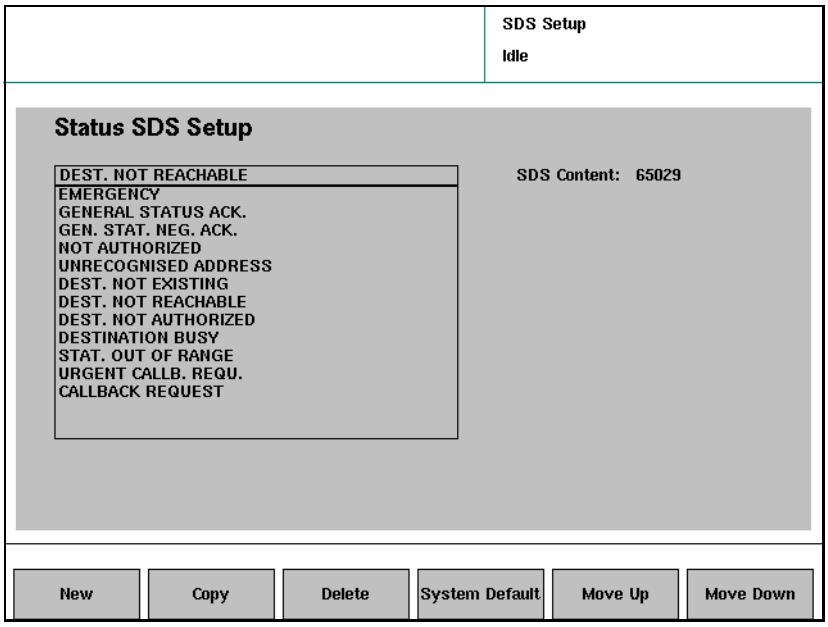
3 On the right-hand side of the menu, select the base station and network parameters as explained in "Setting up the network parameters" on page 13 and in "Calculating channel numbers and frequencies" on page 110.

Defining SDS status messages

The TETRA standard allows to predefine status messages; an individual number is assigned to each of these messages. Instead of entering the complete text, the user selects the predefined message, and a number is transmitted in a Short Data Service message. The radio unit of the receiving party decodes the number and displays the associated message text.

The 2303 Stabilock can send, receive and decode status messages (see "Testing the short data service capabilities" on page 51). The allocation of message numbers can be done in the SDS Setup menu as follows.

1 Select Setup > Stat. SDS Def.
The SDS Setup menu appears.



2 In order to change the message number of a predefined message, select the message text on the left-hand side and enter the new number in the SDS Content entry field on the right-hand side.

3 If you want to assign a different message text to an existing message number, enter the number in the SDS Content field, then select the appropriate message text on the left-hand side.

4 Define a new message as follows:

   a Click on **New**.
   A new message is created with a default text (e.g. "STATUS SDS DEF. 12").

   b Overwrite the default text with a meaningful message text by entering it in the text field (on the left-hand side) using the alpha-numerical keys (e.g. press "2" twice to enter the letter "A") or the push-dial (for letter selection) in conjunction with the **...** key (for switching between lowercase, uppercase and symbols).

   c In the SDS Content field, enter the message number.

Using the 2303 Stabilock with peripherals

Connecting and using an external keyboard

The 2303 Stabilock can be operated conveniently through its front panel elements, in particular with the click-dial. However, if you need to enter a lot of data an external keyboard may be useful. The 2303 Stabilock supports standard keyboards with USB interface; the keyboard layout for France, Germany, the UK and the USA are automatically recognized.

Setting up the keyboard

In the **Setup** menu, select the keyboard layout in the **Keyboard external** selection field. Available layouts are those for the USA, the UK, Germany, France, Italy, Portugal and Spain.

Special keys

The softkeys are assigned to function keys F1 through F6, with the **...** key being assigned to F7.
To enter negative numbers, just press the **–** key in the numeric block (the Num Lock function must be active).

Connecting and using a flash drive

The 2303 Stabilock can store various data on a flash drive and retrieve them at a later time. The following data file types are supported:

- Pictures of the current screen contents (screenshots)
- Instrument settings
- Measurement results
- Configuration for TETRA mobile stations

The 2303 Stabilock supports standard (commercially available) USB flash drive with any capacity from 128 kB to 4 GB. Connect the USB flash drive to any of the USB ports on the front or rear panel.

If a USB flash drive is successfully connected, the USB flash drive symbol appears in the upper left corner of the 2303 menus.

Connecting the instrument to the LAN

In addition to operating the 2303 Stabilock through its front panel elements, it can also be controlled remotely from a PC through the serial (RS-232) interface or the LAN (local area network).

The LAN interface of the 2303 supports 10 or 100 Mbps connections (10BASE-T or 100BASE-TX) over a Cat5 cable (with RJ-45 connectors at both ends).
Simply plug one end of the cable into the LAN socket on the rear panel of the 2303 and the other into the socket of your LAN.

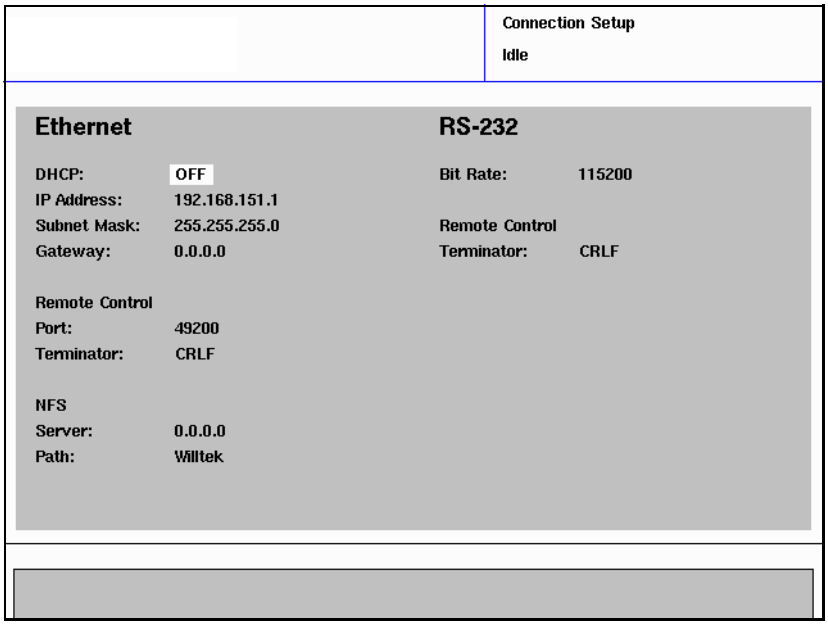
If you do not have a LAN but a PC with a LAN socket, you can connect the instrument to the PC directly using a cross-connect LAN cable. This cable type is available in computer shops or from Willtek.

The 2303 must be physically connected to a LAN or a PC with an active LAN interface before the instrument is switched on.

In order to set up the IP address parameters of the 2303 Stabilock, you can either enter them directly or activate DHCP (Dynamic Host Configuration Protocol). DHCP is a protocol that automates the configuration of TCP/IP devices on a local area network; the IP address and subnet mask are assigned by a DHCP server that must be available on the LAN.

To enable DHCP, proceed as follows:

1 From the Welcome menu, select **Setup > Connection Setup**.
The Connection Setup menu appears.



2 In the DHCP list field, select **On**.
DHCP is activated; if a DHCP server is available on the LAN, the 2303 will obtain its IP address and the subnet mask from that server. If successful, both will be displayed in the Connection Setup menu and the Connected to LAN icon will be shown in the top-left corner of the menu.

3 Switch the 2303 off and on again for the changes to take effect.

To disable DHCP and enter the IP parameters manually, proceed as follows:

1 From the Welcome menu, select **Setup > Connection Setup**.
The Connection Setup menu appears.

2 In the DHCP list field, select **Off**.
DHCP is de-activated.

3 In the IP Address field, enter an IP address that is not already being used on the LAN.

4 In the Subnetmask field, enter the mask for the subnet that the 2303 belongs to.

5 If you communicate with the 2303 Stabilock over a gateway, enter the Gateway address for the Stabilock.

6 Select a port number for remote control. The port number addresses the remote control entity of the 2303 Stabilock. The default (used by the 7310 Lector & Scriptor family of test automation programs) is 49200.

7 Select the line terminator that the remote control software uses. This can be Carriage Return (CR), Line Feed (LF) or a combination of both (CRLF).

8 Switch the 2303 off and on again for the changes to take effect.

As long as the 2303 Stabilock is not successfully connected in hardware and software, the LAN Not Connected symbol is displayed in the upper left corner of the menus.

As long as the 2303 Stabilock is connected, the Connected to LAN symbol is displayed in the upper left corner of the menus, along with the IP address.

Connecting and using a disk drive on the network

The 2303 Stabilock can store various data on a hard disk on the network and retrieve them at a later time. The following data file types are supported:

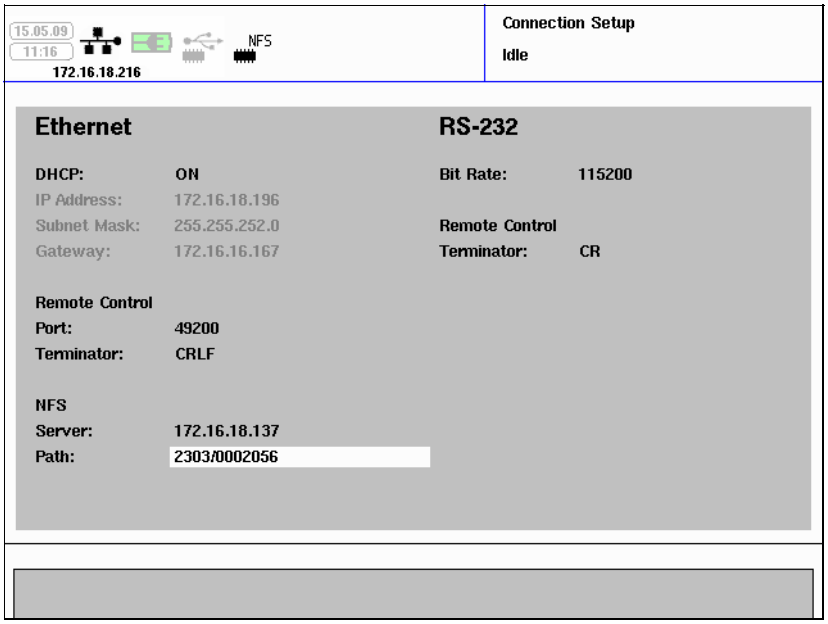
- Pictures of the current screen contents (screenshots)
- Instrument settings
- Measurement results
- Configuration for TETRA mobile stations

For accessing a disk drive on the network, a protocol is required. The 2303 Stabilock supports the NFS (Network File System) and has an NFS client already built into its software. This protocol is available with most operating systems: most UNIX and Linux versions come with NFS server software, and there is free or low-cost third-party NFS server software available for MS Windows (such as TrueGrid NFS Server or nfsAxe). The NFS server typically provides access to a particular folder on a disk drive.

Once an NFS server is set up on the computer network, all you need to know is the computer's IP address and a path where to store the data. In order to set up the NFS connection on the 2303 Stabilock, proceed as follows:

1 Ensure that the 2303 Stabilock is properly connected to a computer network (see "Connecting the instrument to the LAN" on page 26). The network symbol with the Stabilock's IP address appears in the top-left corner.

2 Select the Setup menu.



3 In the Server input field of the NFS section, enter the (numerical) IP address of the remote computer.

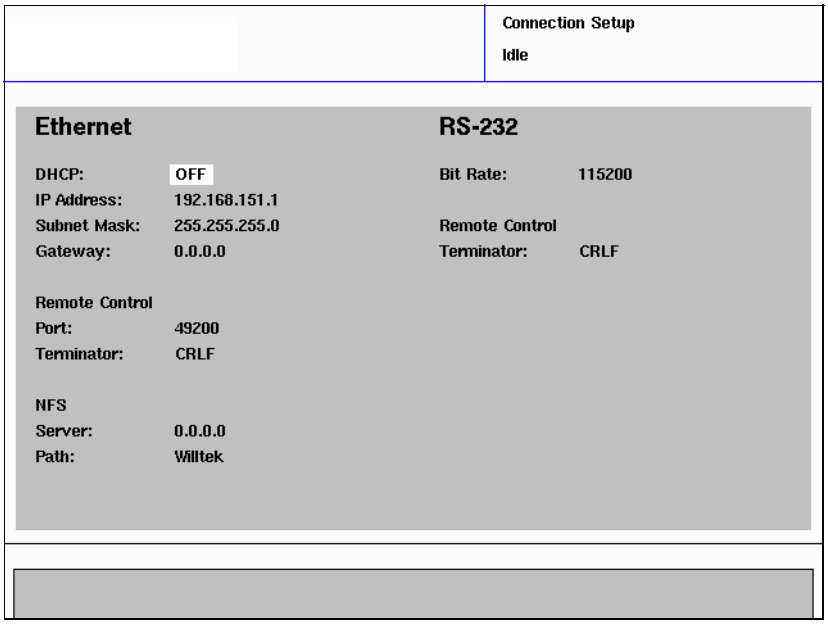
4 In the Path input field, enter the path (i.e. the subfolder of or path relative to the folder which is allocated in the remote computer's NFS server software).
If the data have been entered correctly and the 2303 Stabilock can set up a connection successfully, the NFS drive appears at the top-left of the 2303 menus.

Using the RS-232 interface

In addition to operating the 2303 Stabilock through its front panel elements, it can also be controlled remotely from a PC through the serial (RS-232) interface or the LAN (local area network).

1 Use an RS-232 cable with 9-pin female connectors at both ends to connect the RS-232 socket on the rear panel of the 2303 to the RS-232 socket of the PC.

2 From the Welcome menu, select **Setup > Connection Setup**. The Connection Setup menu appears.



3 Use the Baudrate field to select a bit rate; valid entries are 9600, 19,200, 38,400, 57,600 and 115,200 bps. The default bit rate is 115,200 bps.

4 Select the line terminator that the remote control software uses. This can be Carriage Return (CR), Line Feed (LF) or a combination of both (CRLF).

5 On the PC, select the same bit rate and set the interface parameters as follows:

- Data bits: 8
- Stop bits: 1
- Parity: None
- RTS, CTS: active

Using the TRIGGER OUT connector

The 2303 Stabilock uses the **TRIGGER OUT** BNC socket on the rear to output a short TTL pulse at the start of each active (assigned) uplink time slot.

Using an external time base

In order to improve the absolute frequency accuracy of the 2303 Stabilock, you can connect a reference oscillator to **EXT. SYNC IN** on the rear panel. The clock rate must be either 5, 10 or 13 MHz and the power level of the signal must exceed 0 dBm (1 mW into 50 Ω).

Copying the screen contents to a file

The screen contents can be copied to a file upon the press of a key. The file will be saved either on the local hard disk or on the USB flash drive (if inserted) or on a disk on the computer network (if connected). See "Managing files on the 2303 Stabilock" on page 36 to learn how to copy or move screenshots stored on the internal disk onto a USB flash drive or a network drive. Section "Connecting and using a flash drive" on page 26 explains how to use a USB flash drive, and section "Connecting and using a disk drive on the network" on page 28 shows how to connect the 2303 Stabilock to a disk drive on the network.

1 You can define the location where the file will be stored as described in "Selecting the file location for screenshots and Autotest results" on page 35.

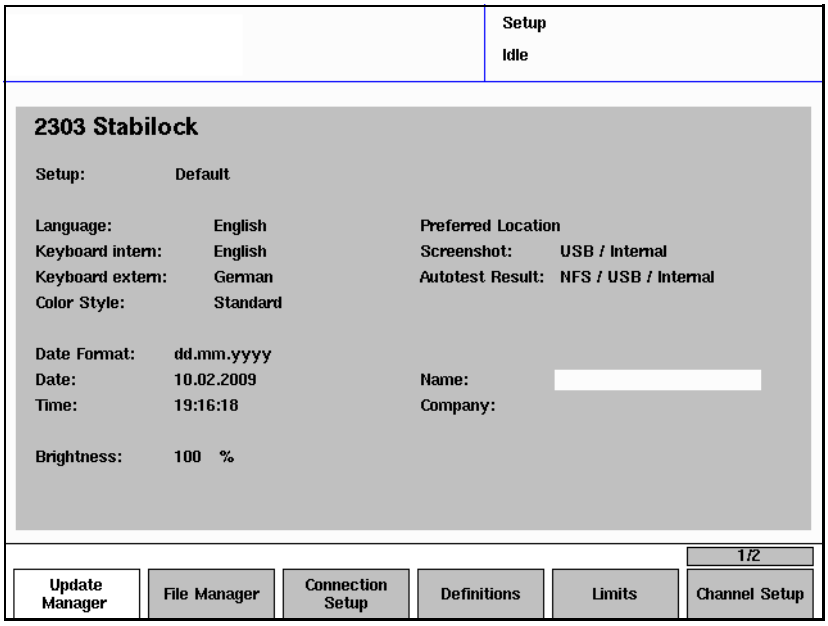
2 Push the **BACKSPACE** key.
A file with the screen contents at the time of the keypress is written to the specified disk. The file format is Windows Bitmap (BMP).

Setting up general parameters of the 2303 Stabilock

Selecting an instrument setup

All instrument settings including the channel setups and SDS status messages can be stored in files using the File Manager (see menu **Setup > File Manager**). The file name assigned can be used to retrieve an instrument setup as follows.

1 From the Welcome menu, select the **Setup** menu.
The Setup menu appears.



2 In the Setup selection field, select a setup file name from the list.

3 Push Enter to confirm your selection.
The instrument settings that were active when the file was saved are retrieved and re-activated.

Setting up the user interface language

The default language of the user interface is English, i.e. all text is displayed in this language. You can change the language as follows:

1 From the Welcome menu, select the **Setup** menu.
The Setup menu appears.

2 In the Language list field, select the desired language. Languages currently supported are English, French and German.

Entering special national characters

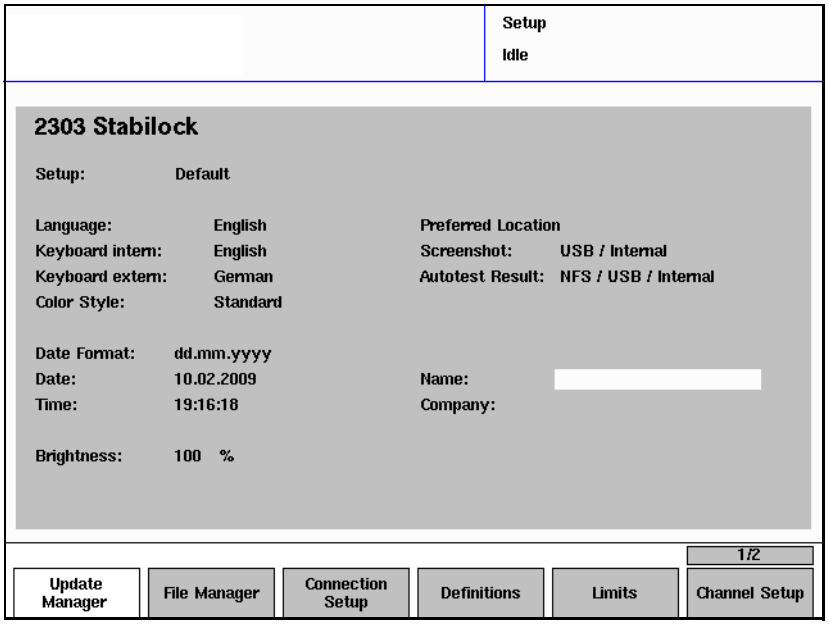
Some menus allow you to enter text (see paragraph on alphanumerical input fields in section ‘‘Entry fields‘‘). Text can be entered with either the entry keys or the push-dial. The character set available with the push-dial

can be extended by national characters such as ''ü''. To do so, go to the **Setup** menu and select a different character set in the **Keyboard internal** selection field. ''English'' and ''German'' are currently available.

Setting up the menu colors

The color style of the 2303 menus can be changed as follows:

1 From the Welcome menu, select the **Setup** menu.
The Setup menu appears.



2 In the Color Style field, select a style from the list. Currently supported styles are Standard (grey background, the active input field is shown with white background), Std Color Select (the list in active list input fields is shown on yellow background) and One Background (white background with the active input field shown with grey background); the default is Standard.
The new color style becomes active immediately after closing the input field.

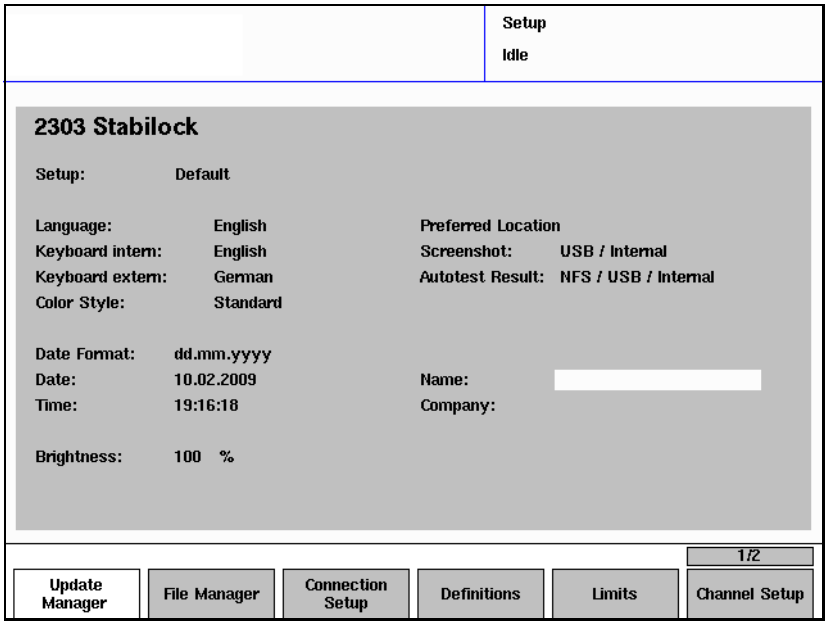
Setting the date format

The 2303 Stabilock supports the following date formats:

- yyyy-mm-dd (international notation, e.g. 2008-04-25)
- dd.mm.yyyy (continental European style, e.g. 25.04.2008)
- mm/dd/yyyy (American format, e.g. 04/25/2008)

The date format affects the way the date is presented in the upper left corner of each menu and in the test protocols. Change the date format as follows:

1 From the Welcome menu, select the **Setup** menu.
The Setup menu appears.



2 In the Date Format field, select a format from the list.
The new date format becomes active immediately after closing the input field.

Setting the date and time

The date and time can be entered in the **Setup** menu.

Entering the date

The date should be entered in the selected date format, except that the slash '/' should be replaced by the minus sign '-'.

Entering the time

The time should be entered in the 24-hour format. The colon ':' should be replaced by the dot '.'.

Setting the brightness of the display

You can set the display brightness in the Brightness field of the **Setup** menu as a value from 0 (dark) to 100 (very bright).

Entering service centre details

Test protocols generated by the Autorun feature may include the name of the company (service centre) and the repair technician. Just enter these details in the Name and Company text fields within the Setup menu.

Selecting the file location for screenshots and Autotest results

Screenshotsand Autotest results of the 2303 Stabilock can be saved either on the internal hard disk, on a USB flash drive (if attached to the 2303) or on a disk on the computer network (if connected). The screenshots are saved in folder \Stabilock2303\Screenshot; Autotest results are saved in Stabilock2303\Autotest. The file name includes the date (in the format yyyymmdd) and the time (in the format hhmmss).

In order to select the device on which the 2303 Stabilock shall store the files, proceed as follows:

1 Select the **Setup** menu.

2 In the Screenshot or Autotest Result selection field, select
- **Internal** for the storage device within the 2303 Stabilock.
- **USB/Internal** to have the 2303 Stabilock save the respective file type on the USB flash drive (if connected).
- **USB/NFS/Internal** to have the 2303 Stabilock save the respective file type on the USB drive if available. If the USB drive is not connected then the 2303 Stabilock will attempt to save the file on an external computer using the NFS protocol. If this is not available either, the files will be saved on the Stabilock's internal storage device.
- **NFS/USB/Internal** to have the 2303 Stabilock save files of the respective type on an external computer using the NFS protocol if available. If the NFS drive is not connected then the 2303 Stabilock will attempt to save the files on the USB drive. If this is not available either, the files will be saved on the Stabilock's internal storage device.

See "Copying the screen contents to a file" on page 31 to learn how to create a screenshot. See "Managing files on the 2303 Stabilock" on page 36 to learn how to copy or move screenshots stored on the internal disk onto a USB flash drive.

See Chapter 6 "Performing Autotests" to learn more about Autotests.

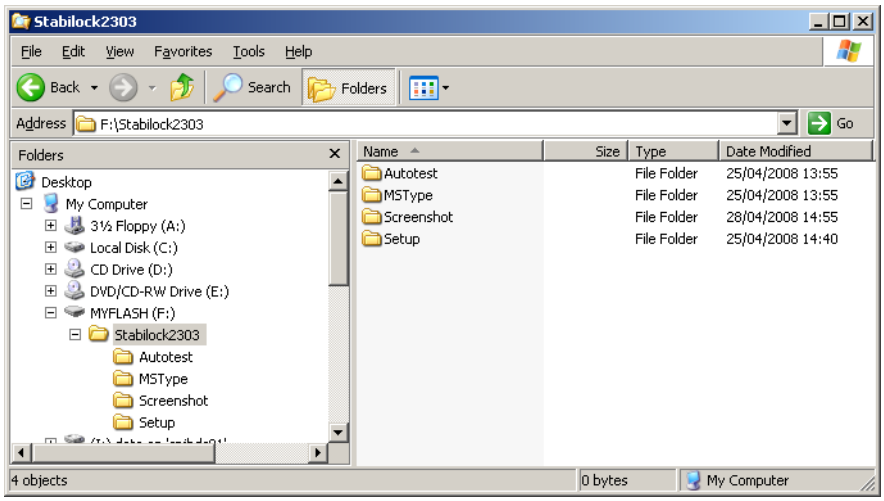
Managing files on the 2303 Stabilock

You can save various types of data on the Stabilock's internal hard disk, on a USB flash drive or on a hard disk on an external computer (using the NFS protocol). Internally stored files can be deleted, or copied or moved to a USB flash drive using the Stabilock's File Manager.

The following types of files can be processed:

- Setups (these may be useful to store and quickly reload a set of individual instrument settings, and for error reporting)
- Screenshots (see "Copying the screen contents to a file" on page 31)
- Lists of MS types
- Autotest results (see "Performing Autotests" on page 91)

Files are saved on the USB flash drive in the following folder structure:



You can process the internal files as follows:

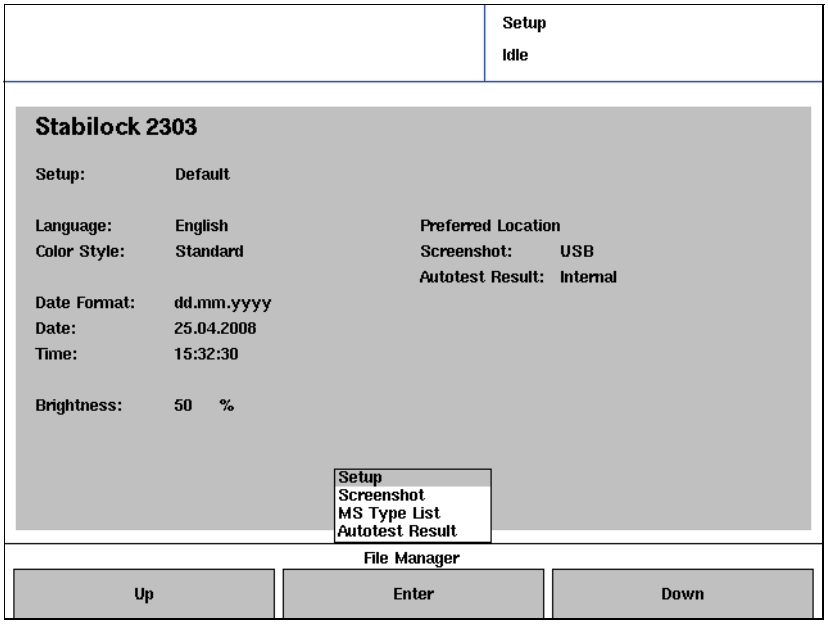
Note

A USB flash drive must be attached when entering the File Manager in order to save files on the USB drive. Similarly, an NFS connection to a remote computer must be set up when entering the File Manager in order to save files on the remote computer's disk drive.

Note

The amount of disk space available on the internal hard disk, the USB flash drive and the NFS drive on the remote computer can be viewed in the **Setup > Status** menu.

1 To enter the File Manager, press **Setup > File Manager**.
A pop-up menu with the types of files appears.



2 Select the desired file type and press **ENTER**.
The corresponding File Manager menu appears, on the left-hand side displaying the available files that are stored on the Stabilock and with the files in the corresponding folder of the USB or NFS drive on the right-hand side.

3 If a folder on the USB drive is displayed and you want to exchange files with the network drive, push the **Load NFS** button. Similarly, if a folder on the NSF drive is displayed and you want to exchange files with the USB drive, push the **Load USB** button.

4 Select a file on the Stabilock

5 Push the following key for the corresponding action:

a In the Setups menu, push **New** to save the current setup in a new file.
A pop-up menu appears; select if you want to save the factory settings or the current settings (setup 'Default') and push **ENTER** to save the file. The file name will automatically be generated by the Stabilock.

b In order to copy files from the Stabilock onto the respective drive, select a file on the Stabilock and push **Copy**. A pop-up menu appears, allowing you to choose between the selected file and all files to be copied. Select an entry and push **ENTER**; the file(s) will then be copied onto the external drive. Note that files with the same file name already existing on the external drive will be overwritten!

c In order to copy files from the Stabilock onto the external drive and delete the file on the Stabilock, select a file on the Stabilock and push **Move**. A pop-up menu appears, allowing you to choose between the selected file and all files to be moved. Select an entry and push **ENTER**; the file(s) will then be copied onto the external drive and deleted on the Stabilock. Note that files with the same file name already existing on the drive will be overwritten!

d In order to delete files on the Stabilock, select a file on the Stabilock and push **Delete**. A pop-up menu appears, allowing you to choose between the selected file and all files to be deleted. Select an entry and push **ENTER**; the file(s) will then be removed from the Stabilock's hard disk.

Note

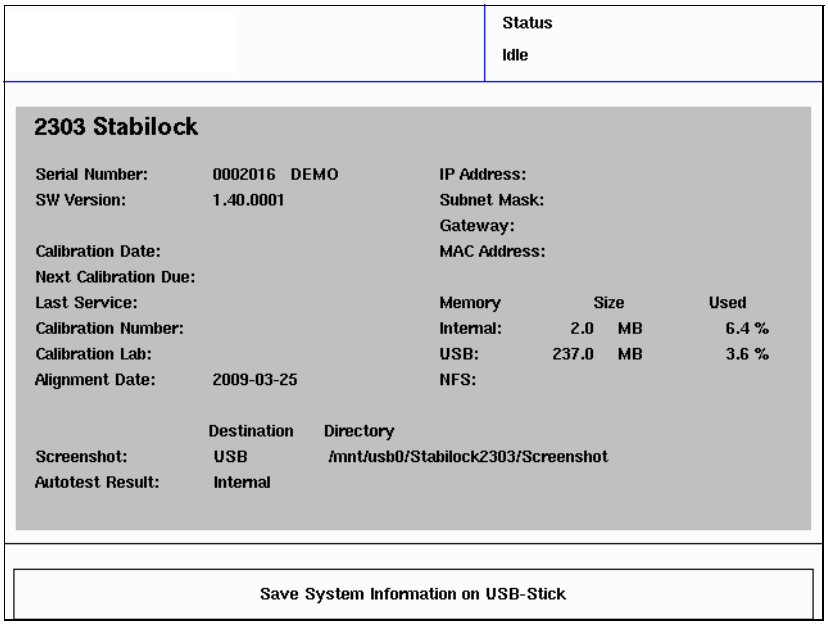
You can also copy or move setup and MS type files from the external drive to the 2303 Stabilock: Select the file on the respective drive to be copied or moved twice. The copy or move direction is changed, indicated by the arrow changing its direction. You can now push the **Copy** or **Move** softkey for the appropriate action.

The direction is changed back by selecting a file on the 2303 Stabilock twice.

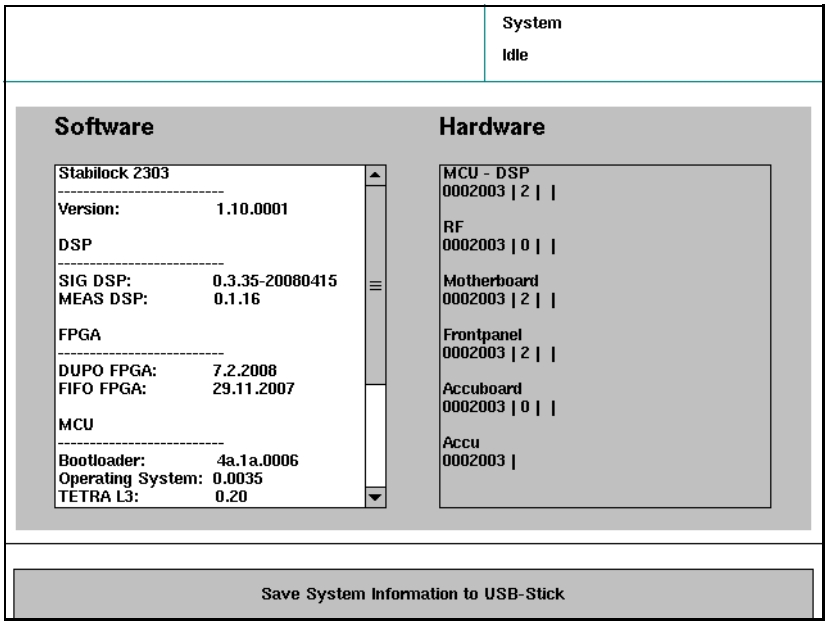
Obtaining the instrument status

For service and support purposes, it may be useful to see the instrument status in terms of firmware and hardware. The status can also be saved on a USB flash drive

For a quick and easy-to-read overview of serial number, firmware version, calibration status and IP connection, press **Setup > ... > Status**.



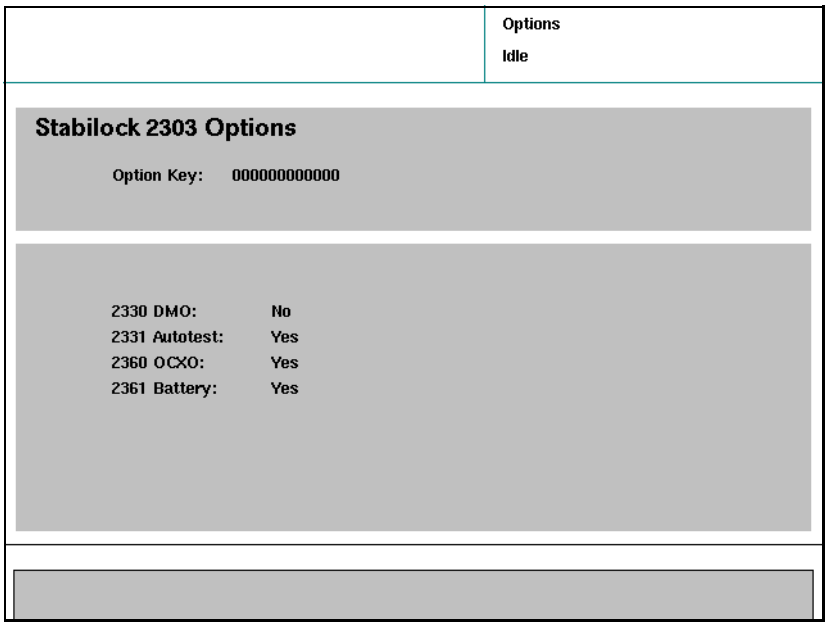
For a more detailed status, press **Setup > ... > System**.



Insert a USB flash drive into a free USB slot and push **Save System Information to USB Stick**.
Hardware and firmware information is stored in file infodat.txt in the root directory of the USB flash drive. A previous file will be overwritten without a warning.

Installing software options

You can check which options are installed by pressing **Setup > ... > Options** from the Welcome menu.
The Options menu appears.



If you purchase a new software option as an upgrade, you will receive an option key. This key is a sequence of alphanumericals that allow you to install the option quickly on your workbench, without the need to ship it to a Willtek service center.

1 Ensure that the Stabilock is running the latest firmware. The version number of the firmware installed can be checked under **Setup > ... > Status**. The latest firmware is available from Willtek's website at www.willtek.com.

2 To install a new software option, enter the code in the Option Key input field and hit **Return**.
The Stabilock checks if the option key is valid for this instrument (depending on its serial number).

3 Switch off and on your Stabilock to enable the new functionality.

Performing Manual Tests and Measurements in Trunked Mode

3

This chapter provides task-based instructions for using the 2303 Stabilock features. Topics discussed in this chapter are as follows:

Performing functional tests

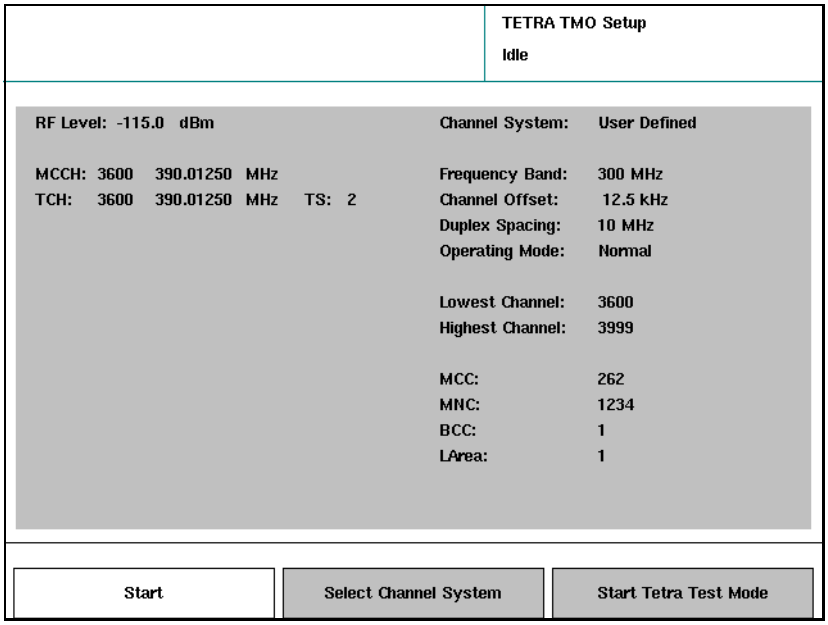
Reading capabilities of the TETRA MS

Once a TETRA mobile station (MS) has registered with the network (in other words, when it is attached to a network), some parameters and capabilities of the TETRA MS can be read over the air interface. The 2303 Stabilock can display some of these parameters, e.g. the simplex and duplex capabilities.

In order to read the parameters, proceed as follows:

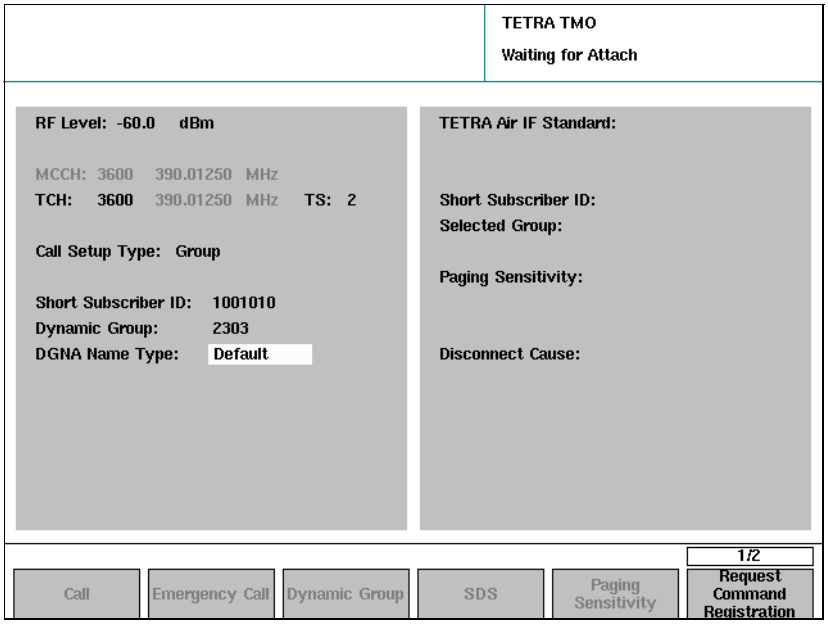
1 Connect the MS as described in "Connecting the device under test" on page 11.

2 On the Welcome menu, press the **TETRA TMO** softkey.
The TETRA TMO Setup menu appears.



3 Set up the parameters for the network and base station as described in "Setting up the network parameters" on page 13.

4 Press the **Start** softkey.
The TETRA TMO menu appears.



5 Switch on the MS and wait until the 2303 displays Attached in the upper right corner.
The air interface standard version supported, the short subscriber ID of the MS and its group number are displayed on the right-hand side of the menu.

6 Press **...** > **Class of MS**.
The Class of MS menu appears. You can now read the TETRA mobile's capabilities.

NOTE

Although it would be useful to know the power class of the TETRA MS, this parameter is not communicated over the air interface in normal operation, so the 2303 Stabilock cannot query and display this information from the MS.

The power class can, however, be queried in TETRA Test Mode. See section "TETRA Test Mode" on page 66 for more details.

7 To return to the Idle menu, press the **ESC** key.

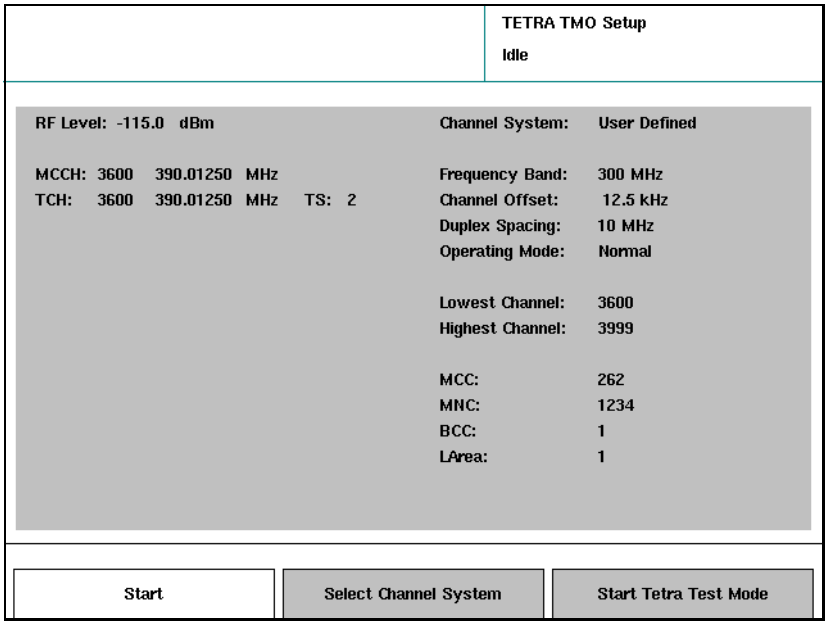
Testing the incoming call (mobile terminated)

The purpose of the incoming test call is to verify that the MS can receive and accept calls. This includes that the display of the calling party and the alert tone speaker are tested.
The call can also be used to perform transmitter and receiver measurements.

In order to test the incoming call capabilities, proceed as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

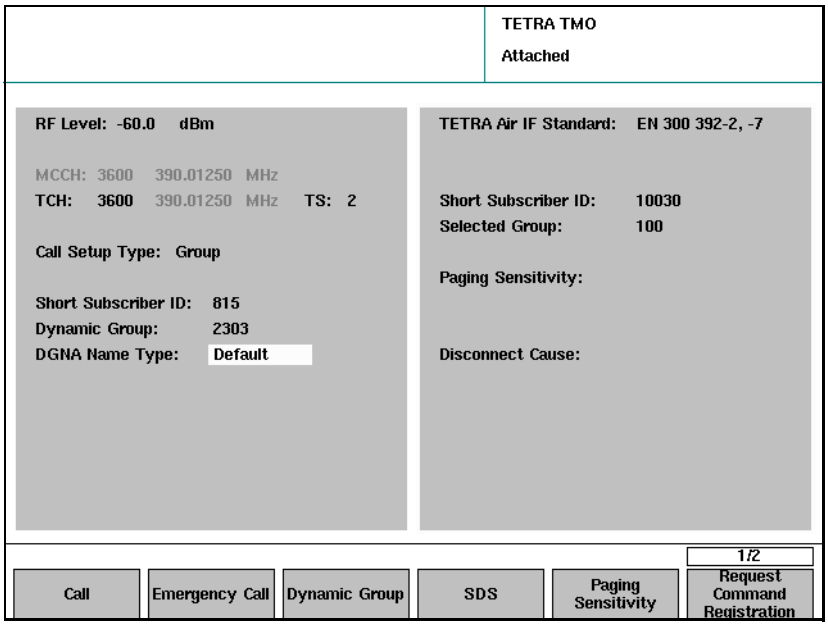
2 On the Welcome menu, press the **TETRA TMO** softkey.
The TETRA TMO Setup menu appears.



3 Set up the parameters for the network and base station as described in "Setting up the network parameters" on page 13.

4 Press the **Start** softkey.
The TETRA TMO menu appears.

5 Switch on the MS and wait until the 2303 displays Attached in the upper right corner.
The air interface standard version supported and the Short Subscriber ID of the MS are displayed on the right-hand side of the menu.



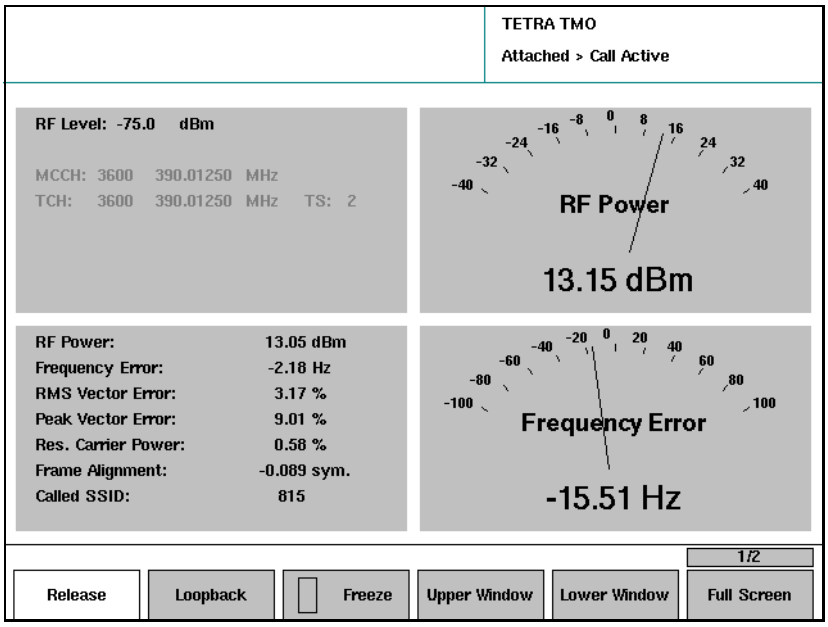
6 Set up the call parameters as explained in "Setting up the call parameters" on page 16. In particular, enter the call setup type and Short Subscriber ID; the dynamic group number is not required in an individual call.

7 Push the **Call** softkey.
An individual call is set up and the MS starts ringing. The short subscriber ID entered on the left-hand side of the 2303 menu is displayed on the MS as the calling party.

8 Accept the call: If an individual simplex call is selected, press the PTT button. If this is an indvidual duplex call, press the Call key.
The Call Active menu appears. You can now perform radio measurements (see "Performing transmitter tests" on page 54).

NOTE

If the call fails or when the call is released, the Attach menu re-appears.



9 To stop the call, push the release button on either the TETRA MS or the 2303 Stabilock.
The Attach menu appears again. The MS is still attached to the network and you can now perform another call.

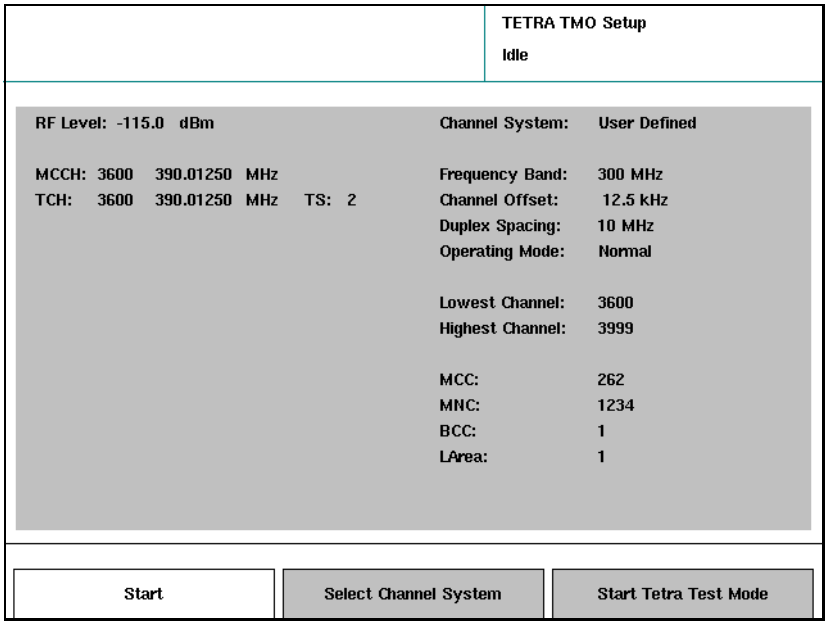
Testing the outgoing call (mobile originated)

The purpose of the outgoing test call is to verify that the TETRA MS can originate calls. This includes a test of the numeric keys and the call button. The call can also be used to intiate transmitter and receiver measurements.

In order to test the outgoing call capabilities, proceed as follows:

1 Connect the MS as described in "Connecting the device under test" on page 11.

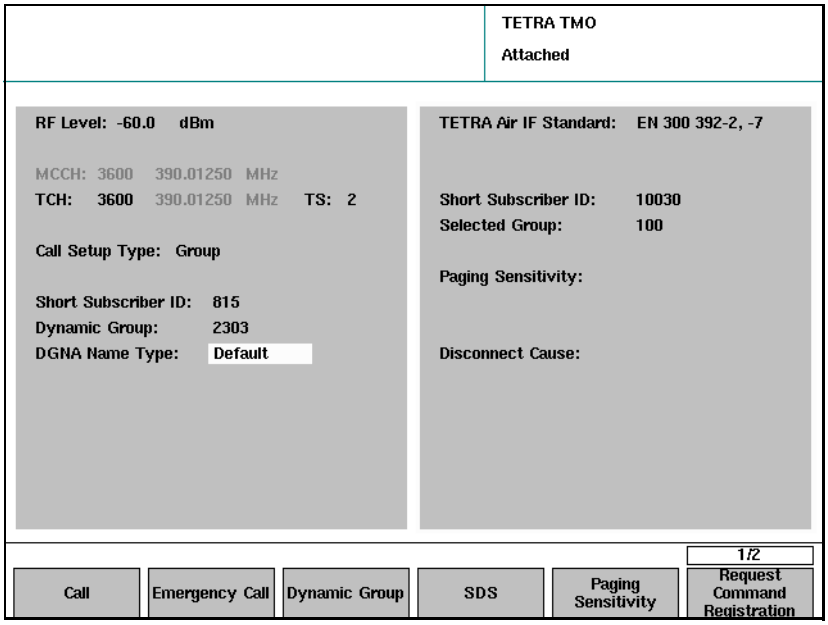
2 On the Welcome menu, press the **TETRA TMO** softkey.
The TETRA TMO Setup menu appears.



3 Set up the parameters for the network and base station as described in "Setting up the network parameters" on page 13.

4 Press the **Start** softkey.
The TETRA TMO menu appears.

5 Switch on the MS and wait until the 2303 displays Attached in the upper right corner.
The air interface standard version supported and the Short Subscriber ID of the MS are displayed on the right-hand side of the menu.



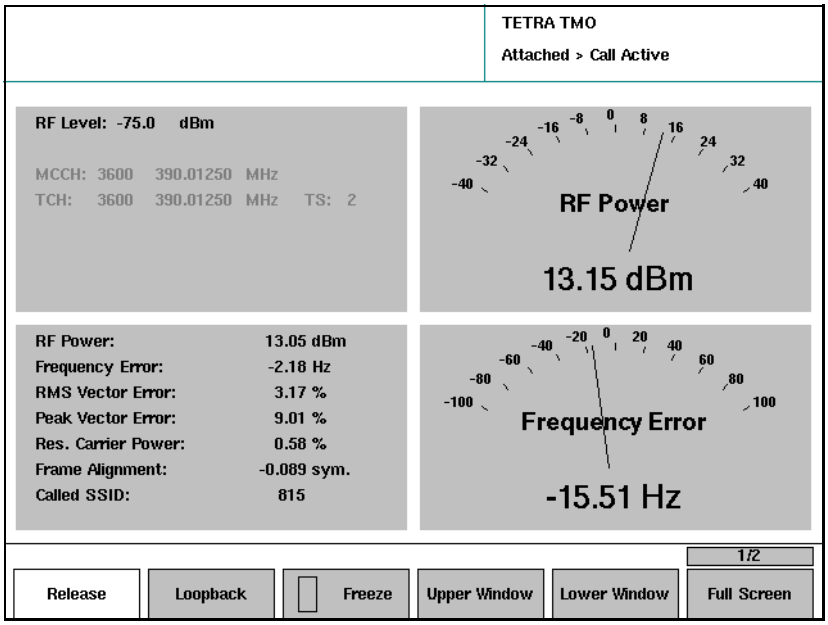
6 Set up the call parameters as explained in "Setting up the call parameters" on page 16. In particular, enter the call setup type (Individual Duplex or Individual Simplex); the Short Subscriber ID and the dynamic group number are not required in an individual, outgoing call.

7 On the MS, dial a number in the range from 1 to 16,777,215 using as many different numeric keys as possible (e.g. 12345678) and verify the dialed number on the display of the MS.

8 Push the Call key on the MS.
An individual call is set up and the Call Active menu appears. You can now perform radio measurements.

NOTE

If the call fails or when the call is released, the Attached menu re-appears.



9 To stop the call, push the release button on either the MS or the 2303 Stabilock.
The Attached menu appears again. The MS is still attached to the network and you can now perform another call.

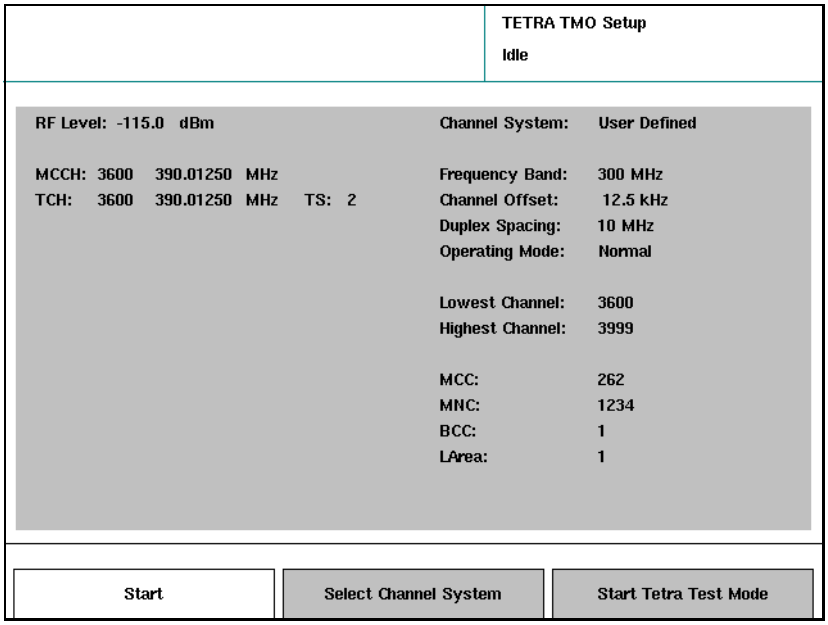
Testing the incoming group call

The purpose of the incoming group call test is to verify that the MS can be reached under the programmed group number.
The call can also be used to intiate transmitter and receiver measurements.

In order to test the incoming call capabilities, proceed as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

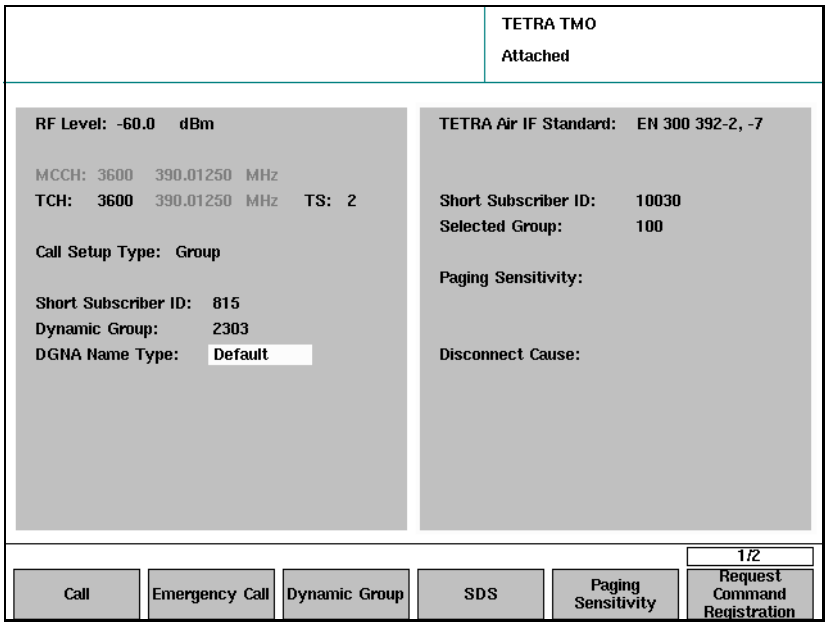
2 On the Welcome menu, press the **TETRA TMO** softkey.
The TETRA TMO Setup menu appears.



3 Set up the parameters for the network and base station as described in "Setting up the network parameters" on page 13.

4 Press the **Start** softkey.
The TETRA TMO menu appears.

5 Switch on the MS and wait until the 2303 displays Attached in the upper right corner.
The air interface standard version supported and the Short Subscriber ID of the MS are displayed on the right-hand side of the menu.



6 Set up the call parameters as explained in "Setting up the call parameters" on page 16. In particular, enter the call setup type and the dynamic group number; the Short Subscriber ID is not required in an incoming group call.

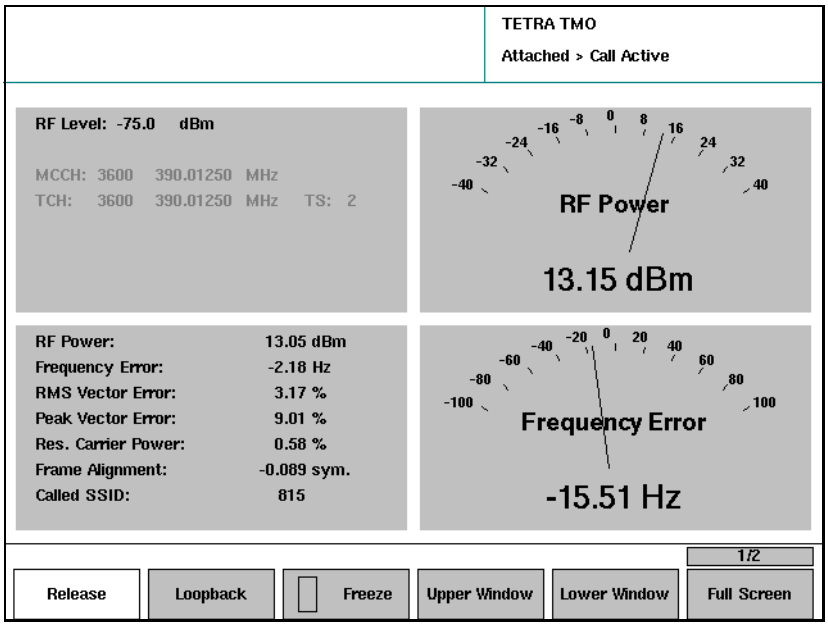
7 If the TETRA MS does not hold any pre-programmed group numbers:
Push the **Dynamic Group** softkey. (Observe warning on page 18.)
The group number entered in step 6 is assigned to the MS.
You will be asked if the 2303 Stabilock shall assign the dynamic group number permanently or temporarily. If you do not want the MS to keep the number used for test purposes, select "Temporary".

8 Push the **Call** softkey at the 2303.
The TETRA MS alerts.

9 Accept the call by pressing the PTT button.
The Call Active menu appears. You can now perform radio measurements (see "Performing transmitter tests" on page 54).

NOTE

If the call fails or when the call is released, the Attach menu re-appears.



10 To stop the call, push the release button on either the MS or the 2303 Stabilock.
The Attach menu appears again. The MS is still attached to the network and you can now perform another call.

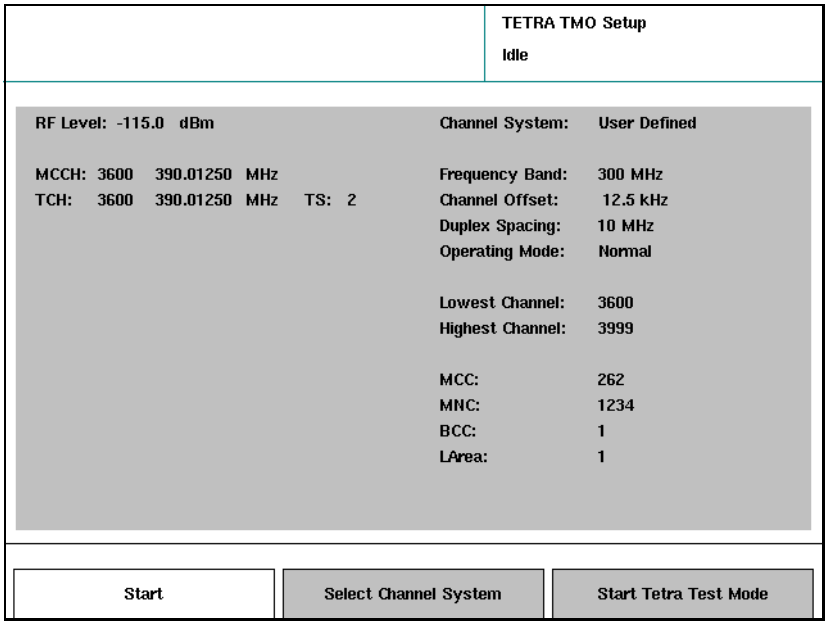
Testing the incoming emergency call

The purpose of the incoming emergency call test is to verify that the TETRA MS alerts the user accordingly when an emergency call is received.
The call can also be used to intiate transmitter and receiver measurements.

In order to test the incoming call capabilities, proceed as follows:

1 Connect the MS as described in "Connecting the device under test" on page 11.

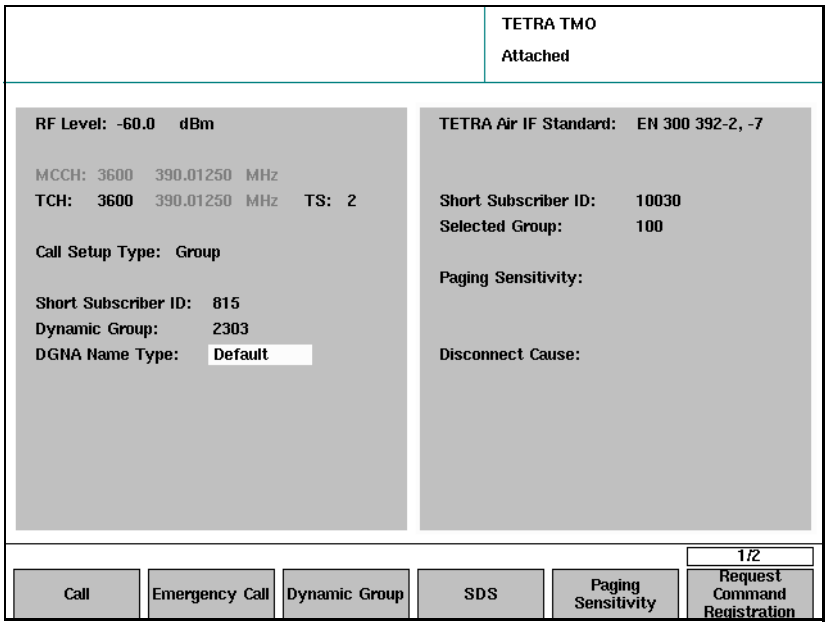
2 On the Welcome menu, press the **TETRA TMO** softkey.
The TETRA TMO Setup menu appears.



3 Set up the parameters for the network and base station as described in "Setting up the network parameters" on page 13.

4 Press the **Start** softkey.
The TETRA TMO menu appears.

5 Switch on the MS and wait until the 2303 displays Attached in the upper right corner.
The air interface standard version supported and the Short Subscriber ID of the MS are displayed on the right-hand side of the menu.



6 Set up the call parameters as explained in "Setting up the call parameters" on page 16. In particular, enter the call setup type; the Short Subscriber ID and the group number are not required in an incoming emergency call.

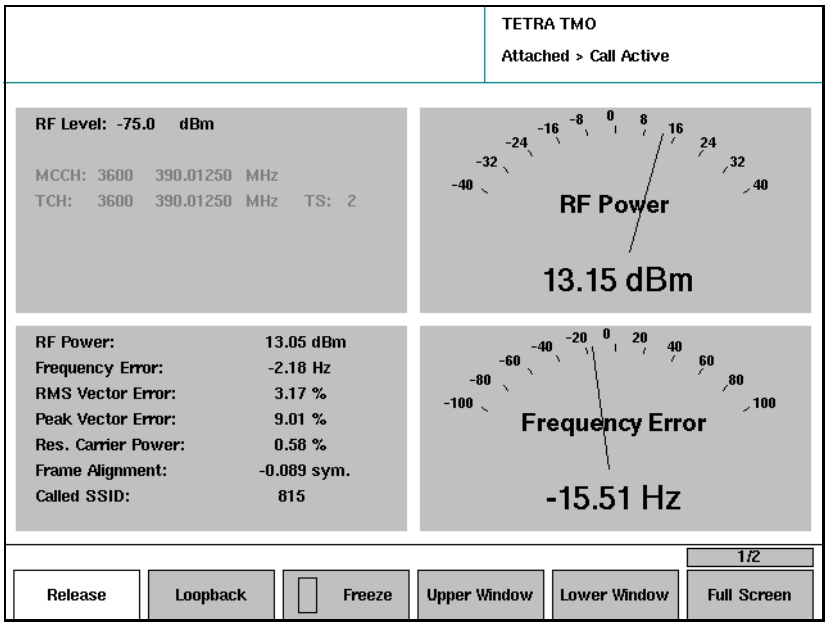
7 Push the **Emergency Call** softkey at the 2303.
The TETRA MS alerts.

8 Check if the acoustic and visual alert is according to the settings for an emergency call.

9 Accept the call by pressing the PTT button.
The Call Active menu appears. You can now perform radio measurements (see "Performing transmitter tests" on page 54).

NOTE

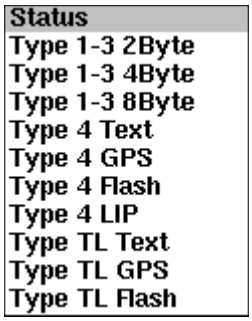
If the call fails or when the call is released, the Attach menu re-appears.



10 To stop the call, push the release button on either the MS or the 2303 Stabilock.
The Attach menu appears again. The MS is still attached to the network and you can now perform another call.

Testing the short data service capabilities

The 2303 Stabilock can send, receive and display the various types of SDS (Short Data Service) messages defined in the TETRA standard. The supported types are:



For transmission of an SDS message, data can be entered for the respective message type. For Status messages, for example, a predefined message can be selected in the Status Message line (see "Defining SDS status messages" on page 25). For byte-type messages, a decimal number can be entered, and for text messages, text can be entered using the alphanumerical keypad.

The TETRA TMO SDS menu displays two sections – the upper part contains the message that the 2303 Stabilock is to send, and the lower part displays the message received from the TETRA MS.

Sending an SDS message to the TETRA radio

In order to send an SDS message to the TETRA radio, proceed as follows:

1 On the Welcome menu, press **TETRA TMO > Start > SDS**.
The TETRA TMO SDS menu appears.

2 Select the RF level (the level from the TETRA TMO menu is selected by default).

3 Select an SDS message type from the list that appears either by selecting the SDS Type menu item in the upper section, or by pushing the **SDS Type** softkey.

4 Select or enter the contents of the message in the Message field.

5 Push **Send SDS** to send the message.
The message is sent to the TETRA radio; the radio may display the message and/or return an SDS message to the 2303 Stabilock.

Note

Whether or not the TETRA radio displays the message sent, depends on the capabilities programmed into the radio.

Receiving an SDS message

While on the TETRA TMO SDS menu, the 2303 Stabilock always displays the last message received from the TETRA radio in the lower section of the menu.

Testing the Direct Mode capability

The Direct Mode test and associated measurements are described in Chapter 4 ‘‘Testing the TETRA Radio in Direct Mode’’.

Performing transmitter tests

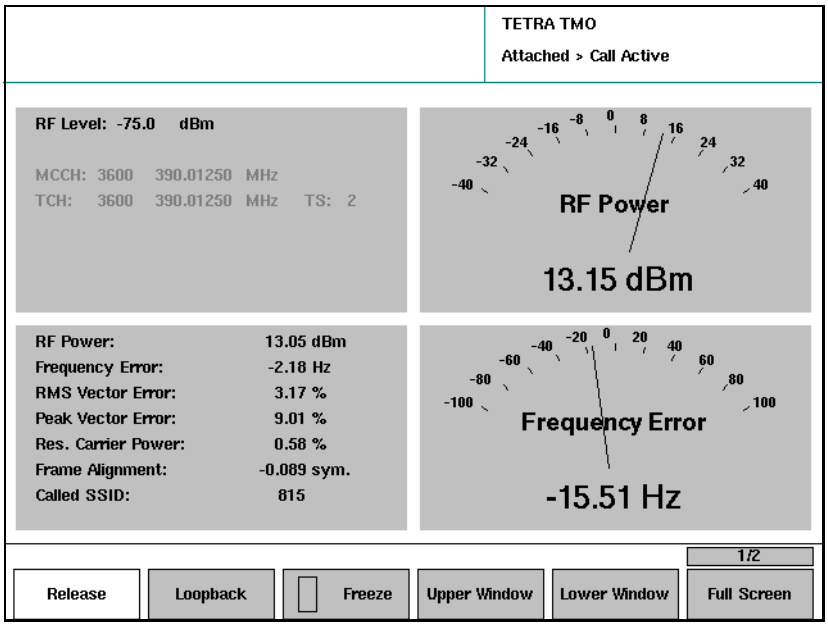
Measuring the transmit power

This measurement relates to the average transmit power in the active part of the time slot. Separate measurements relate to the residual carrier power and the burst profile.

The transmit power is averaged over the active time slot. The power level of the TETRA MS depends on the signal strength received from the base station, i.e. the 2303 Stabilock. See "Power levels in TETRA" on page 113 for more information about power control, power levels and tolerances.

To take a power measurement, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in "Testing the incoming call (mobile terminated)" on page 43 or "Testing the outgoing call (mobile originated)" on page 45. An individual call is set up and the Call Active menu appears.

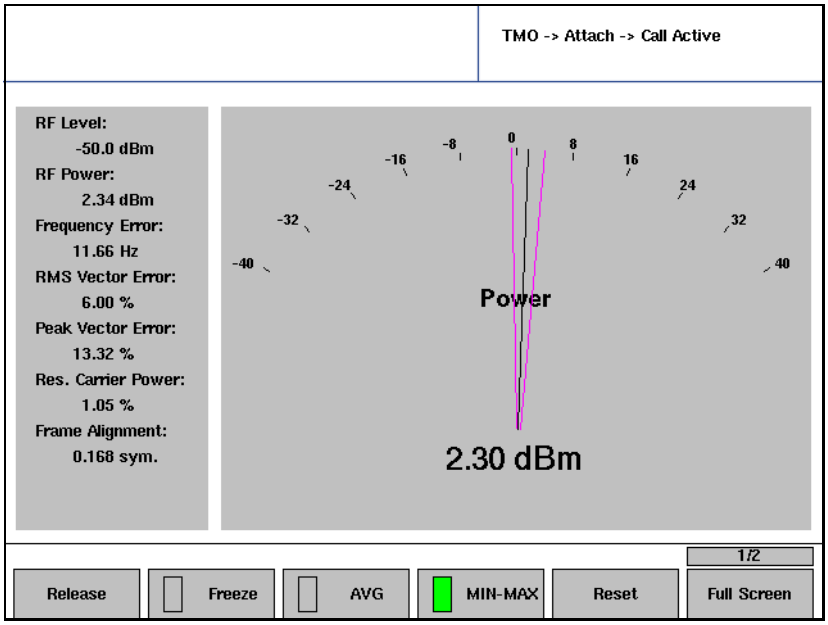


2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 Read the Power value on the left-hand side of the menu.
You can compare the power measurement value to limits if you know a) the power class and b) the current power step.

4 You can also configure one of the pointer instruments on the right-hand side to display the power level by pushing the **Upper Window** or **Lower Window** softkey and selecting **Power**.

5 Alternatively, you can even have the power level graphically displayed in large size by pushing the **Full Screen** softkey and selecting **Power**. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) displayed by pushing the **MIN-MAX** softkey to the on state, i.e. until the green rectangle appears, indicating that the minimum and maximum pointers are switched on.



6 While the call is active, you can also perform other transmitter measurements.

7 When you are finished with measurements you can stop the call by pushing the Release button on either the MS or the 2303 Stabilock. The Attach menu appears again. The MS is still attached to the network.

Measuring the frequency error

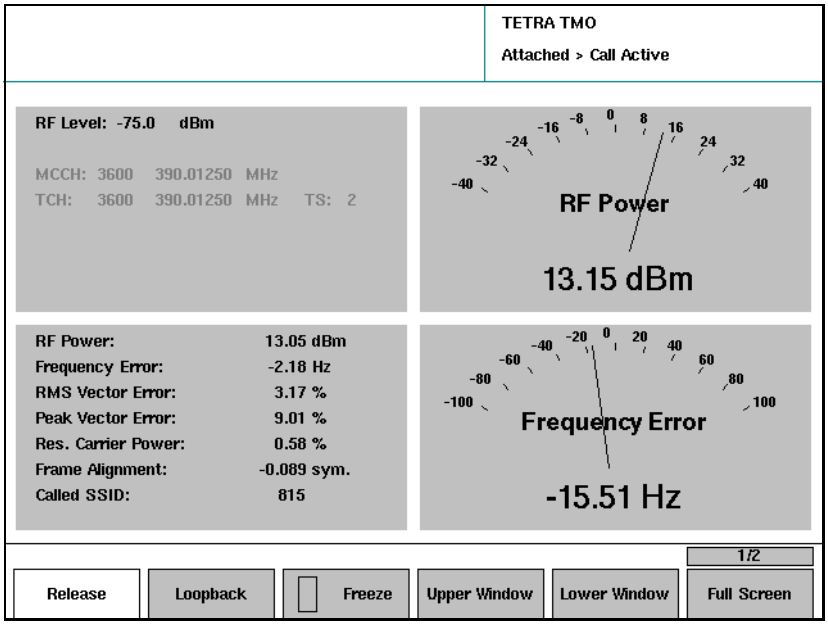
The frequency error is a measure of the TETRA mobile station's capability to keep its base frequency locked to the base station's center frequency.

NOTE

According to the TETRA specifications (EN 300 394-1), the frequency error should not exceed 100 Hz.

To take a frequency error measurement, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in "Testing the incoming call (mobile terminated)" on page 43 or "Testing the outgoing call (mobile originated)" on page 45. An individual call is set up and the Call Active menu appears.

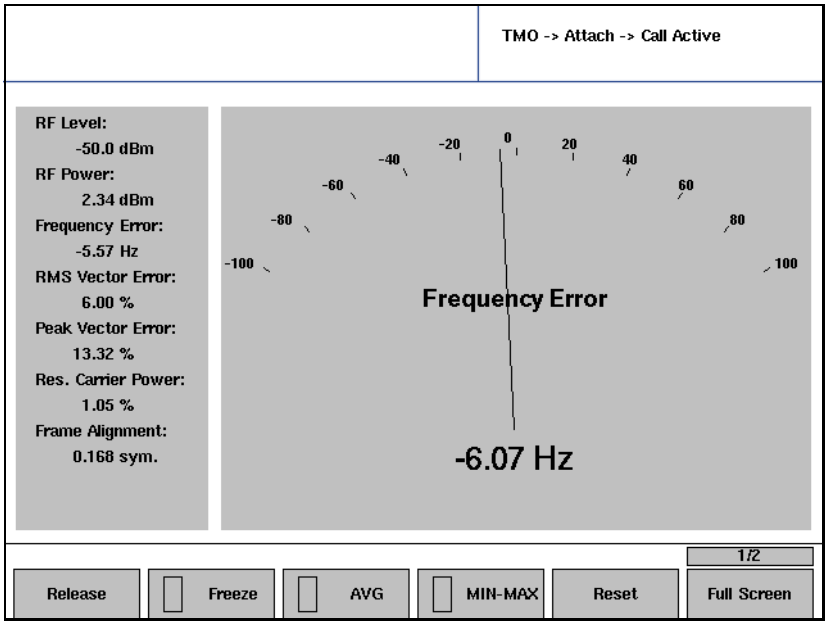


2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 Read the Frequency Error value on the left-hand side of the menu.

4 You can also configure one of the pointer instruments on the right-hand side to display the frequency error by pushing the **Upper Window** or **Lower Window** softkey and selecting **Frequency Offset**.

5 Alternatively, you can even have the frequency error graphically displayed in large size by pushing the **Full Screen** softkey and selecting **Frequency Offset**. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) displayed by pushing the **MIN-MAX** softkey until the function is de-activated (indicated by the green rectangular in the softkey description field disappearing).



6 While the call is active, you can also perform other transmitter measurements.

7 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock. The Call Active menu appears again. The MS is still attached to the network.

Measuring the modulation error (vector error)

The vector error is a measure of the TETRA mobile station's modulation quality. The lower the vector error, the better the radio connection will be at low receive levels or under interference conditions.

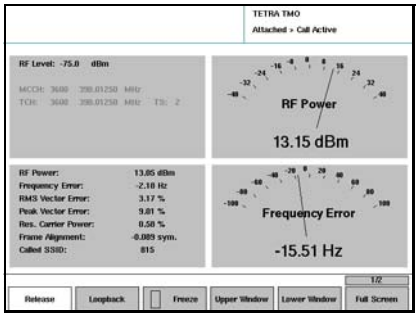
The vector error is calculated for each symbol; the maximum (peak) value over all the symbols of a burst is examined as well as the RMS average.

NOTE

According to the TETRA specifications (EN 300 394-1), the RMS vector error should not exceed 10%; the peak vector error should be less than 30%.

To take vector error measurements, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in ''Testing the incoming call (mobile terminated)'' on page 43 or ''Testing the outgoing call (mobile originated)'' on page 45. An individual call is set up and the Call Active menu appears.

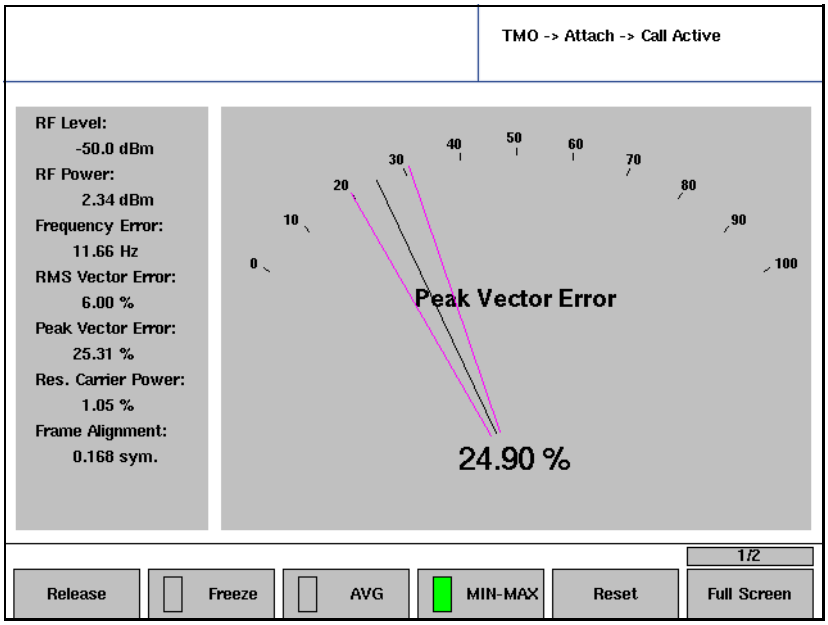


2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 Read the RMS Vector Error and the Peak Vector Error values on the left-hand side of the menu.

4 You can also configure one of the pointer instruments on the right-hand side to display the vector error by pushing the **Upper Window** or **Lower Window** softkey and selecting the corresponding vector error measurement (**RMS Error** or **Peak Error**).

5 Alternatively, you can even have the vector error graphically displayed in large size by pushing the **Full Screen** softkey and selecting the corresponding vector error measurement. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) displayed by pushing the **MIN-MAX OFF** softkey.



6 While the call is active, you can also perform other transmitter measurements.

7 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock.
The Attach menu appears again. The MS is still attached to the network.

Measuring the residual carrier power

The residual carrier power is a measure of the TETRA mobile station's modulation quality and may caused by DC offsets in the I and Q signal paths. The lower the carrier power, the better the radio connection will be at low receive levels or under interference conditions.

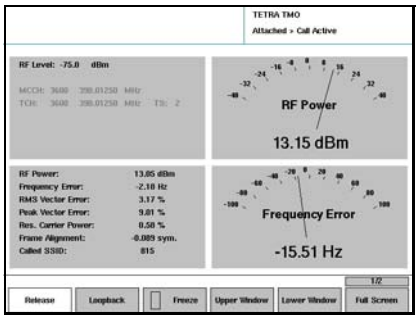
The residual carrier power is calculated over all symbols of a burst.

NOTE

According to the TETRA specifications (EN 300 394-1), the residual carrier magnitude should not exceed 5%.

To take residual carrier power measurements, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in "Testing the incoming call (mobile terminated)" on page 43 or "Testing the outgoing call (mobile originated)" on page 45. An individual call is set up and the Call Active menu appears.



2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 Read the Res. Carrier Power values on the left-hand side of the menu.

4 While the call is active, you can also perform other transmitter measurements.

5 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock.
The Attach menu appears again. The MS is still attached to the network.

Viewing the modulation error in the constellation diagram

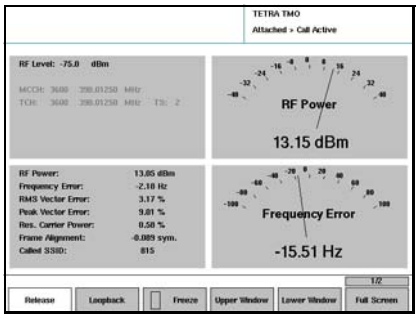
The constellation diagram allows you to test the modulation characteristics of the mobile. The 2303 offers fast visual judgement of the modulation quality with the graphical representation of the modulation quality in several configurable ways. The horizontal axis shows the in-phase component (I) of the signal while the vertical axis displays the quadature component (Q), normalized to the average burst power.

NOTE

Willtek offers the constellation display for your convenience, e.g. for modulator alignment; it is not a measurement specified in TETRA specification EN 300 394-1.

To view the constellation diagram, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in "Testing the incoming call (mobile terminated)" on page 43 or "Testing the outgoing call (mobile originated)" on page 45. An individual call is set up and the Call Active menu appears.

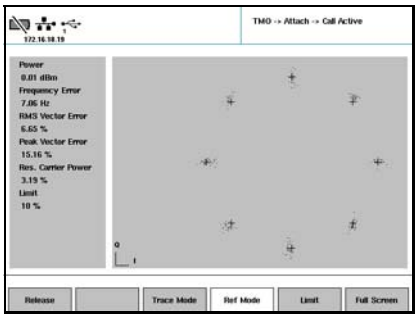


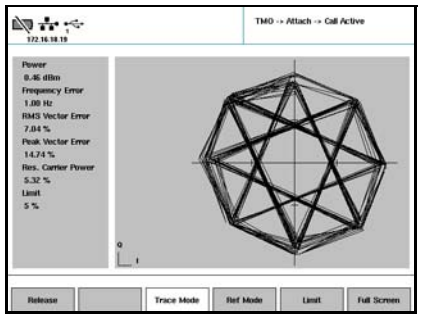
2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

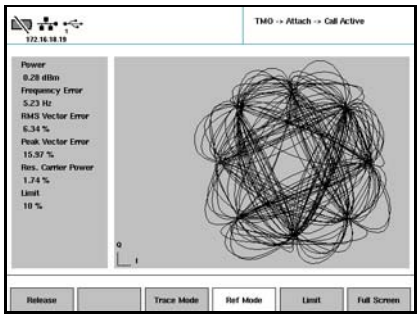
3 You can now configure one of the graphs on the right-hand side to show the constellation display by pushing the **Upper Window** or **Lower Window** softkey and selecting **Constellation**.

4 You can have the constellation display shown in large size instead by pushing the **Full Screen** softkey and selecting **Constellation**. The display is configurable:

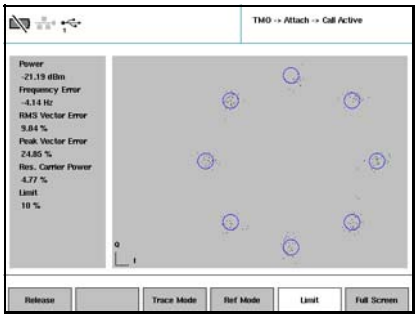
– Push **Trace Mode** and select one of the options (**Dots**, **Lines, Phase Tracer**) from the pull-down menu.

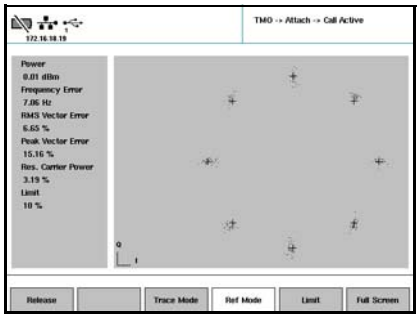


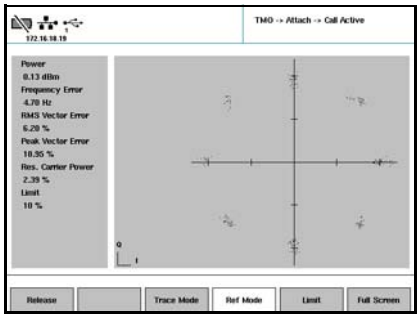




– Push **Ref Mode** and select one of the options from the pull-down menu: **Ref Circles** for a limit circle around each point of maximum effect,
Ref Lines for a cross-hair at each point of maximum effect,
Ref Scale for coordinate axes.







– Push **Limit** and select either **5 %** or **10 %** as the limit for the peak vector error. The selected limit is then shown as a circle while Ref Circles is selected.

When you are finished with the full-screen constellation display, return to the Call Active menu by pushing the **ESC** button.

5 While the call is active, you can also perform other transmitter measurements.

6 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock. The Attach menu appears again. The MS is still attached to the network.

Viewing the burst profile

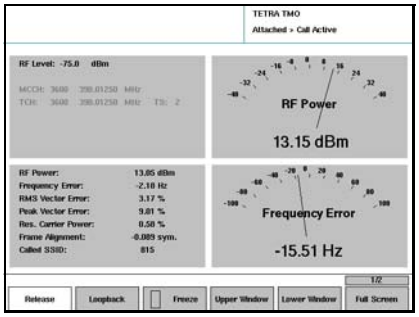
The burst profile display allows you to assess the TETRA mobile station's ability to ramp up and down the power level within the required time, and to keep the power level during the active part of the burst at a constant power level for the points of maximum effect.

NOTE

According to the TETRA specifications (EN 300 392-2), the following power limits apply:
During the last 16 symbol periods before the first information symbol is transmitted, the power level must not exceed 6 dB above the average burst power during the active part.
During the first 15 symbol periods after the last information symbol is transmitted, the power level must not exceed 3 dB above the average burst power during the active part.

To view the burst profile, proceed as follows:

1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in ''Testing the incoming call (mobile terminated)'' on page 43 or ''Testing the outgoing call (mobile originated)'' on page 45. An individual call is set up and the Call Active menu appears.



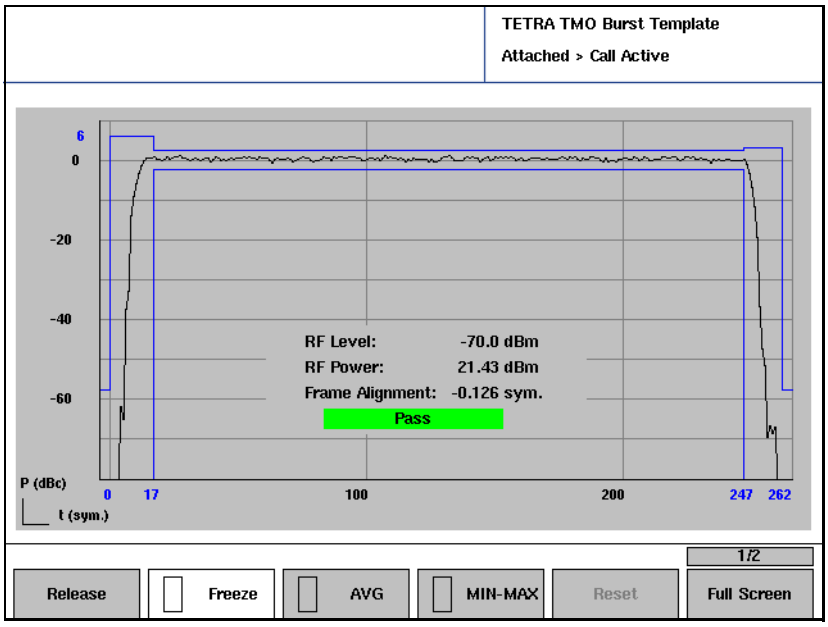
2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 You can now configure one of the graphs on the right-hand side to show the burst profile by pushing the **Upper Window** or **Lower Window** softkey and selecting **Burst Template**.

4 You can have the burst profile shown in large size instead by pushing the **Full Screen** softkey and selecting **Burst Template**.
The burst profile is shown (with 16 leading symbol periods, 231 symbol periods as the active part of the burst and 15 trailing symbol periods). The horizontal axis shows the time in bit periods, the vertical axis indicates the power level in dBc. In addition, the timing error of the burst is shown in multiples of symbol periods (Frame alignment).

NOTE

According to the TETRA specifications (EN 300 394-1), the burst timing error (frame alignment) should not exceed ±0.25 symbol periods.



5 When you are finished with the full-screen burst profile display, return to the Call Active menu by pushing the **ESC** button.

6 While the call is active, you can also perform other transmitter measurements.

7 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock. The Attach menu appears again. The MS is still attached to the network.

Viewing the modulation spectrum

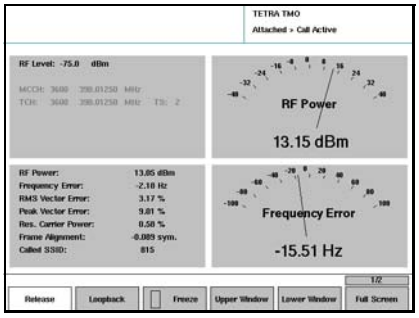
The modulation spectrum display allows you to assess the TETRA mobile station's modulation quality in the frequency domain.

The modulation spectrum is shown in the range ±18 kHz from the carrier frequency, i.e. the span is 36 kHz.

The horizontal axis shows the frequency in kHz, the vertical axis indicates the power spectrum density. The vertical blue lines indicate the boundaries of the 25 kHz TETRA channel.

To view the modulation spectrum, proceed as follows:

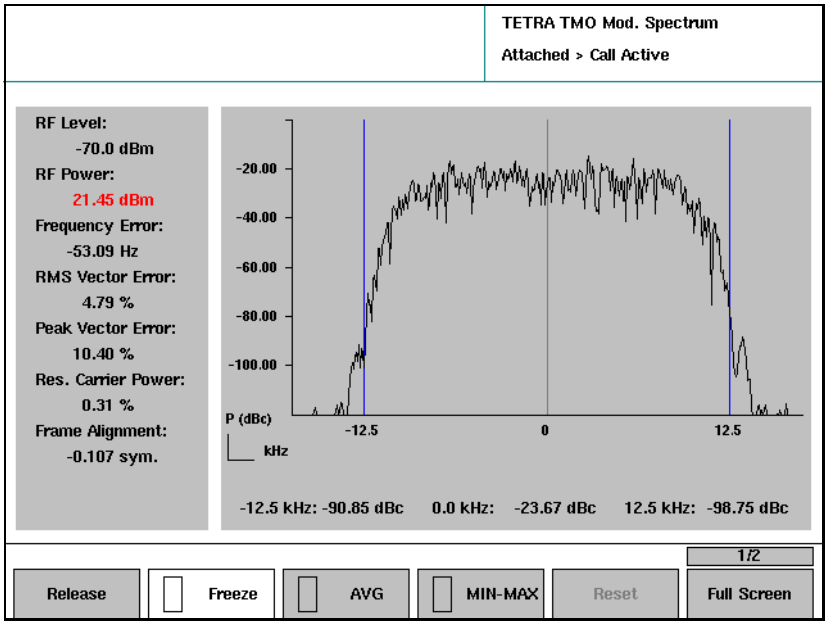
1 Connect the TETRA MS, initialize the 2303 Stabilock and set up a call as described in "Testing the incoming call (mobile terminated)" on page 43 or "Testing the outgoing call (mobile originated)" on page 45. An individual call is set up and the Call Active menu appears.



2 If you have set up an individual simplex call, keep the PTT button of the MS pressed.
The MS transmits, and the 2303 Stabilock continually updates the measurement results.

3 You can now configure one of the graphs on the right-hand side to show the burst profile by pushing the **Upper Window** or **Lower Window** softkey and selecting **Mod Spectrum**.

4 You can have the burst profile shown in large size instead by pushing the **Full Screen** softkey and selecting **Mod Spectrum**.
The modulation spectrum is displayed along with the power at the band center and the edges.



5 When you are finished with the full-screen modulation spectrum display, return to the Call Active menu by pushing the **ESC** button.

6 While the call is active, you can also perform other transmitter measurements.

7 When you are finished with measurements you can stop the call by pushing the release button on either the MS or the 2303 Stabilock. The Attach menu appears again. The MS is still attached to the network.

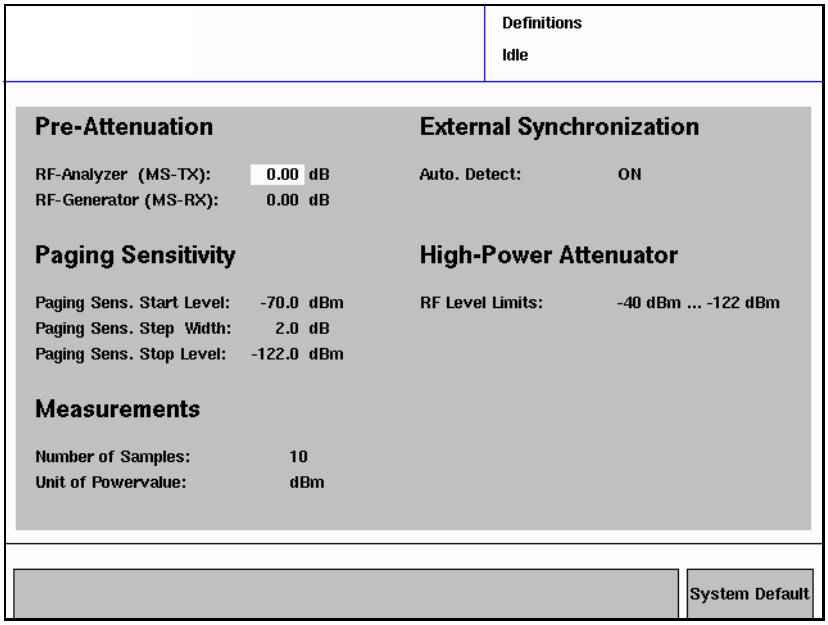
Performing receiver tests

This section describes the receiver tests supported by the 2303 Stabilock in call mode under Trunked Mode Operation. Please also refer to "Performing receiver measurements" on page 87 in Chapter 5 "Performing Tests without a Call Setup".

Paging Sensitivity test

In the paging sensitivity test, the 2303 Stabilock pages the TETRA radio at a defined power level. If the radio responds, the test is passed for that level, the instrument decreases its power level and repeats the test. This continues until a predefined power level is reached. The paging sensitivity test is passed if the TETRA radio still responds at a predefined (low) power.

1 From the Welcome menu, select **Setup > Definitions**.
The Definitions menu appears.



Note

The Definitions menu can also be called up directly from measurement menus by selecting **...** > **Definitions**. By returning from the Definitions menu to the measurement menu, the measurements will be reset and started with the new averaging and pre-attenuation values.

2 Set up the Paging Sensitivity test parameters:

   a Paging Sens. Start Level is the receive power level in the TETRA radio at which the paging sensitivity test is started.

   b Paging Sens. Step Width is the interval by which the receive power level is decreased in each test step.

   c Paging Sens. Stop Level defines the lowest receive power level at which the paging sensitivity test is performed (unless the radio fails the test at a higher level).

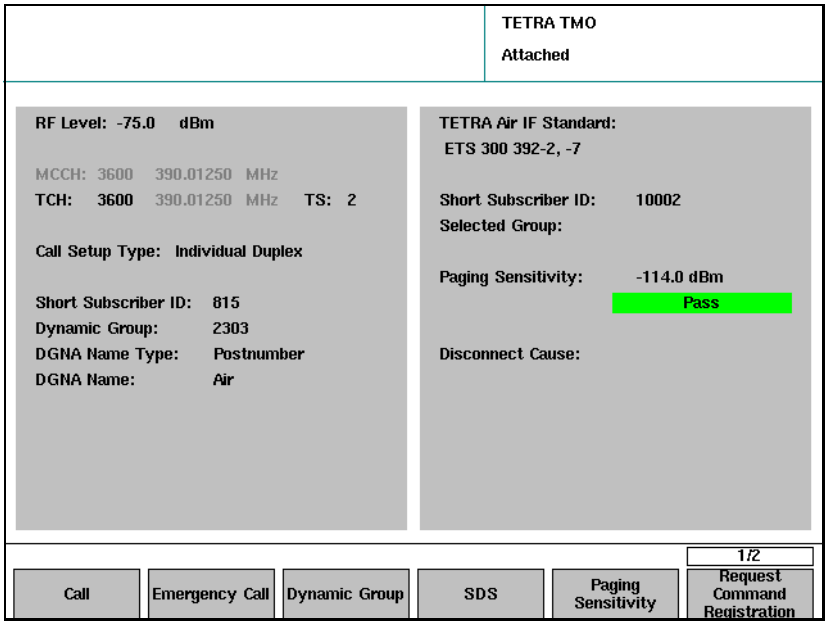
   d Paging Sens. Retries specifies how often the TETRA radio is paged on any power level step before the test is failed.

3 Return to the Welcome menu by selecting **ESC** twice.

4 Select **TETRA TMO > Start** and wait until the radio is attached.

5 Push the **Paging Sensitivity** softkey.
The test is started and the TETRA radio is paged while the power level is reduced until the paging sensitivity stop level has been reached.

6 The result of the paging sensitivity test is displayed on the right-hand side of the menu.



TETRA Test Mode

With Edition 2 in 1999, the ETSI conformance testing specification for TETRA introduced a new, mandatory TETRA Test protocol for RF loop back tests, enabling in particular receiver measurements. This method allows a test set to set up a connection, transmit a pseudo-random bit sequence (PRBS) to the TETRA radio and receive the data looped back over the RF to calculate the bit error rate.

The 2303 Stabilock supports BER and MER measurements on a voice channel (TCH/S) with and without frame erasure.

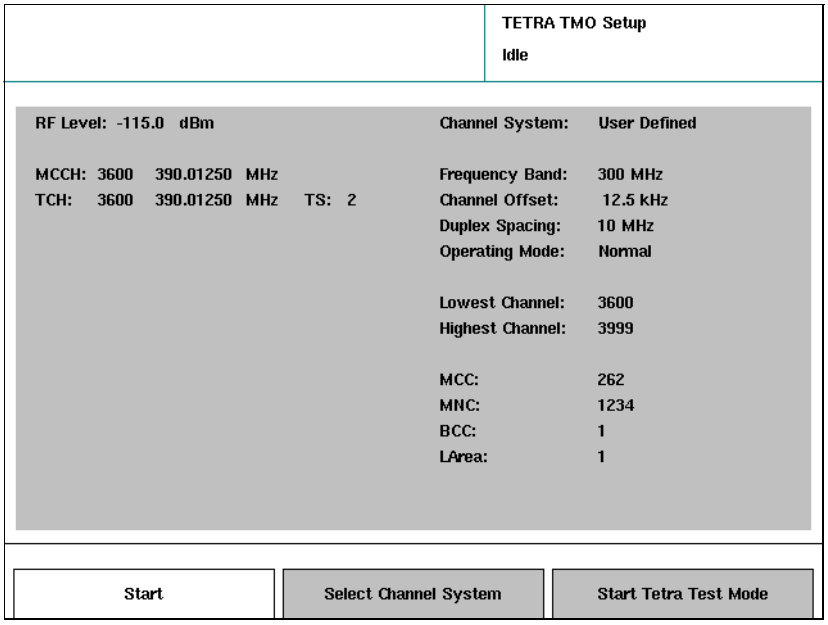
The TETRA Test mode uses an extended TETRA protocol to measure the receiver performance. Additional receiver measurements utilizing non-call mode features are the T1 loopback BER and the single-ended receiver measurements; please refer to "Performing receiver measurements" on page 87 for more information.

Preparing and starting a receiver measurement

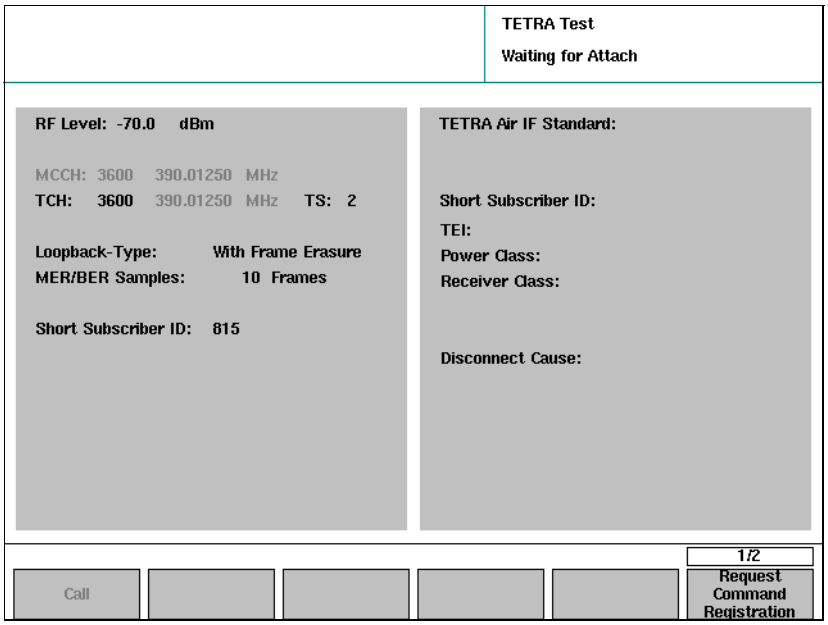
1 From the Welcome menu, select TETRA TMO to enter the TETRA TMO Setup menu, and select the parameters as outlined in "Setting up the network parameters" on page 13.

Note

The entries for MCC and MNC are ignored for the purposes of the TETRA Test mode; they are both set to 1.



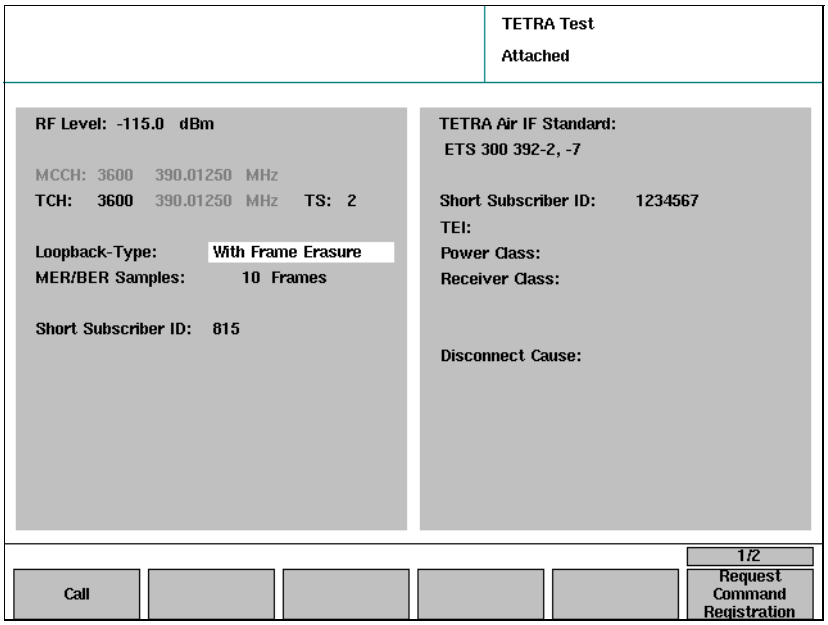
2 Select "Start Tetra Test Mode".
The TETRA Test menu appears.



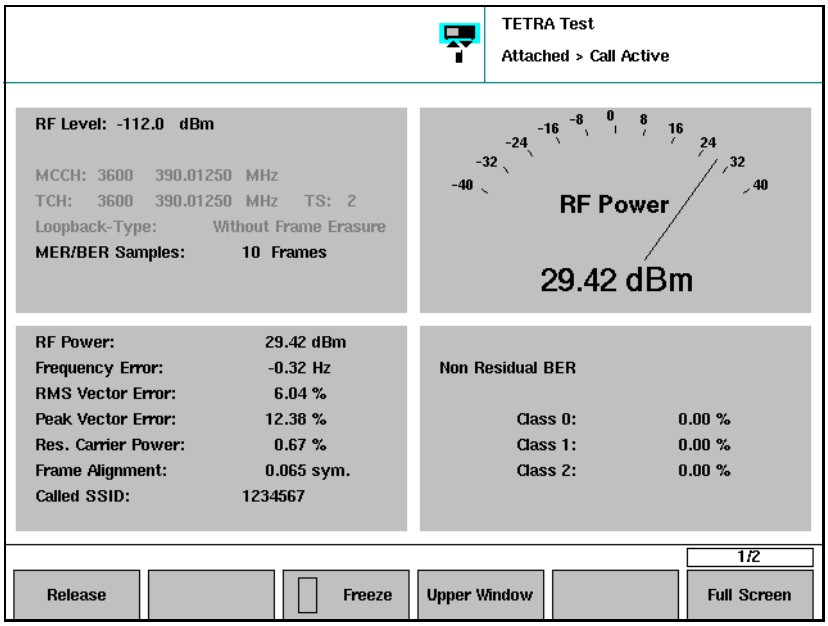
3 Enter the RF level, the traffic channel, the time slot and the short subscriber ID as explained in "Setting up the call parameters" on page 16.

4 Select a loopback type. Available types are "with frame erasure" and "without frame erasure".
Loopback with frame erasure supports BER measurements on class 0 bits (unprotected on the air interface) and class 2 bits (with strong protection against failure).
Loopback without frame erasure supports BER measurements on class 0 bits, class 1 bits and the measurements of the Message Erasure Rate (MER).

5 Activate the TETRA Test mode in the mobile station.
The TETRA radio registers with the 2303 Stabilock.The Stabilock requests important parameters from the TETRA radio and displays them on the right-hand side of the menu. These parameters are Short Subscriber ID, TEI, Power Class and Receiver Class. See section "Understanding TETRA radio parameters in TETRA Test Mode" on page 70 for a discussion of these parameters.



6 Push **Call** to set up a voice channel and activate the loop.
The Call Active menu appears. You can now switch between different views and observe the measurement results.



> ***Note***
>
> In TETRA Test mode you can switch between different views as in TMO, except that the window on the lower right-hand side is not configurable. It will always display the receiver results instead.

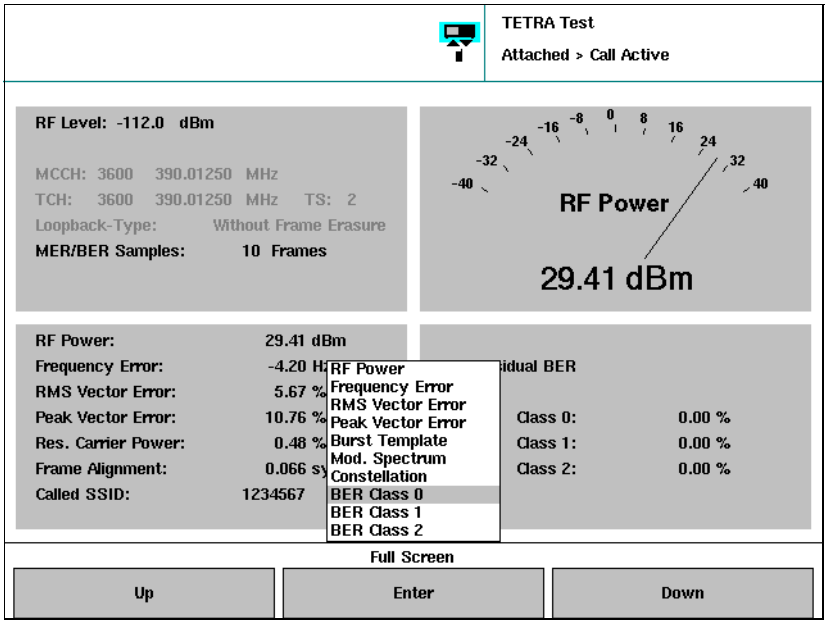
Performing measurements

Upper and lower results window

The measurement window on the lower right-hand side always displays the receiver measurement results. The window on the upper right-hand side is configurable using the **Upper Window** softkey.

Observing results in full-screen mode

In order to observe one (set of) results in large, push the **Full Screen** softkey.
A pull-up menu appears, offering different measurement views.



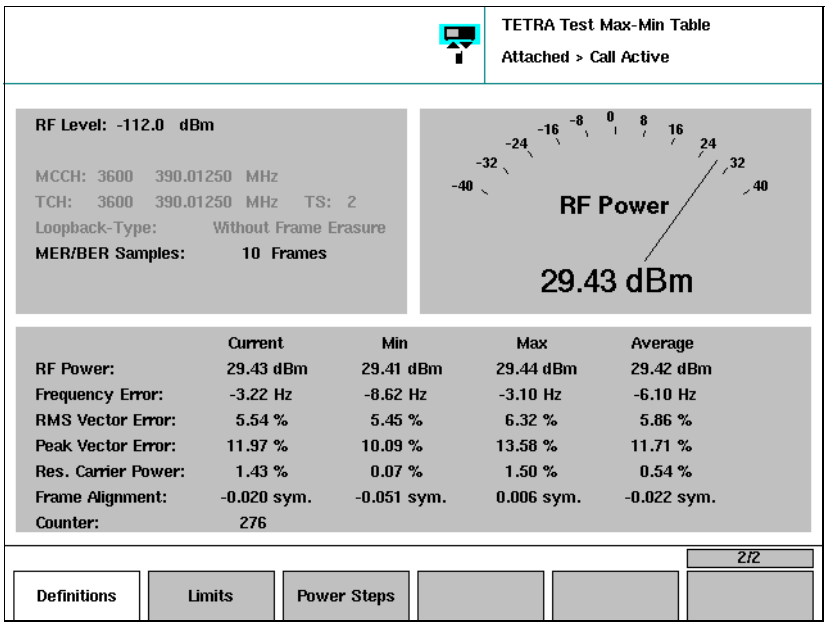
Measurement samples, results, counter

Each BER measurement sample on a TCH/S is comprised of 51 class 0 bits (unprotected), 56 class 1 bits (moderately protected) and 30 class 2 bits (strongly protected).

Each numerical measurement result presented is an average over a defined number of samples. The number of samples over which the 2303 Stabilock averages is defined in the Definitions menu.

Please note that the average values presented in the TETRA Test Max-Min Table menu are an average of all the measurement results since the start of the test.

The measurement counter in the TETRA Test Max-Min Table menu is incremented with each measurement result. If the number of measurement samples over which the 2303 averages is very low, the results appear at a very high rate and the 2303 may not be able to display all of them. This is why the counter may increment at step size higher than 1.



Understanding TETRA radio parameters in TETRA Test Mode

The TETRA Test Mode provides an opportunity to request information about the TETRA radio that is not normally available over the radio interface.

Short Subscriber ID

The short subscriber ID is a number used over the radio interface to identify individual TETRA mobile stations. See also "Short Subscriber ID" on page 17.

TEI

The TETRA Equipment Identifier (TEI) is the electronic serial number of the TETRA radio. It consists of six-digit type approval code (TAC), a 2-digit final assembly code (FAC), a 6-digit electronic serial number (ESN) and a 1-digit spare number. Each digit is a hexadecimal number (from 0 to 9 or A to F).

Power Class

The power class determines the maximum power that the TETRA radio can transmit. See a list of power classes on page 113.

Receiver Class

Valid receiver classes are A, B, D and E. See "Glossary" on page 129 for a definition of receiver classes.

Testing the TETRA Radio in Direct Mode

4

This chapter provides task-based instructions for using the 2303 Stabilock to test the DMO function of the TETRA mobile station. Topics discussed in this chapter are as follows:

Introduction

This chapter shows how the direct mode operation of the TETRA radio can be tested using the 2303 Stabilock with the 2330 DMO Option. The functional test of the DMO capability can be complemented by transmitter measurements.

In DMO, the TETRA radios communicate directly with each other, without a base station. The 2303 Stabilock simulates a DMO radio that is already transmitting a presence signal. If the radio parameters of the 2303 and the TETRA mobile match, the mobile should be able to find the channel with the presence signal. By pressing the PTT button, the transmitter is keyed on and measurements can be performed.

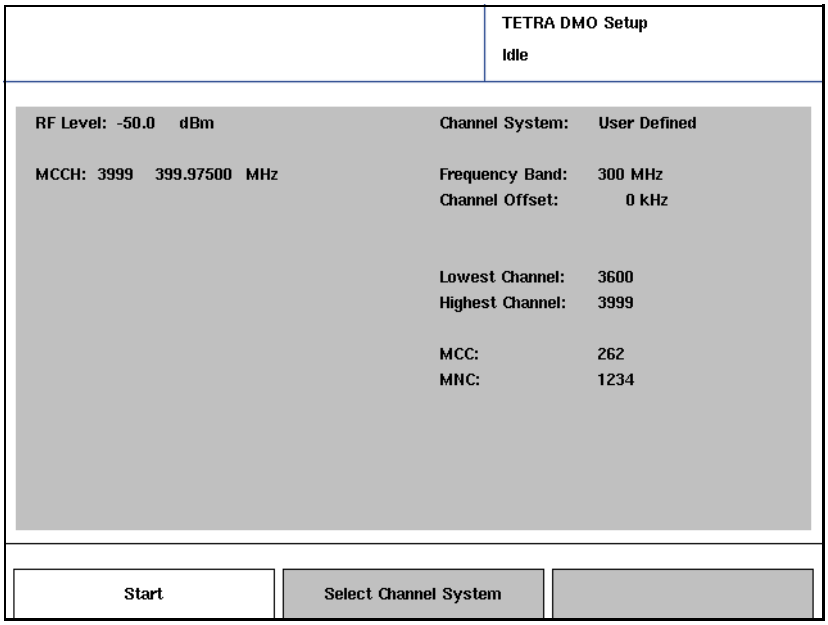
Preparing the measurement

In this step, the TETRA MS and the 2303 Stabilock are prepared for the measurements.

Prepare the TETRA tester and the TETRA radio as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

2 On the Welcome menu, press the **TETRA DMO** softkey.
The TETRA DMO Setup menu appears. The parameters are explained briefly below; for more details, please refer to section "Setting up the network parameters" on page 13.



3 Push the **Select Channel System** softkey to select a set of predefined channel parameters. Alternatively, if the RF and network parameters required are not stored in a file, proceed as follows:

a On the right-hand side of the menu, enter the lowest and highest channel number supported by the TETRA radio under test. (These parameters are for your convenience to avoid trying to test on channels that are not supported by the mobile station.)

b Select the frequency band and channel offset.

4 On the left-hand side of the menu, set the RF Level value according to your requirements. This is the output level of Stabilock's RF generator.

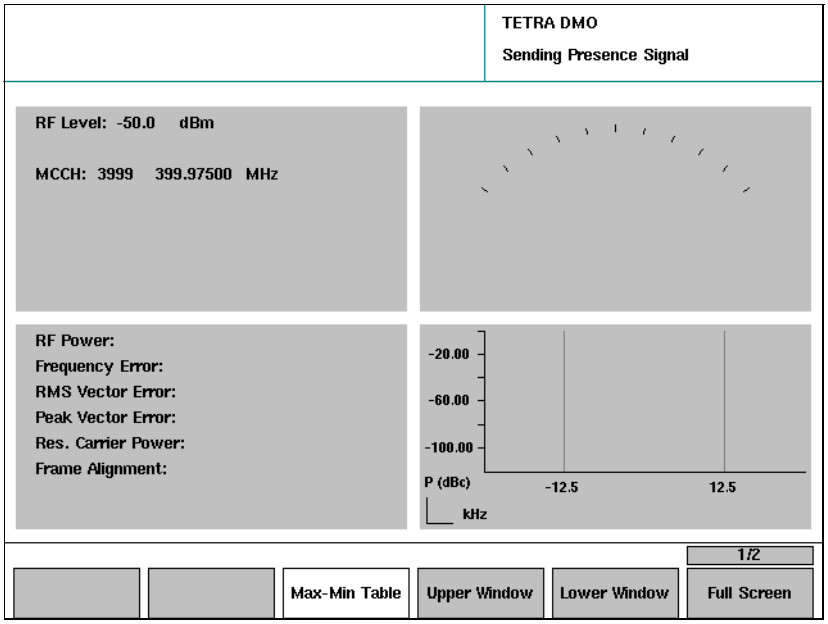
5 Enter the channel number or center frequency under MCCH. This is the frequency on which either the 2303 or the TETRA radio will transmit. (There is no duplex spacing in DMO.)

Note

If you enter a frequency that does not correspond to the channel frequency system on the lower right-hand side of the menu, those channel frequency parameters will be changed accordingly.

Performing a DMO functional test

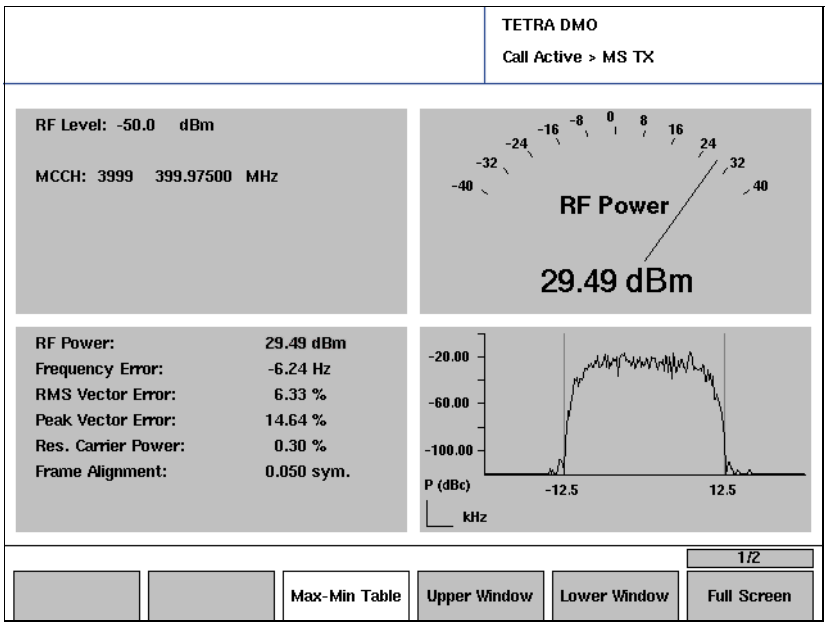
1 From the Welcome menu, select **TETRA DMO** > **Start** to proceed to the tests.
The 2303 displays the DMO menu and starts transmitting a presence signal.



2 Turn the TETRA MS on and switch it into DMO mode.
The 2303 emits a presence signal, allowing the TETRA radio to synchronize with the 2303.

3 When the MS indicates that it has found a DMO channel, keep the PTT pressel pushed.
The TETRA MS transmits a DMO signal in synchronization with the

2303's signal. The 2303 displays "Call Active > MS TX" in the upper right-hand corner of the menu, and transmitter measurement results in the results section.



Performing transmitter measurements

In DMO, the TETRA radio keeps transmitting DMO bursts while the PTT is pressed.

When the measurements are running (see "Preparing the measurement" on page 72), the following measurement results are available on the left-hand side of the TETRA DMO menu:

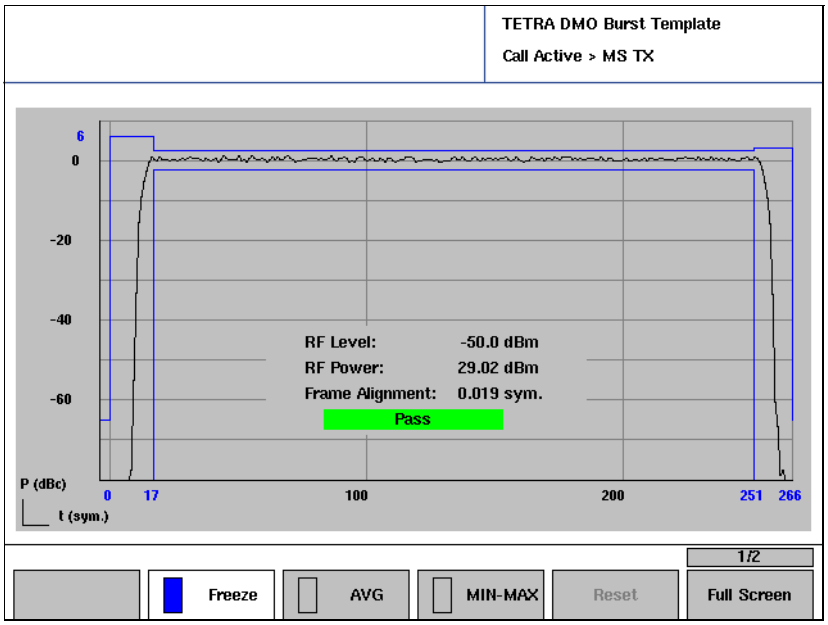
- RF power
- Frequency error
- RMS and peak vector error
- Residual carrier magnitude
- Frame alignment

Some of these measurements are also available in a graphical representation. Additional graphical measurements include:

- Burst profile
- Modulation spectrum
- Constellation diagram

The transmitter measurements are basically the same as in trunked mode (TMO), please see "Performing transmitter tests" on page 54. There are two exceptions:

– The frequency offset has different limits in DMO. The carrier frequency error in DMO must not exceed 1 kHz.
– The power-time template in DMO differs from that in trunked mode because the setup and length of the time slot is different. See a typical measurement below.



Performing Tests without a Call Setup

5

This chapter provides task-based instructions for using the 2303 Stabilock features in asynchronous mode. Topics discussed in this chapter are as follows:

Introduction

The tests and measurements shown in Chapter 3 "Performing Manual Tests and Measurements in Trunked Mode" assume a fully functional TETRA mobile station (MS) with call processing capabilities.

This chapter shows how transmitter measurements can be made without the need to set up a call beforehand. These measurements may even be possible without synchronization to a base station; that's why they are called asynchronous measurements.

The prerequisite for these measurement tasks is that the TETRA MS is in a special mode where it transmits without any registration and call processing. This mode is sometimes referred to as a service mode in the MS.

The signal to be measured should consist of either normal uplink bursts or a continuous signal made up of normal uplink bursts, with one of the defined training sequences.

The test steps are explained for the Generator/Analyzer mode. In addition, the 2303 Stabilock can also take measurements while generating a special test signal (T1). Details about the T1 signal generator can be found at the end of this chapter.

The 2303 Stabilock can perform transmitter measurements at continuous signals, synchronized burst signals (using the same frequency and time reference) and asynchronous burst signals. Although the 2303 Stabilock usually takes several measurements per second it may sometimes need a second between two measurements to resynchronize with the transmit signal.

Preparing the measurement

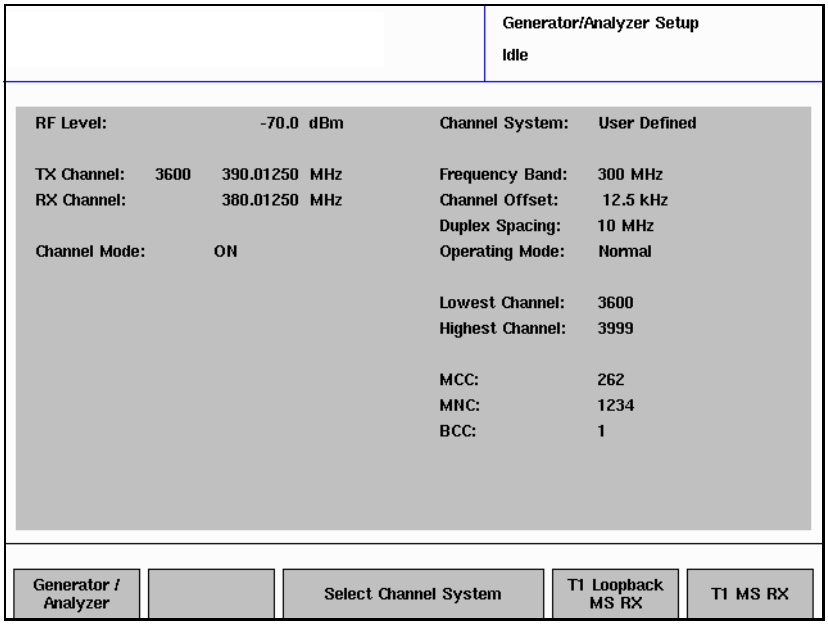
In this step, the TETRA MS and the 2303 Stabilock are prepared for the measurements.

The MS may require a certain signal from the 2303 Stabilock (the simulated base station), e.g. a typical base station signal including the SCH/F for frequency alignment.

To take a power measurement, proceed as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

2 On the Welcome menu, press the **Generator / Analyzer** softkey.
The Generator/Analyzer Setup menu appears. The parameters are explained briefly below; for more details, please refer to section "Setting up the network parameters" on page 13.



3 Push the **Select Channel System** softkey to select a set of predefined channel parameters. Alternatively, if the RF and network parameters required are not stored in a file, proceed as follows:

   a On the right-hand side of the menu, select the frequency band, channel offset and duplex spacing. If your system requires the mobile station to transmit in the higher band (MS frequency above BS frequency), set the **Operating Mode** field to Reverse, otherwise to Normal.

   b Enter the lowest and highest channel number supported by the TETRA radio under test. (These parameters are for your convenience to avoid trying to test on channels that are not supported by the mobile station.)

   c Enter the MCC, MNC and BCC parameters of the base station simulated by the 2303. (Skip these parameters if you do not require a typical base station signal from the 2303 Stabilock.)

4 On the left-hand side of the menu, set the RF Level value according to your requirements. This is the output level of Stabilock's RF generator.

5 Enter the transmit channel number or center frequency under TX Channel. This is the (uplink) frequency at which the Stabilock will take measurements. The downlink frequency (2303 generator frequency) will be set according to the selected duplex spacing.
Alternatively, enter the downlink (generator) frequency in the RX Channel input field; the 2303 will automatically adapt the analyzer frequency.

Note

If you enter a frequency that does not correspond to the channel frequency system on the lower right-hand side of the menu, those channel frequency parameters will be changed accordingly.

Note

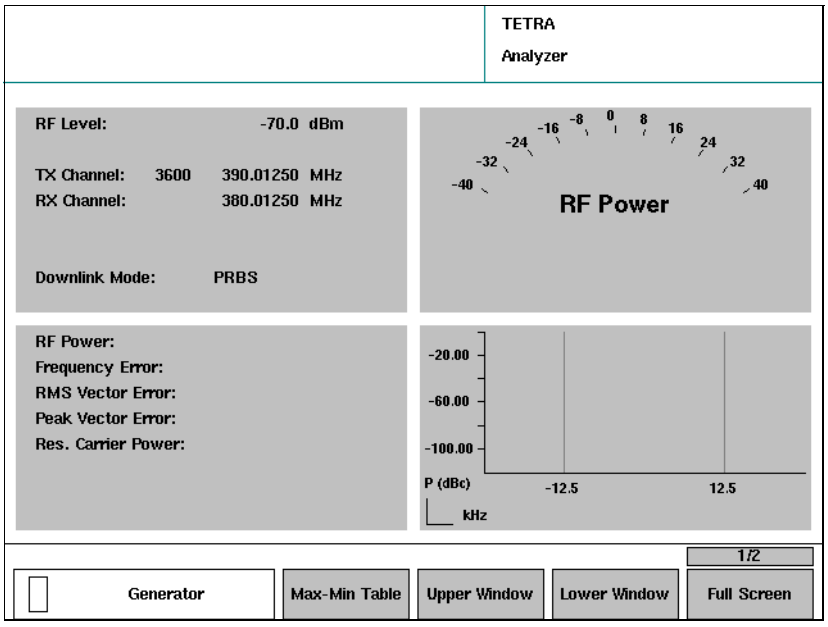
The channel spacing in TETRA is 25 kHz; however the 2303 Stabilock can be tuned in steps of 250 Hz. If you perform tests with the generator or analyzer frequency tuned in smaller steps that 25 kHz you can set the **Channel Mode** input field to Off. The Channel Number input field will disappear. Set Channel Mode to On again for the Channel Number field to reappear.

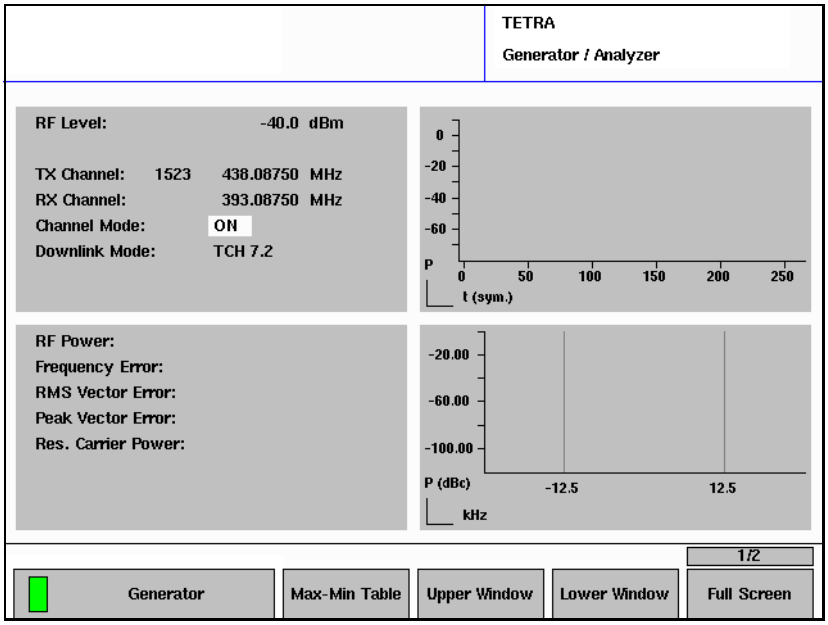
6 Select **Generator/Analyzer** to perform transmitter measurements with or without the signal generator function. (Please refer to "Performing receiver measurements" on page 87 for measurements involving a T1 signal).
The Analyzer or the Generator / Analyzer menu appears, see next section.

Using the signal generator

The signal generator in asynchronous mode can be set up to transmit a modulated signal with different bit patterns or with a typical TETRA channel signal. Alternatively, the signal generator can be switched while asynchronous transmitter measurements without a downlink (base station) signal are required.

1 From the Welcome menu, select **Generator / Analyzer** > **Generator / Analyzer**.
The Analyzer menu or the Generator / Analyzer menu appears.





2 If you want to turn on the signal generator, push the **Generator** softkey until the green symbol appears in the softkey description and the menu name displayed in the top-right corner is ''Generator / Analyzer''.

3 In the Downlink Mode field, select one of the following generator signals:
T1 (TCH 7.2) (the 2303 transmits four time slots per frame, one containing a typical TCH/7.2 signal, the other slot filled with dummy bursts)
T1 (TCH 2.4) (the 2303 transmits four time slots per frame, one containing a typical TCH/2.4 signal, the other slot filled with dummy bursts)
T1 (SCH/F) (the 2303 transmits four time slots per frame, one containing a typical control channel; this signal is useful for MER measurements)
PRBS (T1 signal; the 2303 transmits a pseudo-random bit sequence)
All Symbols 00 (the 2303 transmits a sequence of zeros only)
All Symbols 01 (the 2303 transmits a sequence of bit inversals only)
All Symbols 10 (the 2303 transmits a sequence of bit inversals only)
All Symbols 11 (the 2303 transmits a sequence of ones only)
Unscrambled TCH 7.2 (the 2303 transmits four time slots, one with a TCH)
T2 (PRBS) (the 2303 transmits the T2 signal as defined in EN 300 394-1 § 5.3.3)
T3 (All Symbols 00) (the 2303 transmits the T3 signal as defined in EN 300 394-1 § 5.3.4)
The selected signal is transmitted by the 2303.

4 For taking transmitter measurements, turn on the transmitter of the MS.
The 2303 starts the measurements.

Performing transmitter measurements

When the measurements are running (see "Preparing the measurement" on page 78), the following measurement results are available on the left-hand side of the Generator / Analyzer menu:

- Power
- Frequency error
- RMS and peak vector error
- Residual carrier magnitude

Some of these measurements are also available in a graphical representation. Additional graphical measurements include:

- Burst profile
- Modulation spectrum
- Constellation diagram

Note

For optimal accuracy of transmitter measurement results, switch off the generator of the 2303 Stabilock to avoid any interference with the internal signal.

Power measurements

The transmit power is averaged over the active time slot, taking the training sequence into account to determine the active part of the burst.

In addition to the numeric result shown on the left-hand side, you can also configure one of the pointer instruments on the right-hand side to display the power level by pushing the **Upper Window** or **Lower Window** softkey and selecting **Power**.

Alternatively, you can even have the power level graphically displayed in large size by pushing the **Full Screen** softkey and selecting **Power**. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) graphically displayed by pushing the **MIN-MAX** softkey to OFF state.
A statistical evaluation of the results is available upon a push of the **Max-Min Table** softkey. The associated menu displays a matrix of different transmitter parameters with the last measurement result, the minimum and maximum results and the average value since the start of the measurements. The evaluation can be restarted with the **Reset** softkey.

Frequency error measurements

The frequency error is a measure of the TETRA mobile station's capability to keep its base frequency locked to the base station's center frequency.

NOTE

According to the TETRA specifications (EN 300 394-1), the frequency error should not exceed 100 Hz.

You can also configure one of the pointer instruments on the right-hand side to display the frequency error by pushing the **Upper Window** or **Lower Window** softkey and selecting **Frequency Offset**.

Alternatively, you can even have the frequency error graphically displayed in large size by pushing the **Full Screen** softkey and selecting **Frequency Offset**. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) graphically displayed by pushing the **MIN-MAX OFF** softkey.
A statistical evaluation of the results is available upon a push of the **Max-Min Table** softkey. The associated menu displays a matrix of different transmitter parameters with the last measurement result, the minimum and maximum results and the average value since the start of the measurements. The evaluation can be restarted with the **Reset** softkey.

Vector error

The vector error is a measure of the TETRA mobile station's modulation quality. The lower the vector error, the better the radio connection will be at low receive levels or under interference conditions.

The vector error is calculated for each symbol; the maximum (peak) value over all the symbols of a burst is examined as well as the RMS average.

NOTE

According to the TETRA specifications (EN 300 394-1), the RMS vector error should not exceed 10%; the peak vector error should be less than 30%.

You can also configure one of the pointer instruments on the right-hand side to display the vector error by pushing the **Upper Window** or **Lower Window** softkey and selecting the corresponding vector error measurement (**RMS Error** or **Peak Error**).

Alternatively, you can even have the vector error graphically displayed in large size by pushing the **Full Screen** softkey and selecting the corresponding vector error measurement. In this mode you can also have the minimum and maximum measurement values (since the start of the measurements) graphically displayed by pushing the **MIN-MAX OFF** softkey.
A statistical evaluation of the results is available upon a push of the **Max-Min Table** softkey. The associated menu displays a matrix of different transmitter parameters with the last measurement result, the minimum and maximum results and the average value since the start of the measurements. The evaluation can be restarted with the **Reset** softkey.

Residual carrier power

The residual carrier power is a measure of the TETRA mobile station's modulation quality and may caused by DC offsets in the I and Q signal paths. The lower the carrier power, the better the radio connection will be at low receive levels or under interference conditions.

The residual carrier power is calculated over all symbols of a burst.

NOTE

According to the TETRA specifications (EN 300 394-1), the residual carrier magnitude should not exceed 5%.

A statistical evaluation of the results is available upon a push of the **Max-Min Table** softkey. The associated menu displays a matrix of different transmitter parameters with the last measurement result, the minimum and maximum results and the average value since the start of the measurements. The evaluation can be restarted with the **Reset** softkey.

Constellation diagram

The constellation diagram allows you to test the modulation characteristics of the mobile. The 2303 offers fast visual judgement of the modulation quality with the graphical representation of the modulation quality in several configurable ways. The horizontal axis shows the in-phase component (I) of the signal while the vertical axis displays the quadature component (Q), normalized to the average burst power.

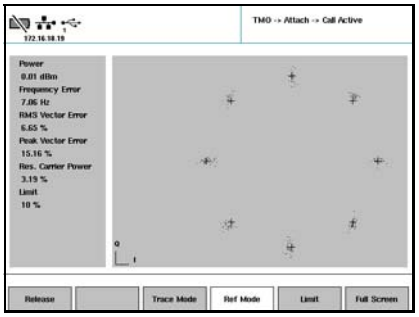
NOTE

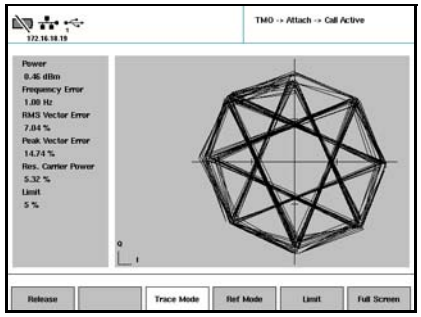
Willtek offers the constellation display for your convenience, e.g. for modulator alignment; it is not a measurement specified in TETRA specification EN 300 394-1.

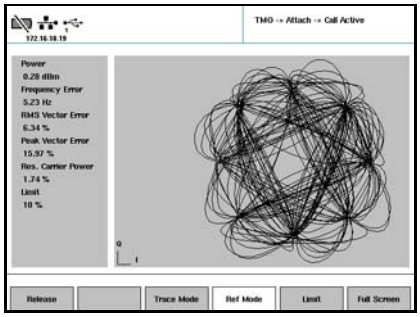
You can configure one of the graphs on the right-hand side to show the constellation display by pushing the **Upper Window** or **Lower Window** softkey and selecting **Constellation**.

Alternatively, you can have the constellation display shown in large size instead by pushing the **Full Screen** softkey and selecting **Constellation**. The display is configurable:

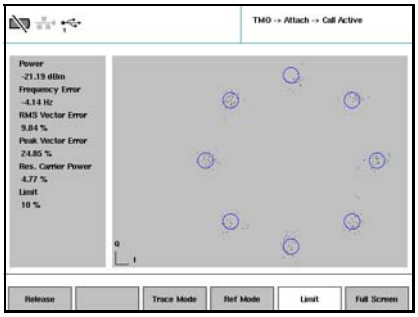
– Push **Trace Mode** and select one of the options (**Phase Tracer**, **Dots**, **Lines**) from the pull-down menu.

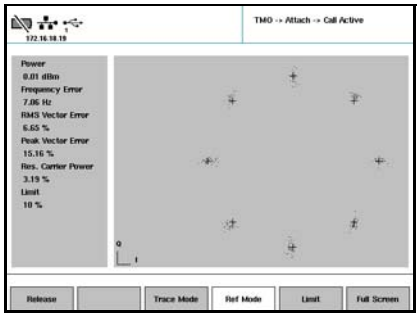


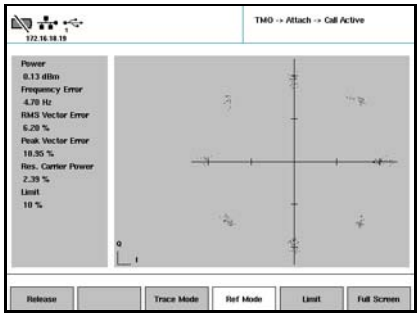




– Push **Ref Mode** and select one of the options from the pull-down menu:
Ref Circles for a limit circle around each point of maximum effect,
Ref Lines for a cross-hair at each point of maximum effect,
Ref Scale for coordinate axes.







– Push **Limit** and select either **5 %** or **10 %** as the limit for the peak vector error. The selected limit is then shown as a circle while Ref Circles is selected.

When you are finished with the full-screen constellation display, return to the Generator / Analyzer menu by pushing the **ESC** button.

Burst profile

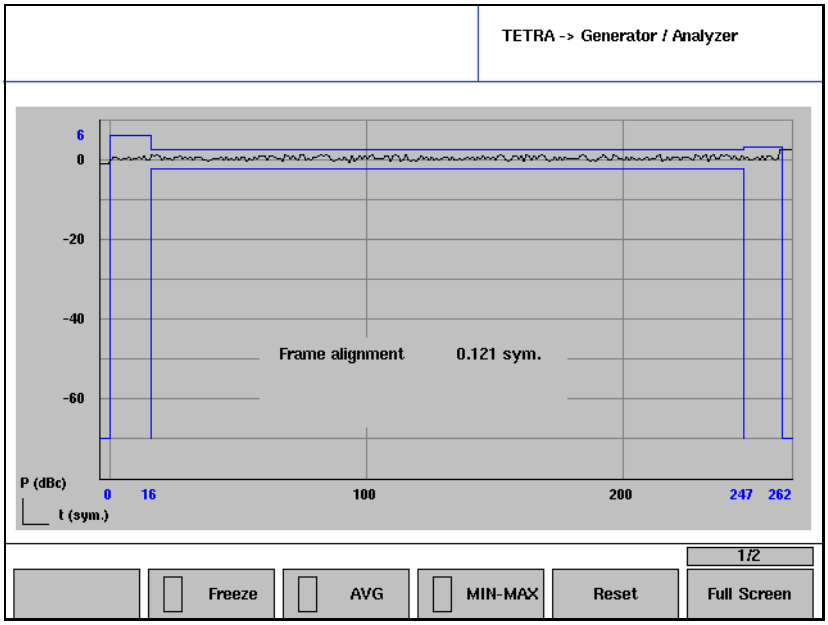
The burst profile display allows you to assess the TETRA mobile station's ability to ramp up and down the power level within the required time, and to keep the power level during the active part of the burst at a constant power level for the points of maximum effect.

NOTE

According to the TETRA specifications (EN 300 392-2), the following power limits apply:
During the last 16 symbol periods before the first information symbol is transmitted, the power level must not exceed 6 dB above the average burst power during the active part.
During the first 15 symbol periods after the last information symbol is transmitted, the power level must not exceed 3 dB above the average burst power during the active part.

You can configure one of the graphs on the right-hand side to show the burst profile by pushing the **Upper Window** or **Lower Window** softkey and selecting **Burst Template**.

You can have the burst profile shown in large size instead by pushing the **Full Screen** softkey and selecting **Burst Template**.
The burst profile is shown (with 16 leading symbol periods, 231 symbol periods as the active part of the burst and 15 trailing symbol periods). The horizontal axis shows the time in bit periods, the vertical axis indicates the power level in dBc.



When you are finished with the full-screen burst profile display, return to the Generator / Analyzer menu by pushing the **ESC** button.

Modulation spectrum

The modulation spectrum display allows you to assess the TETRA mobile station's modulation quality in the frequency domain.

The modulation spectrum is shown in the range ±18 kHz from the carrier frequency, i.e. the span is 36 kHz.

The horizontal axis shows the frequency in kHz, the vertical axis indicates the power spectrum density. The vertical blue lines indicate the boundaries of the 25 kHz TETRA channel.

NOTE

Willtek offers the constellation display for your convenience, e.g. for modulator alignment; it is not a measurement specified in TETRA specification EN 300 394-1.

You can configure one of the graphs on the right-hand side to show the burst profile by pushing the **Upper Window** or **Lower Window** softkey and selecting **Mod Spectrum**.

Alternatively, you can have the burst profile shown in large size instead by pushing the **Full Screen** softkey and selecting **Mod Spectrum**.

When you are finished with the full-screen modulation spectrum display, return to the Generator / Analyzer menu by pushing the **ESC** button.

Performing receiver measurements

The 2303 Stabilock supports two types of receiver measurements in asynchronous mode, i.e. they do not require a call setup. You should, however, have knowledge how to set the TETRA radio into a test mode so that the radio supports the measurement.

Single-ended BER measurement (normal T1 test mode)

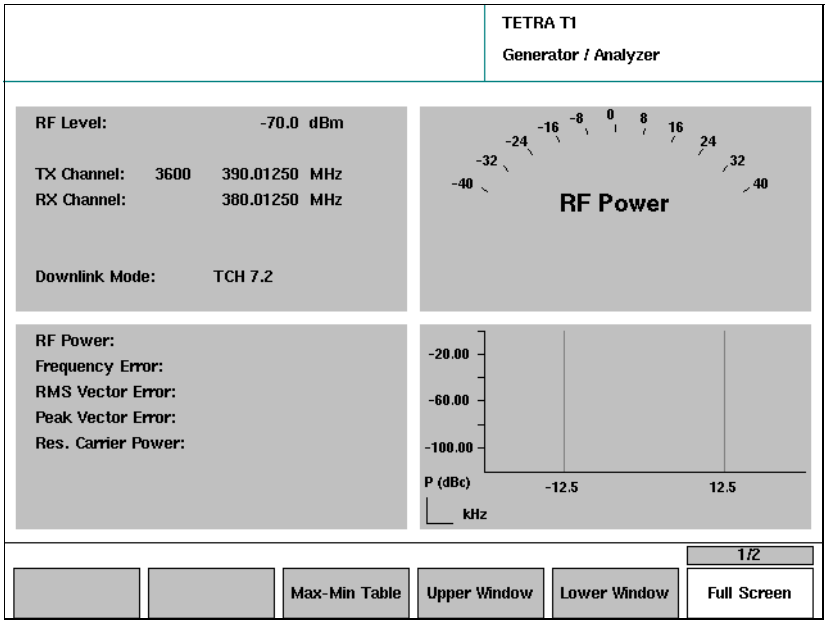
The measurement is performed within the TETRA mobile station. For this purpose, TETRA specification EN 300 394-1 defines a test signal T1 which is a scrambled downlink traffic channel containing a pseudo-random bit sequence (PRBS). The instrument transmits this signal at a defined power level and the MS tries to demodulate and decode the signal. Many types of TETRA mobile stations support the measurement by evaluating the received signal, correlating it with the known PRBS and calculating the bit error rate (BER). The BER is then displayed on the MS or a computer attached to the MS.

In order to set up the 2303 Stabilock for the T1-based BER test, proceed as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

2 Set up the generator as described in "Preparing the measurement" on page 78.

3 In the Generator/Analyzer Setup menu, push **MS RX**.
The TETRA T1 menu appears.



4 Select a signal type in the Downlink Mode field:
TCH 7.2 (the 2303 transmits four time slots per frame, one containing a typical TCH/7.2 signal, the other slots filled with dummy bursts)
SCH/F (the 2303 transmits four time slots per frame, one containing a typical control channel; this signal is useful for MER measurements)

BSCH + SCH/HD (the 2303 transmits four time slots per frame, one containing a BSCH + SCH/HD signal with a PRBS, the other slots filled with dummy bursts)
TCH 2.4 (the 2303 transmits four time slots per frame, one containing a typical TCH/2.4 signal, the other slots filled with dummy bursts)

Note

The channel combinations, the scrambling and the data payload are as defined in the ETSI specifications for testing (e.g. EN 300 394-1 Annex D.8.4). MCC and MNC are set to 1, overruling the settings in the Generator/Analyzer Setup menu.

5 Prepare the TETRA MS for the T1 receiver test and read the result on the display of the MS or the attached PC.

NOTE

According to the TETRA specifications (EN 300 394-1), the reference sensitivity performance is defined such that the bit error rate (BER) at a power level of –112 dBm must be below 0.122%.

6 When finished, switch the TETRA radio off and on again to clear the test mode and resume normal operation.

T1 loop back test mode

The TETRA radio must be in service mode. The test set (i.e. the 2303 Stabilock) transmits a T1 signal. The radio recognizes the T1 and loops it back in the uplink path. The test set receives the looped-back data and compares it with the transmitted data. As a result, the test set calculates and displays the bit error rate (BER).

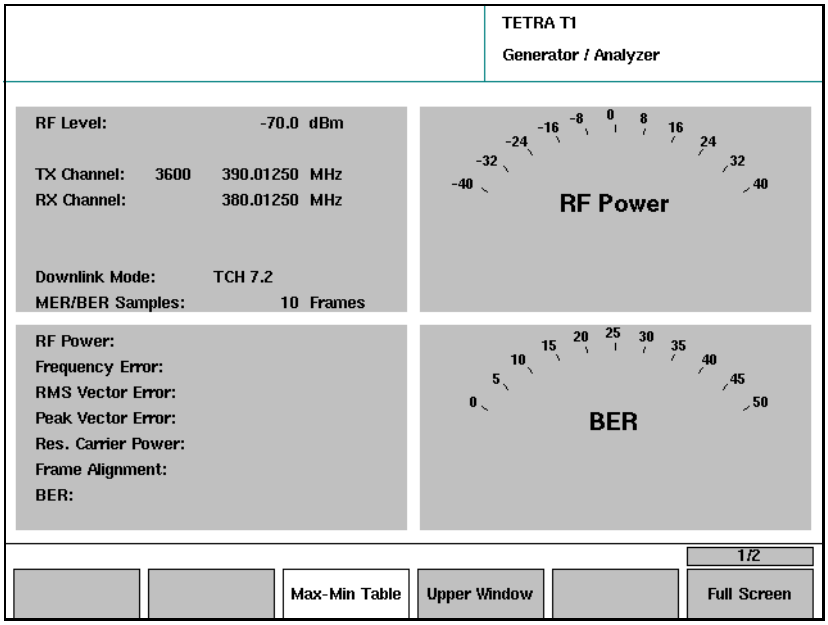
TETRA specification EN 300 394-1 defines several types of test signal T1. T1 is always a scrambled downlink channel containing a pseudo-random bit sequence (PRBS). There are several different channels that may carry the T1 signal.

In order to set up the 2303 Stabilock for the T1-based BER test in loopback mode, proceed as follows:

1 Connect the TETRA MS as described in "Connecting the device under test" on page 11.

2 Set up the generator as described in "Preparing the measurement" on page 78.

3 In the Generator/Analyzer Setup menu, push **T1 Loopback MS RX**. The TETRA T1 menu appears.



4 Select a signal type in the Downlink Mode field:
TCH 7.2 (the 2303 transmits four time slots per frame, one containing a typical TCH/7.2 signal, the other slots filled with dummy bursts)
SCH/F (the 2303 transmits four time slots per frame, one containing a typical control channel; this signal is useful for MER measurements)
BSCH + SCH/HD (the 2303 transmits four time slots per frame, one containing a BSCH + SCH/HD signal with a PRBS, the other slots filled with dummy bursts)
TCH 2.4 (the 2303 transmits four time slots per frame, one containing a typical TCH/2.4 signal, the other slots filled with dummy bursts)

Note

The channel combinations, the scrambling and the data payload are as defined in the ETSI specifications for testing (e.g. EN 300 394-1 Annex D.8.4). MCC and MNC are set to 1, overruling the settings in the Generator/Analyzer Setup menu.

5 In the MER/BER Samples field, enter the number of frames over which a measurement shall be performed.

6 Prepare the TETRA MS for the T1 loopback receiver test. (This procedure depends on the vendor and model of the TETRA radio.)
Once the TETRA MS is in loopback mode, the 2303 Stabilock synchronizes onto the signal received from the TETRA MS and displays the receiver measurement results in terms of bit error rate.

NOTE

According to the TETRA specifications (EN 300 394-1), the reference sensitivity performance is defined such that the bit error rate (BER) at a power level of –112 dBm must be below 0.122%.

7 When finished, switch the TETRA radio off and on again to clear the test mode and resume normal operation.

Performing Autotests

6

This chapter provides task-based instructions for performing Autotests with the 2303 Stabilock. Topics discussed in this chapter are as follows:

Introduction

The Autotest feature of the 2303 Stabilock allows you to perform an overall RF check of the mobile station. There is a test sequence stored in the Stabilock, with certain parameters that can be affected by the user:

- Stored mobile-specific parameters (type of coupling and shuttle position) are stored in the 2303 and can easily be loaded.
- Network-specific parameters (such as the frequency range being used) are stored in the 2303 and can be called up.
- A few test parameters can be affected, e.g. if and how the paging sensitivity test is performed.
- The test limits can be changed.

The concept behind the setup and test capabilities is that the same setup parameters are used when testing a particular type of TETRA radio, e.g. you will always use the same test setup (instrument, coupler and RF shielding device, or cable) and use the same frequency channels and network parameters to be tested.

Setting up a test

Managing types of TETRA radios

Before starting an Autotest, the radio frequency (RF) connection between the TETRA mobile station and the 2303 Stabilock should be defined. Also, if the 4914 Antenna Coupler is used then the RF coupling factors should be entered so that the correct factors can be taken into account in the measurement setup and results.

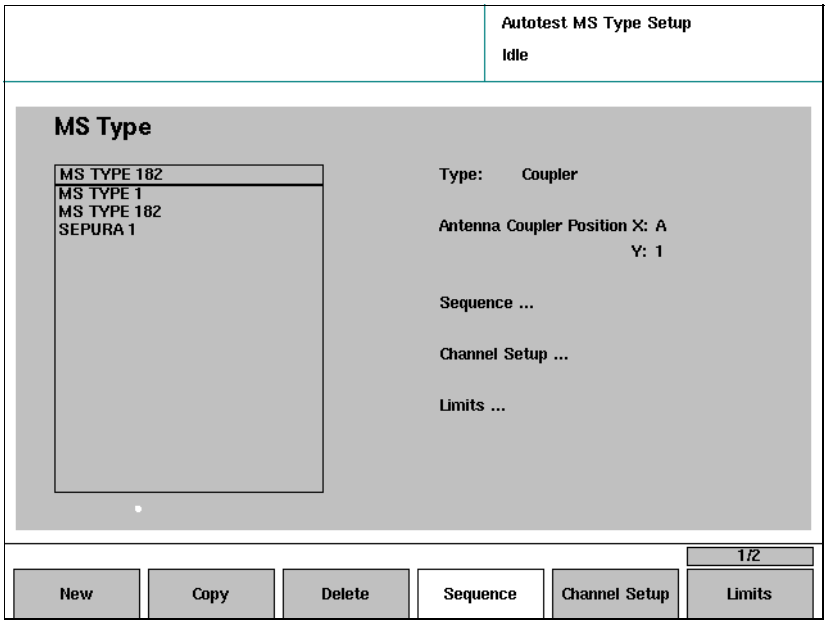
These parameters can be set up either by manually entering the information before each test is started, or they can be stored in an MS Type setup file and easily loaded at the beginning of a test.

Note

In the Autotest MS Type Setup menus described below, there is always an active MS type selected and loaded. Any changes you make to a configuration will be stored immediately with that MS type, i.e. the previous settings will be overwritten without warning.

Loading predefined radio settings

1 From the Welcome menu, select **Autotest > Setup**.
The Autotest MS Type Setup menu appears. The top-left input field displays the radio settings file currently loaded.

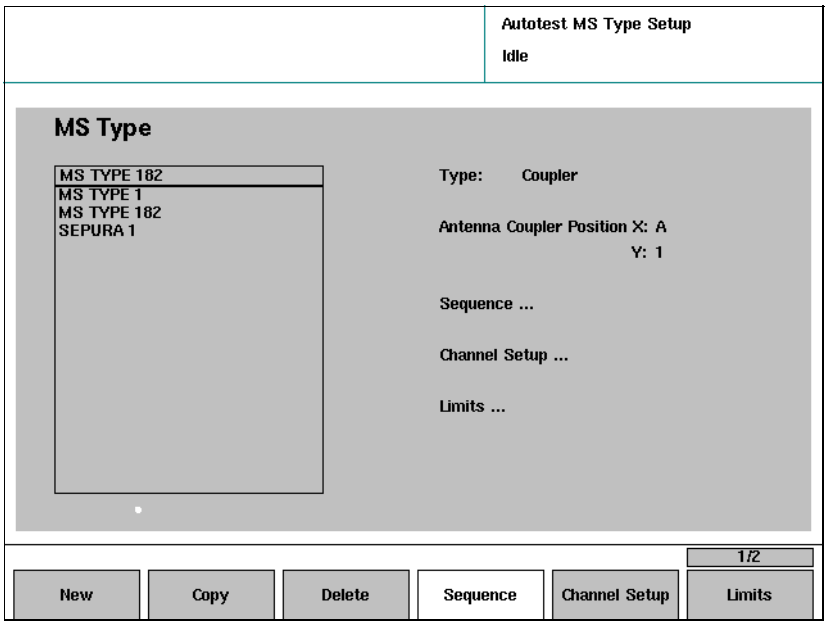


2 From the list on the left-hand side, select an entry that corresponds to the type of mobile station to be tested.
The connection type and (if the TETRA is connected through a coupler) the shuttle are displayed on the right-hand side.

Defining the radio settings

This section explains how to set up the radio type-specific parameters before starting an Autotest.

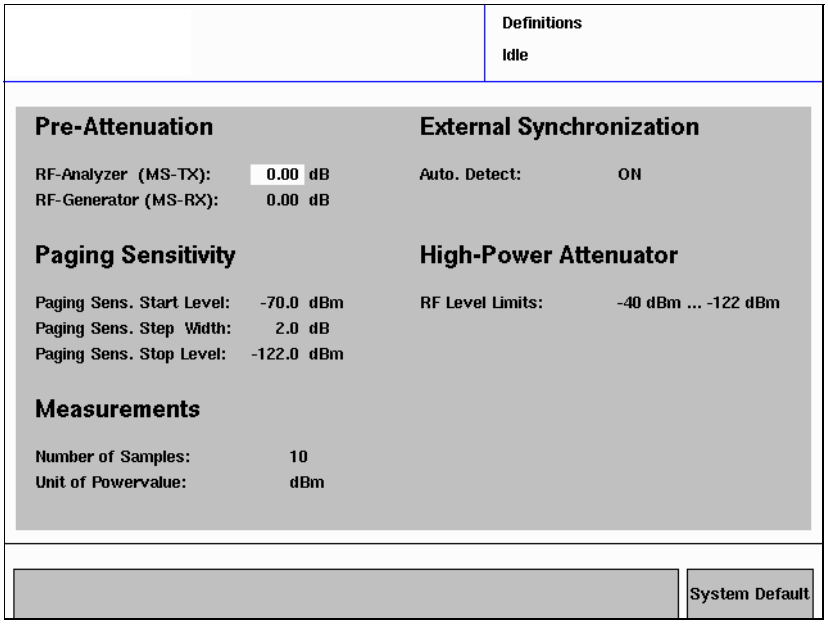
1 From the Welcome menu, select **Autotest > Setup**.
The Autotest MS Type Setup menu appears.



2 In the Type selection field, choose how you connect the TETRA radio to the Stabilock (Cable or Coupler).

3 If the TETRA radio is connected through the 4914 Antenna Coupler, you can enter the position of the shuttle on the coupler in the Antenna Coupler Position fields (X and Y).

4 In order to enter the coupling factors for transmission and reception, return to the Welcome menu by pressing **ESC** twice, then push **Setup > Definitions**. The coupling factor for the direction from the Stabilock to the TETRA mobile can be entered in the RX field and the factor for the direction from the TETRA mobile to the Stabilock can be entered in the TX field.



Note

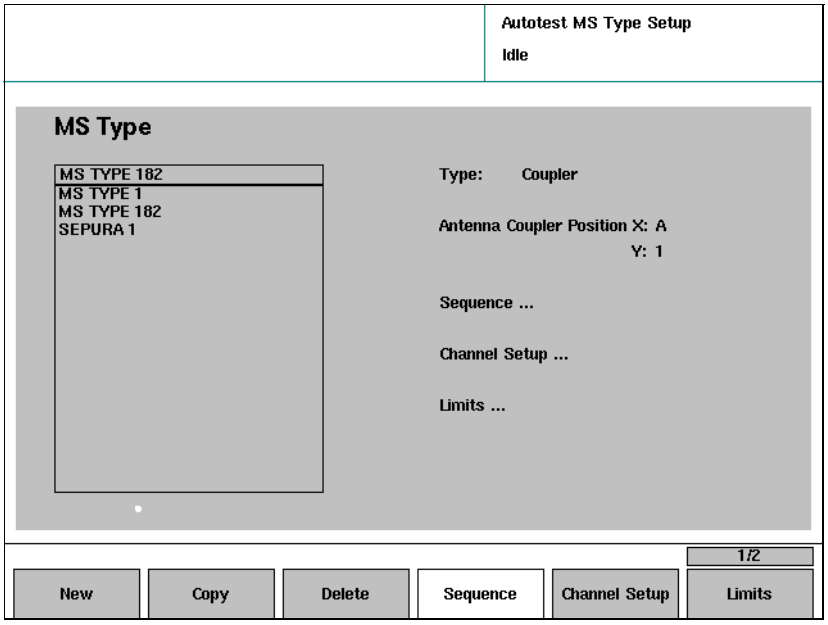
The Definitions menu can also be called up directly from measurement menus by selecting **...** > **Definitions**. By returning from the Definitions menu to the measurement menu, the measurements will be reset and started with the new averaging and pre-attenuation values.

Storing radio settings in a file

The TETRA radio settings can be entered as described above, and stored in a file so that the settings can easily be loaded and used again. The Stabilock stores the connection type, the position of the shuttle and the coupling factors.

1 Set the TETRA radio parameters as described in ''Defining the radio settings'' above.

2 From the Welcome menu, push **Autotest > Setup**.



3 Push the **New** softkey to store the settings.
The Stabilock stores the TETRA radio settings in a file on its internal hard disk. The file name is chosen automatically. The new settings file becomes the active file in the MS Type selection box.

Renaming an MS Type file

It is a good idea to use the type of TETRA radio (and test conditions if there are more than one) as a file name, so that you can easily find the correct setup file for your tests. An MS Type file can be renamed as follows:

1 Make the file to be renamed the active file (i.e. select the file name in the file selector box).
The file name appears in the field above.

2 Go to the field showing the file name, and enter a new name using the alphanumerical keypad.

3 Close the field by pushing the **ENTER** key.
The new file name is displayed both in the field for the active file and in the file selector box.

Copying an MS Type file

In order to copy a file with TETRA radio settings (rather than storing the currently active settings), select the file in the Autotest MS Type Setup menu, and push the **Copy** softkey.
A copy of the file is stored on the internal hard disk. The file name is chosen automatically. The new settings file becomes the active file in the MS Type selection box.

Deleting an MS Type file

1 In the Autotest MS Type Setup menu, select the file that you want to delete.

2 Push the **Delete** softkey.
The selected file is deleted. The next file in the list is highlighted, but not loaded.

Sorting MS Type files

You want to maintain a certain sequence of MS Type files in the list, e.g. to be able to access the most used file with the least keypresses. In order to change the sequence of files:

1 Select the file that you want to move up or down in the list on the right-hand side of the Autotest MS Type Setup menu.

2 Push **...**, then **Move Up** or **Move Down** to change the position of the file in the list.

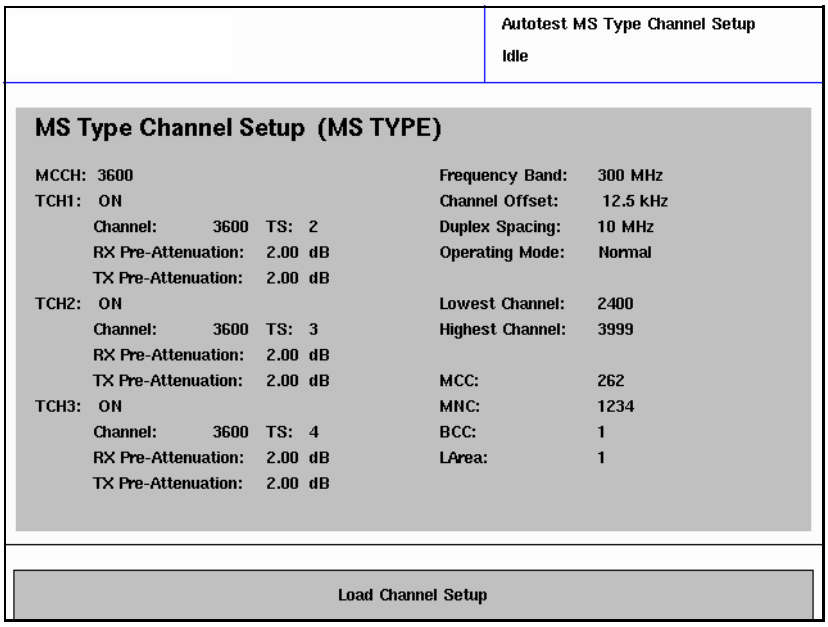
Setting up the channels

When you define an MS Type configuration, the channels and the network parameters must be defined. These definitions are stored with the MS Type configuration.

You can load an existing channel setup that was previously defined and saved in the Channel Setup menu.

You can define the channel setup for Autotests as follows:

1 From the Welcome menu, select **Autotest > Setup > Channel Setup**. The Autotest MS Type Channel Setup menu appears.



2 If you already have a base station and network configuration file from manual mode, select **Load Channel Setup** and select a channel setup file. Otherwise, enter the network and channel parameters on the right-hand side of the menu as described in "Setting up the network parameters" on page 13.

3 On the left-hand side of the menu, select a channel number for the MCCH (Main Control Channel) if not given by the channel setup file loaded.

4 The menu offers up to three channels to test. You can define on which of the channels a test should be performed (e.g. three channels to test the frequency band at the lower end, in the middle and at the higher end). For each of the three channels:

   a Specify if the TETRA radio should be tested on the channel by selecting either ON (radio tests will be performed) or OFF (no test will be performed).

   b Enter the channel number and a time slot to test.

   c Enter the attenuation for that frequency in the downlink (RX: base station transmit, TETRA radio receive frequency) and in the uplink (TX: base station receive, TETRA radio transmit frequency). The attenuation may be caused by cable loss or radiation over the air, and is frequency-dependent. See "Connecting the device under test" on page 11 for more details.

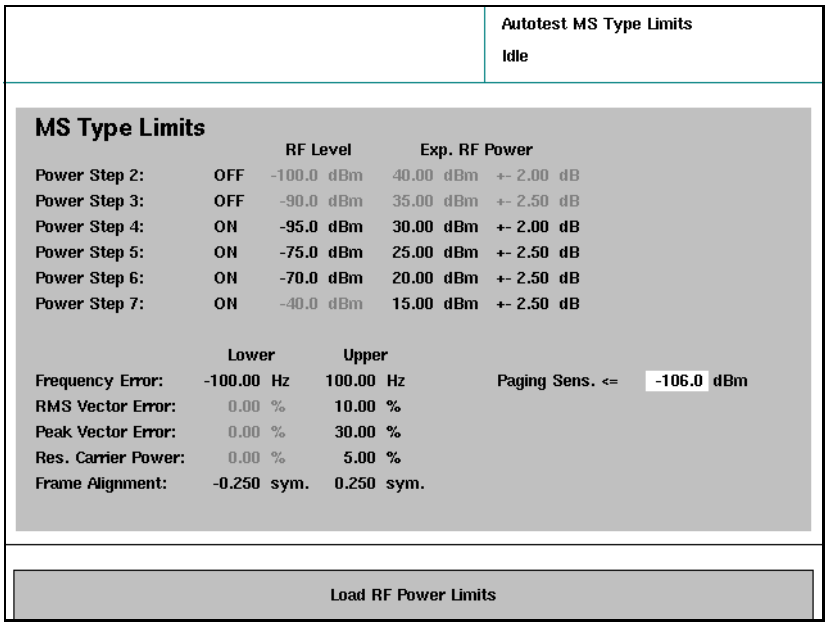
5 Select **ESC** to return to the Autotest MS Type Setup menu.

Changing the test limits

In each test, a number of measurements are performed, averaged and the result is compared with predefined limits. If one result fails the limit, the whole Autotest is failed.

In order to define the limits, proceed as follows:

1 From the Welcome menu, select **Autotest > Setup > Limits**.
The Autotest MS Type Limits menu appears.



2 You may want to push the **Load RF Power Limits** softkey to select the power class of the TETRA radio to be tested.
The power step settings are overwritten with typical values, and the power steps not applicable to the selected power class are greyed out.

3 For each of the power step values, select the receive RF level, the nominal transmit power level and the limits as described in "RF Level, Exp. RF Power" on page 20. (Whether or not a power step is tested depends on the appropriate entry in the Autotest MS Type Sequence menu, see "Affecting the test sequence" on page 99).

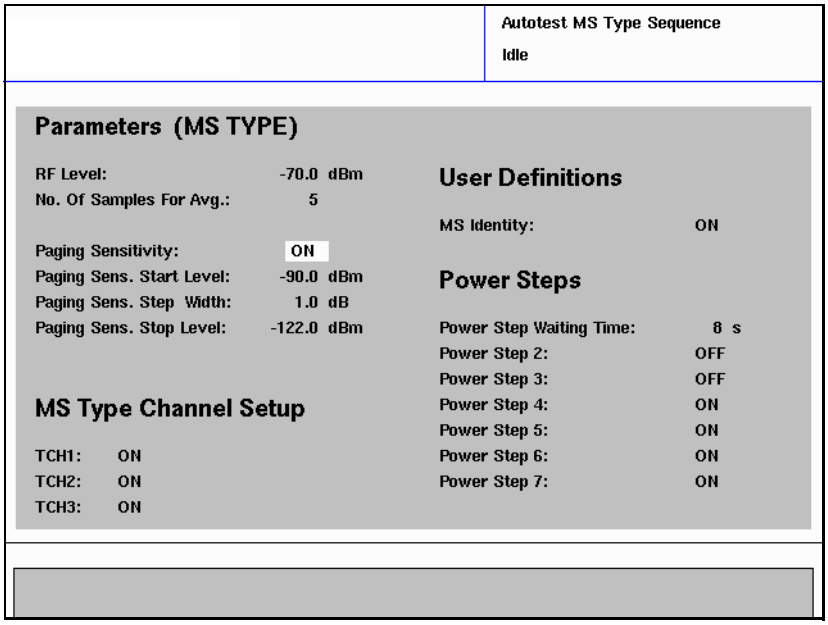
4 Enter the limit values for the transmitter test parameters (frequency error etc.) and the paging sensitivity as described in "Setting up test limits" on page 19.

5 Select **ESC** to return to the Autotest MS Type Setup menu.

Affecting the test sequence

Some parameters of the standard Autotest sequence can be customised as follows:

1 From the Welcome menu, select **Autotest > Setup > Sequence**. The Autotest MS Type Sequence menu appears.



2 Change any of the parameters if required.

a RF Level affects the receive power level in the TETRA radio. This power level is applied during the signalling processes, i.e. while setting up or releasing a call, and should be sufficiently high to ensure that the signalling assumes an unknown state.

b Meas. Count of Avg is the number of measurements to be averaged before comparing the result with a test limit.

c Paging Sensitivity defines whether this receiver test shall be performed or not. See "Paging Sensitivity test" on page 64 for more details.

d Paging Sens. Start Level is the receive power level in the TETRA radio at which the paging sensitivity test is started.

e Paging Sens. Step Width is the interval by which the receive power level is decreased in each test step.

f Paging Sens. Stop Level defines the lowest receive power level at which the paging sensitivity test is performed (unless the radio fails the test at a higher level).

g Paging Sens. Retries specifies how often the TETRA radio is paged on any power level step before the test is failed.

h TCH1 through TCH3 define whether these channels are tested in the Autotest. The channel number for each TCH is defined in the Autotest MS Type Channel Setup menu, see "Setting up the channels" on page 97 for more details.

i MS Identity specifies if the serial number or inventory number of the TETRA radio shall be recorded for the results log. If set to "ON", the MS identity will be queried at the beginning of an Autotest. The number (up to 16 characters) can be entered manually using the front panel or an external keyboard, or automatically using a bar code scanner connected to the USB interface.

j Power Step Waiting Time is the time the 2303 Stabilock waits after changing its output power level until the next power level is performed. Due to the open loop power control procedure, the TETRA radio adapts its transmit power according its receive power level; it may take some time until the TETRA radio changes its transmit power.

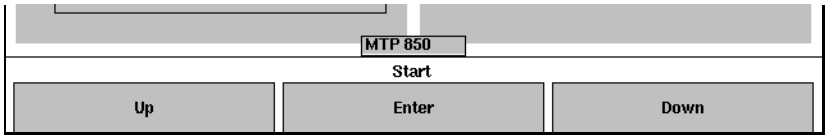
k Power Step 2 through Power Step 7 define if a test at the respective transmit power level step is performed or not. The power level steps and their limits are defined in the Autotest MS Type Limits menu.

3 Select **ESC** to return to the Autotest MS Type Setup menu.

Performing a test

1 In the Welcome menu, push the **Autotest** softkey.
The Autotest menu appears.

2 Push **Start**.
A list of predefined TETRA radio types is shown.



3 From the list of TETRA mobile stations, select the type that is equivalent to the TETRA radio that you want to test.
The test is started. The left-hand side of the menu displays the test progress while the right-hand side displays the result.

4 To abort a running test, press the **ESC** key. Otherwise, once the test is completed, the final results will be displayed on the right-hand side. The results will be stored (see "Selecting the file location for screenshots and Autotest results" on page 35) and can be viewed in detail as explained in "Viewing the results" on page 102.

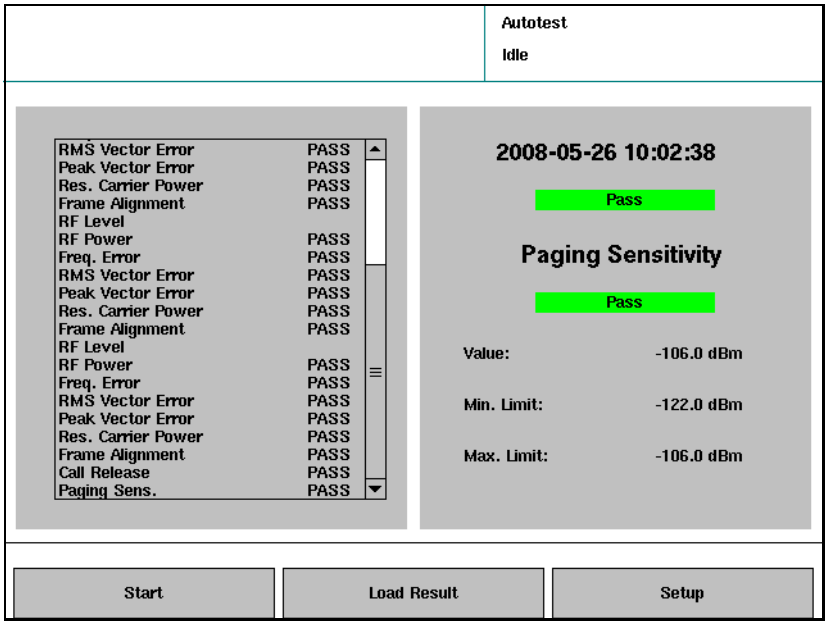
5 To start a new test, continue with step 2.

Viewing the results

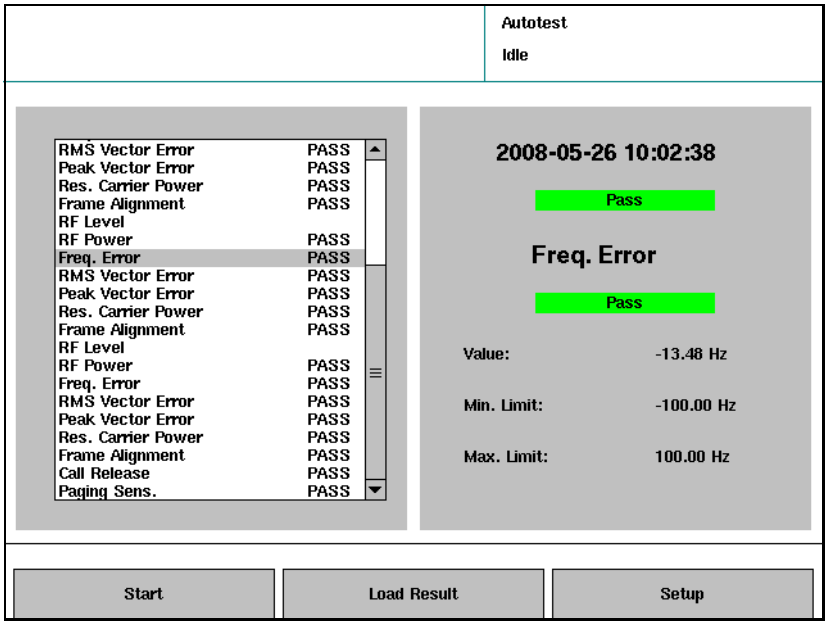
The results of a test can be checked in detail either immediately after the test or later on.

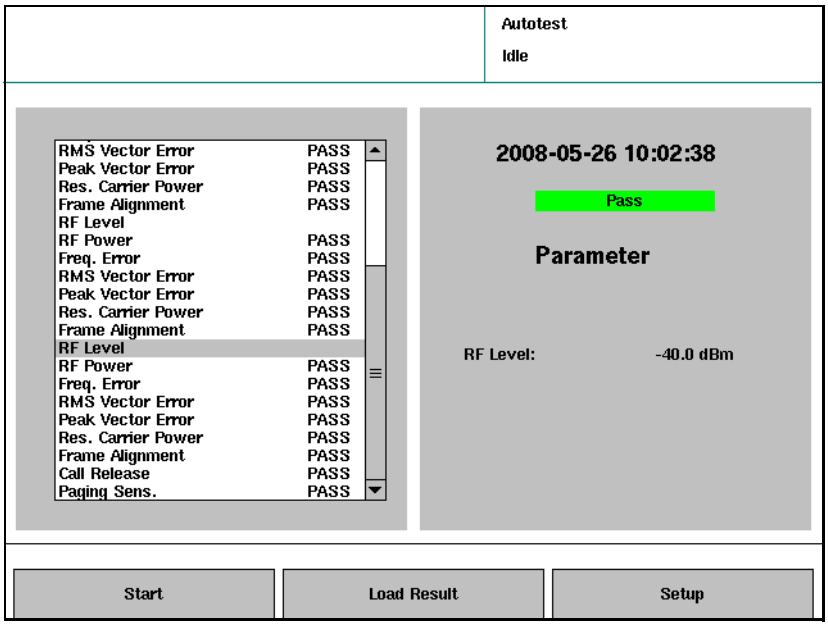
1 If the results are not already being displayed, click on the **Load Result** softkey of the Autotest menu.
The 2303 Stabilock displays a list of Autotest results stored in the current Autotest save folder (see "Selecting the file location for screen-shots and Autotest results" on page 35).

2 Select an Autotest results log file and push the **Enter** softkey.
The short-form results are displayed on the left-hand side of the display (progress section). The right-hand side (details section) shows the date and time of the test, the overall result, the name of the test or test step, the measurement result and the upper and lower limits (if applicable, otherwise the progress details are displayed).



3 In the progress section, highlight a short-form result or test step.
Details regarding the short-form result or test step are shown in the details section.





4 Press **ESC** to return to the Welcome menu.

Maintenance and Troubleshooting

7

This chapter describes how to identify and correct problems related to the 2303 Stabilock. Topics discussed in this chapter are as follows:

Maintaining your unit

Firmware updates

Willtek seeks to permanently improve its products. Firmware updates are available on the Internet at www.willtek.com.

In order to replace Firmware version 1.50 or higher by a newer one, proceed as follows:

1 Download the firmware from Willtek's website.

2 Copy the firmware into the root directory of a USB flash drive.

3 Connect the USB flash drive to a USB port of the 2303 Stabilock.

4 From the Welcome menu, select **Setup > Update Manager**.
The Update Manager menu appears.

5 Select **Verify**.
Stabilock compares all the firmware parts on the USB flash drive with the firmware currently installed, and displays the results on the screen. If any part of the firmware can be updated to a newer version, the softkey description changes to ''Install''.

6 Select **Install**.
Newer firmware components are copied to the 2303 Stabilock. At the end of the update, the softkey description will change to ''Reboot''.

7 Select **Reboot**.
The instrument is rebooted and the new firmware is ready to be used.

Note

Ensure that the 2303 Stabilock is powered from a mains supply or has enough battery capacity for the entire update process!
If the 2303 Stabilock with firmware 1.40 or higher is operated from its battery and the capacity is low, the firmware update will not start.

Calibration and adjustment

The 2303 Stabilock is a measurement device. As with all such instruments, the 2303 should be calibrated on a regular basis to ensure accuracy. Willtek recommends calibration of the 2303 at yearly intervals.

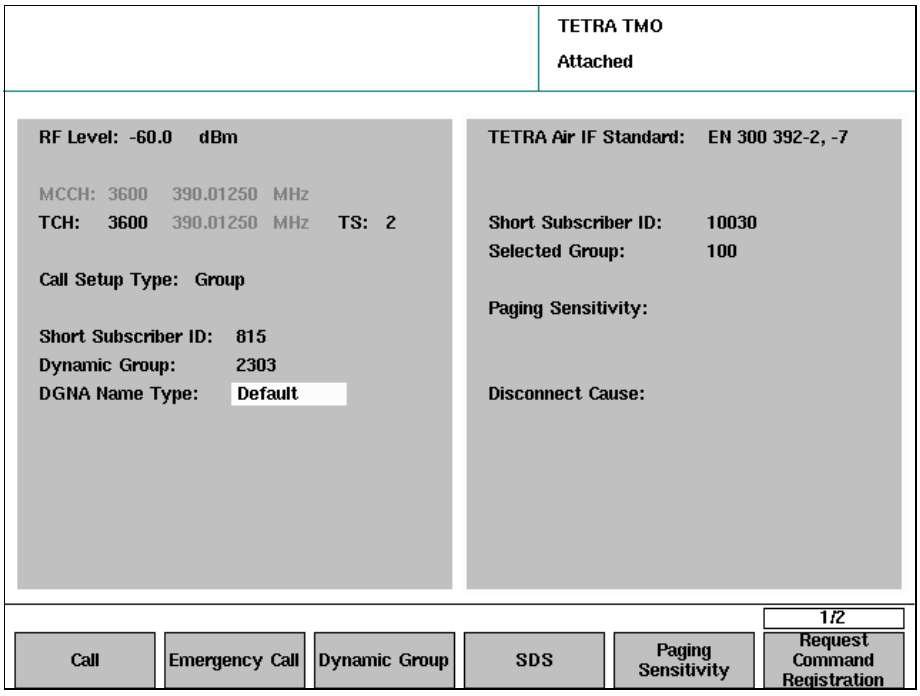
Troubleshooting

If you are unable to resolve problems related to the 2303 Stabilock, please refer to "Technical assistance" on page x.

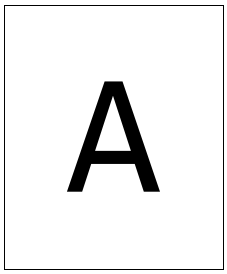
Call ends unexpectedly

If the phone is registered (attached) to the simulated network and you are trying in vain to set up a call, observe the Disconnect Cause field on the right-hand side; it might provide useful information for finding the source of the problem.

The same applies if you experience calls dropping unexpectedly.



Channel Parameters



This appendix is designed to help you properly select the channel and network parameters for testing. Topics discussed in this appendix are as follows:

Calculating channel numbers and frequencies

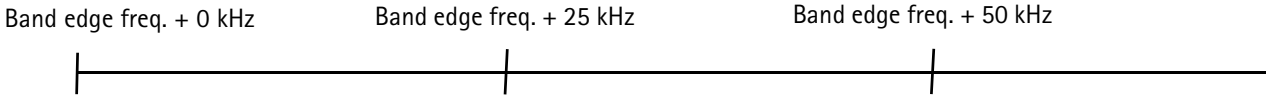
In TETRA systems, there are typically two different channel numbering systems: One applied by the users or the network operator staff, and one used in the protocol.

User speak: the radio channel numbers

The network operator and user groups typically start their channel numbers with 1 for the first channel of the allocated spectrum (e.g. the spectrum allocated for public safety and security services in Europe, starting at 380 MHz). This channel numbering system is also referred to as the radio channel numbers (see TS 300 392-15). The alloated spectrum typically starts at a full MHz number (380.000 MHz), irrespective of the channel offset (e.g. 12.5 kHz).
Users often agree on a distinct radio channel number in TETRA direct mode (DMO).

The following figure depicts different variants of channel radio numbering. Note the difference between the terms applied by users (radio channel numbers) and the terms applied by the signaling protocol (radio carrier number, carrier frequency, frequency offset).

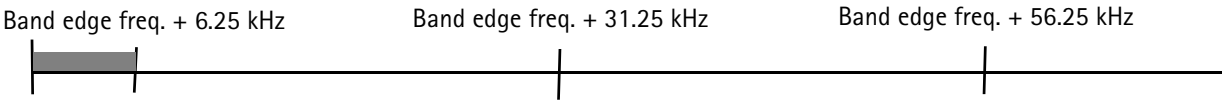
Variant A



Radio **channel** number: 1 2

Radio **carrier** number: N N+1
Carrier frequency: Band edge freq. + 12.5 kHz Band edge freq. + 37.5 kHz
Frequency offset = 12.5 kHz

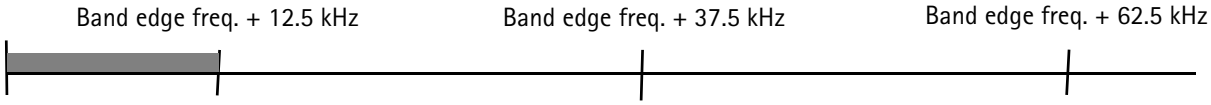
Variant B



Radio **channel** number: 1 2

Radio **carrier** number: N+1 N+2
Carrier frequency: Band edge freq. + 18.75 kHz Band edge freq. + 43.75 kHz
Frequency offset = –6.25 kHz

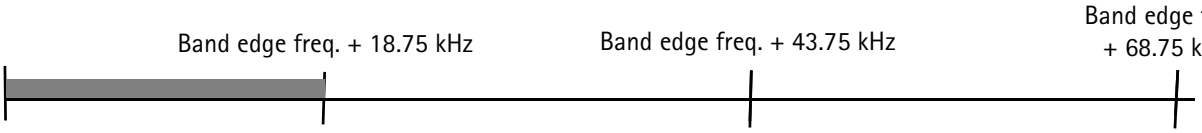
Variant C



Radio **channel** number: 1 2

Radio **carrier** number: N+1 N+2
Carrier frequency: Band edge freq. + 25 kHz Band edge freq. + 50 kHz
Frequency offset = 0 kHz

Variant D



Radio **channel** number: 1 2

Radio **carrier** number: N+1 N+2
Carrier frequency: Band edge freq. + 31.25 kHz Band edge freq. + 56.25 kHz
Frequency offset = +6.25 kHz

Signaling and instrument speak: the radio carrier numbers

In conjunction with the TETRA frequency band, the frequency offset and the duplex spacing, the radio carrier number in the TETRA protocol is used to assign a well-defined radio frequency that is univocal in all TETRA systems and hence independent of the network implementation.

The equation that makes up the downlink (TETRA base station to TETRA mobile station) carrier frequency from these components is:

DL Carrier Frequency = Frequency Band + (Radio Carrier Number) * 25 kHz + Frequency Offset

The uplink (TETRA MS to BS) carrier frequency is:

UL Carrier Frequency = DL Carrier Frequency – Duplex Spacing

The TETRA frequency band is a multiple of 100 MHz, so valid frequency bands are 100 MHz, 200 MHz, 300 MHz and so forth up until 900 MHz. (Note that the 2303 Stabilock only supports the frequency bands that are currently in use).

The frequency offset takes on one of the following values: 0, 12.5 kHz, +6.25 kHz, –6.25 kHz. The most common value is 12.5 kHz.

The duplex spacing determines the offset between the transmission frequencies of base station and mobile station. 10 MHz duplex spacing is most common in the 300 and 400 MHz bands, while 45 MHz is common in the 800 and 900 MHz bands.

The radio carrier number is simply a number that starts with 0 for a carrier frequency at or around the frequency denoted by the frequency band, e.g. 300 MHz.

Example: With a frequency offset of 12.5 kHz in the 300 MHz band, radio carrier number 3600 equates to DL carrier frequency 390.0125 MHz. In the European band reserved for public safety and security services, this would give the radio downlink channel number 1 as defined for the users. The corresponding uplink frequency is 380.0125 MHz.

Power levels in TETRA

Power classes

Each TETRA MS belongs to a power class defining the maximum RF output power capability. The power classes correspond to mobiles for different purposes, from small handheld devices (power class 4L, 0.56 W) to vehicle-mount mobile stations powered by the vehicle's battery (power class 1, 30 W). The power classes are listed in the table below.

The power class cannot be queried from the TETRA radio in normal mode. It is, however, available in TETRA Test Mode. See section ''TETRA Test Mode'' on page 64 for more details.

Table 2 Nominal power of TETRA mobile stations

Power class	Approximate power level	Nominal power level
1	30. W	45.0 dBm
1L	17.5 W	42.5 dBm
2	10. W	40.0 dBm
2L	5.6 W	37.5 dBm
3	3. W	35.0 dBm
3L	1.8 W	32.5 dBm
4	1. W	30.0 dBm
4L	0.56 W	27.5 dBm

Power control

In addition, the MS is capable of adapting its power level to the external requirements in 5-dB steps. Two mechanisms are available: Open loop and closed loop power control.

In open loop power control, the TETRA MS adjusts its transmit power based on the signal quality it receives from the base station on the downlink. The weaker the signal from the base station, the more radio frequency (RF) power is transmitted by the MS. If the BS signal gets stronger, the MS reduces its RF power again. So don't be surprised to find the MS change its output power when you change the Stabilock's one!

On a traffic channel, reducing the Stabilock's power level might be the right way to change the power transmitted by the MS.

In closed loop power control, the base station measures the strength of the signal it receives from the MS. It may decide to instruct the MS to change its power level by a multiple of 5 dB. Of course, the MS cannot obey if it is instructed to send at an RF power level that it does not support, i.e. either higher than the equivalent of its power class, or lower than its minimum output power.

The Stabilock does not support closed loop power control.

Power steps

The TETRA MS must be able to change its output power in steps or multiples of 5 dB.

The power accuracy must be ±2 dB at the nominal power level equivalent to the power class, and ±2.5 dB at all other nominal power levels. The difference between two adjacent power steps must be 5 dB ±2.5 dB except for TETRA mobile stations with power class modifier L, where the step width from the highest supported nominal power level to the next lower one must be 2.5 dB ±2.5 dB.

The nominal output power and its tolerances are shown in the tables below.

Table 3 Power steps and tolerances for TETRA mobile stations

Power step	Power class 1 (30 W)	Power class 2 (10 W)	Power class 3 (3 W)	Power class 4 (1 W)
1 (45 dBm)	45 dBm ±2 dB	40 dBm ±2 dB	35 dBm ±2 dB	30 dBm ±2 dB
2 (40 dBm)	40 dBm ±2.5 dB	40 dBm ±2 dB	35 dBm ±2 dB	30 dBm ±2 dB
3 (35 dBm)	35 dBm ±2.5 dB	35 dBm ±2.5 dB	35 dBm ±2 dB	30 dBm ±2 dB
4 (30 dBm)	30 dBm ±2.5 dB	30 dBm ±2.5 dB	30 dBm ±2.5 dB	30 dBm ±2 dB
5 (25 dBm)	25 dBm ±2.5 dB	25 dBm ±2.5 dB	25 dBm ±2.5 dB	25 dBm ±2.5 dB
6 (20 dBm)	20 dBm ±2.5 dB	20 dBm ±2.5 dB	20 dBm ±2.5 dB	20 dBm ±2.5 dB
7 (15 dBm)	15 dBm ±2.5 dB	15 dBm ±2.5 dB	15 dBm ±2.5 dB	15 dBm ±2.5 dB

Table 4 Power steps and tolerances for TETRA mobiles with power class modifier L

Power step	Power class 1L (17.5 W)	Power class 2L (5.6 W)	Power class 3L (1.8 W)	Power class 4L (0.56 W)
1 (45 dBm)	42.5 dBm ±2 dB	37.5 dBm ±2 dB	32.5 dBm ±2 dB	27.5 dBm ±2 dB
2 (40 dBm)	40 dBm ±2.5 dB	37.5 dBm ±2 dB	32.5 dBm ±2 dB	27.5 dBm ±2 dB
3 (35 dBm)	35 dBm ±2.5 dB	35 dBm ±2.5 dB	32.5 dBm ±2 dB	27.5 dBm ±2 dB
4 (30 dBm)	30 dBm ±2.5 dB	30 dBm ±2.5 dB	30 dBm ±2.5 dB	27.5 dBm ±2 dB
5 (25 dBm)	25 dBm ±2.5 dB	25 dBm ±2.5 dB	25 dBm ±2.5 dB	25 dBm ±2.5 dB
6 (20 dBm)	20 dBm ±2.5 dB	20 dBm ±2.5 dB	20 dBm ±2.5 dB	20 dBm ±2.5 dB
7 (15 dBm)	15 dBm ±2.5 dB	15 dBm ±2.5 dB	15 dBm ±2.5 dB	15 dBm ±2.5 dB

Network parameters

Mobile Country Code MCC

The MCC is a three-digit code identifying the country in which the network is set up. Valid Mobile Country Codes are defined in ITU standard E.212 ("Land Mobile Numbering Plan"). The table below lists the country codes currently assigned. In addition, the MCC 001 is often used for test purposes. This is, however, rarely implemented in TETRA mobile stations.

412 Afghanistan
276 Albania
603 Algeria
544 American Samoa (US)
213 Andorra
631 Angola
365 Anguilla
344 Antigua and Barbuda
722 Argentine Republic
283 Armenia
363 Aruba (Netherlands)
505 Australia
232 Austria
400 Azerbaijani Republic
364 Bahamas
426 Bahrain
470 Bangladesh
342 Barbados
257 Belarus
206 Belgium
702 Belize
616 Benin
350 Bermuda (UK)
402 Bhutan
736 Bolivia
218 Bosnia and Herzegovina
652 Botswana
724 Brazil
348 British Virgin Islands (UK)
528 Brunei Darussalam
284 Bulgaria
613 Burkina Faso
642 Burundi
456 Cambodia
624 Cameroon
302 Canada
625 Cape Verde
346 Cayman Islands (UK)
623 Central African Republic
622 Chad
730 Chile
460 China
732 Colombia
654 Comoros
629 Republic of the Congo
548 Cook Islands (NZ)
712 Costa Rica
612 Côte d'Ivoire
219 Croatia
368 Cuba
280 Cyprus
230 Czech Republic
630 Democratic Republic of the Congo
238 Denmark
638 Djibouti
366 Dominica
370 Dominican Republic
514 East Timor
740 Ecuador
602 Egypt
706 El Salvador
627 Equatorial Guinea
657 Eritrea
248 Estonia
636 Ethiopia
288 Faroe Islands (Denmark)
542 Fiji
244 Finland
208 France
742 French Guiana (France)
547 French Polynesia (France)
628 Gabonese Republic
607 Gambia
282 Georgia

262 Germany
620 Ghana
266 Gibraltar (UK)
202 Greece
290 Greenland (Denmark)
352 Grenada
340 Guadeloupe (France)
535 Guam (US)
704 Guatemala
611 Guinea
632 Guinea-Bissau
738 Guyana
372 Haiti
708 Honduras
454 Hong Kong (PRC)
216 Hungary
274 Iceland
404 India
405 India
510 Indonesia
432 Iran
418 Iraq
272 Ireland
425 Israel
222 Italy
338 Jamaica
441 Japan
440 Japan
416 Jordan
401 Kazakhstan
639 Kenya
545 Kiribati
467 Korea, North
450 Korea, South
419 Kuwait
437 Kyrgyz Republic
457 Laos
247 Latvia
415 Lebanon
651 Lesotho
618 Liberia
606 Libya
295 Liechtenstein
246 Lithuania
270 Luxembourg
455 Macao (PRC)
294 Republic of Macedonia
646 Madagascar
650 Malawi
502 Malaysia
472 Maldives
610 Mali
278 Malta
551 Marshall Islands
340 Martinique (France)
609 Mauritania
617 Mauritius
334 Mexico
550 Federated States of Micronesia
259 Moldova
212 Monaco
428 Mongolia
354 Montserrat (UK)
604 Morocco
643 Mozambique
414 Myanmar
649 Namibia
536 Nauru
429 Nepal
204 Netherlands
362 Netherlands Antilles (Netherlands)
546 New Caledonia (France)
530 New Zealand
710 Nicaragua
614 Niger
621 Nigeria
534 Northern Mariana Islands (US)
242 Norway
422 Oman
410 Pakistan
552 Palau
714 Panama
537 Papua New Guinea
744 Paraguay
716 Peru
515 Philippines
260 Poland
351 Portugal
330 Puerto Rico (US)
427 Qatar
647 Réunion (France)

226 Romania
250 Russian Federation
635 Rwandese Republic
356 Saint Kitts and Nevis
358 Saint Lucia
308 Saint Pierre and Miquelon (France)
360 Saint Vincent and the Grenadines
549 Samoa
292 San Marino
626 São Tomé and Príncipe
420 Saudi Arabia
608 Senegal
220 Serbia and Montenegro
633 Seychelles
619 Sierra Leone
525 Singapore
231 Slovakia
293 Slovenia
540 Solomon Islands
637 Somalia
655 South Africa
214 Spain
413 Sri Lanka
634 Sudan
746 Suriname
653 Swaziland
240 Sweden
228 Switzerland
417 Syria
466 Taiwan
436 Tajikistan
640 Tanzania
520 Thailand
615 Togolese Republic
539 Tonga
374 Trinidad and Tobago
605 Tunisia
286 Turkey
438 Turkmenistan
376 Turks and Caicos Islands (UK)
641 Uganda
255 Ukraine
424 United Arab Emirates
430 United Arab Emirates (Abu Dhabi)
431 United Arab Emirates (Dubai)
235 United Kingdom
234 United Kingdom
310 United States of America
311 United States of America
312 United States of America
313 United States of America
314 United States of America
315 United States of America
316 United States of America
332 United States Virgin Islands (US)
748 Uruguay
434 Uzbekistan
541 Vanuatu
225 Vatican City State
734 Venezuela
452 Viet Nam
543 Wallis and Futuna (France)
421 Yemen
645 Zambia
648 Zimbabwe

Mobile Network Code MNC

The MNC is a number in the range from 0 to 16,383. The Mobile Network Codes are assigned individually for each country. Willtek will publish a list of known network codes in due course. For the time being, please refer to the network operator for the correct network code.

Determining the RF Coupling Factors

B

This appendix lists the registers and their contents. The main branches are as follows:

Introduction

Measuring the transmitter and receiver quality through an antenna coupler has several advantages. For precise power and receiver sensitivity measurements, this method requires knowledge of the exact coupling factors between the TETRA radio and the antenna coupler. The coupling factors should be entered in the Definitions menu as RX and TX pre-attenuation values (see "Using an antenna coupler" on page 12 or "Paging Sensitivity test" on page 64).

It should be noted that the coupling factors with the antenna coupler and a shielding device are different from those with an antenna coupler only. Therefore the provider of the coupling factors should state the conditions under which they are valid.

This appendix explains how the pre-attenuation values (coupling factors) can be determined.

Selecting a reference mobile station

The coupling factors are determined with the help of a known good reference radio (also referred to as a "golden mobile" because it should be a mobile station with good performance). Measuring the coupling factor with a TETRA radio with unknown quality bears the risk of obtaining coupling factors that are not typical for a properly working TETRA mobile station.

Determining the TX pre-attenuation

The following instructions apply to a test setup with a TETRA radio, the Willtek 2303 Stabilock and the Willtek 4914 Antenna Coupler. The Willtek 4921 RF Shield can optionally be added.

1 Connecting the antenna coupler:

   a Without the shielding box: Connect the antenna coupler to the 2303 Stabilock using a defined cable.

   b With the shielding box: Place the antenna coupler in a defined position in the shielding box. Connect the RF plug of the antenna coupler with the internal RF plug of the shielding box. Connect the shielding box with the test set using a defined RF cable (N connector on both ends).

2 Switch on the 2303 Stabilock.

3 Under **Setup > Definitions**, set the RX and TX pre-attenuation values to zero.

4 Select **TMO**, and enter a low RF Level value (e.g. –95 dBm).

Note

A low power level from the 2303 is important because the TETRA radio should transmit at its highest power level; this is achieved through open loop power control by stimulating the radio with a low input level.

5 Enter valid network and channel parameters. Either use a channel in the middle of the frequency band supported by the TETRA radio, or determine coupling factors at different frequencies, e.g. at the lowest, highest and a middle frequency.

6 Place the TETRA MS on the XY Shuttle of the antenna coupler, with the shuttle in position A-1. If you are using the shielding box, close it.

7 Start the tests.

8 Set up a call and ensure that the TETRA radio keeps transmitting (either with a duplex call or by keeping the PTT pressed).

9 Note down ten readings of the RF Power measurement.

10 Finish the call and calculate the mean value and the variation of the power results.

11 Repeat step 6 through step 10 for all other shuttle positions, i.e. for A-2, A-3, A-4, B-1 etc. through to D-4.

12 Note down the mean RF power value for the shuttle position with the least variation, together with the shuttle position.

13 Determine the true transmit power value:
Either repeat the measurement without the antenna coupler but with a cable connection between the TETRA radio and the 2303 Stabilock.
Or take the nominal maximum power level (according to the power class of the TETRA radio) as its true transmit power value.

14 The difference between the mean RF power measured at the best position (determined in step 12) and the true transmit power (determined in step 13) is the coupling factor for the transmission direction.

Determining the RX pre-attenuation

The following instructions apply to a test setup with a TETRA radio, the Willtek 2303 Stabilock and the Willtek 4914 Antenna Coupler. The Willtek 4921 RF Shield can optionally be added.

1 Set the TETRA MS into a mode where it displays the received signal strength on its screen or on a PC linked to the MS.

2 Connecting the antenna coupler:

a Without the shielding box: Connect the antenna coupler to the 2303 Stabilock using a defined cable.

b With the shielding box: Place the antenna coupler in a defined position in the shielding box. Connect the RF plug of the antenna coupler with the internal RF plug of the shielding box. Connect the shielding box with the test set using a defined cable.

3 Switch on the 2303 Stabilock.

4 Under **Setup > Definitions**, set the RX and TX pre-attenuation values to zero.

5 Select **TMO**, and enter a medium RF Level value (e.g. –65 dBm).

6 Enter valid network and channel parameters. Either use a channel in the middle of the frequency band supported by the TETRA radio, or determine coupling factors at different frequencies, e.g. at the lowest, highest and a middle frequency.

7 Place the TETRA MS on the XY Shuttle of the antenna coupler, with the shuttle in the position determined in section "Determining the TX pre-attenuation".

8 Start the tests.

9 Set up a call and ensure that the TETRA radio is able to receive data (either with a duplex call or by keeping the PTT released).

10 Note down ten RSSI readings from the (PC or MS) screen.

11 Finish the call and calculate the mean value of the power results.

12 Compare the RSSI reading with the RF Level value set. The difference is the RX pre-attenuation (coupling factor) at this frequency.

Summary

The coupling factors can be entered as pre-attenuation values in the Definitions menu of the 2303 Stabilock. It is important to note the following conditions under which the factors have been determined, and apply them during testing of a TETRA radio of the same type:

- Type of TETRA MS
- Type of antenna coupler
- Shielding box used? Which one?
- Type of RF cable between antenna coupler and test set
- Channel number (if more than one set of values has been determined)

Warranty and Repair

C

This chapter describes the customer services available through Willtek. Topics discussed in this chapter include the following:

Warranty information

Willtek warrants that all of its products conform to Willtek's published specifications and are free from defects in materials and workmanship for a period of one year from the date of delivery to the original buyer, when used under normal operating conditions and within the service conditions for which they were designed. This warranty is not transferable and does not apply to used or demonstration products.

In case of a warranty claim, Willtek's obligation shall be limited to repairing, or at its option, replacing without charge, any assembly or component (except batteries) which in Willtek's sole opinion proves to be defective within the scope of the warranty. In the event Willtek is not able to modify, repair or replace nonconforming defective parts or components to a condition as warranted within a reasonable time after receipt thereof, the buyer shall receive credit in the amount of the original invoiced price of the product.

It is the buyer's responsibility to notify Willtek in writing of the defect or nonconformity within the warranty period and to return the affected product to Willtek's factory, designated service provider, or authorized service center within thirty (30) days after discovery of such defect or nonconformity. The buyer shall prepay shipping charges and insurance for products returned to Willtek or its designated service provider for warranty service. Willtek or its designated service provider shall pay costs for return of products to the buyer.

Willtek's obligation and the customer's sole remedy under this hardware warranty is limited to the repair or replacement, at Willtek's option, of the defective product. Willtek shall have no obligation to remedy any such defect if it can be shown: (a) that the product was altered, repaired, or reworked by any party other than Willtek without Willtek's written consent; (b) that such defects were the result of customer's improper storage, mishandling, abuse, or misuse of the product; (c) that such defects were the result of customer's use of the product in conjunction with equipment electronically or mechanically incompatible or of an inferior quality; or (d) that the defect was the result of damage by fire, explosion, power failure, or any act of nature.

The warranty described above is the buyer's sole and exclusive remedy and no other warranty, whether written or oral, expressed or implied by statute or course of dealing shall apply. Willtek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, or employee of Willtek, which is not contained in the foregoing warranty will be binding upon Willtek, unless made in writing and executed by an authorized representative of Willtek. Under no circumstances shall Willtek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, or losses, including loss of profits, based on contract, tort, or any other legal theory.

Equipment return instructions

Please contact your local service center for Willtek products via telephone or web site for return or reference authorization to accompany your equipment. For each piece of equipment returned for repair, attach a tag that includes the following information:

- Owner's name, address, and telephone number.
- Serial number, product type, and model.
- Warranty status. (If you are unsure of the warranty status of your instrument, include a copy of the invoice or delivery note.)
- Detailed description of the problem or service requested.
- Name and telephone number of the person to contact regarding questions about the repair.
- Return authorization (RA) number or reference number.

If possible, return the equipment using the original shipping container and material. Additional Willtek shipping containers are available from Willtek on request. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. Willtek is not liable for any damage that may occur during shipping. The customer should clearly mark the Willtek-issued RA or reference number on the outside of the package and ship it prepaid and insured to Willtek.

End-User License Agreement

D

This appendix describes the conditions for using the instrument software (firmware).

All copyrights in and to the software product are owned by Willtek Communications or its licensors. The software is protected by copyright laws and international copyright treaties, as well as other intellectual property laws and treaties.

This end-user license agreement grants you the right to use the software contained in this product subject to the following restrictions. You may not:

(i) use the software and/or any copy of the software in different computers concurrently, unless the software is an update that has been downloaded from the Internet at www.willtek.com;

(ii) copy the software, except for archive purposes consistent with your standard archive procedures;

(iii) transfer the software to a third party apart from the entire product;

(iv) modify, decompile, disassemble, reverse engineer or otherwise attempt to derive the source code of the software;

(v) export the software in contravention of applicable export laws and regulations of the country of purchase;

(vi) use the software other than in connection with operation of the product.

The licensor's suppliers do not make or pass on to end users or any other third party, any express, implied or statutory warranty or representation on behalf of such suppliers, including but not limited to the implied warranties of noninfringement, title, merchantability or fitness for a particular purpose.

Willtek Communications shall not be held liable for any damages suffered or incurred by you or any other third party (including, but not limited to, general, special, consequential or incidental damages including damages for loss of business profits, business interruption, loss of business information and the like), arising out of or in connection with the delivery, use or performance of the software.

Glossary

B

BER Bit error rate.

D

DGNA Dynamic Group Number Assignment.

DMO Direct Mode Operation, an alternative mode (to TMO) in which TETRA radios communicate with each other directly, without a base station. All TETRA radios use a single frequency (simplex mode).

E

ETSI European Telecommunications Standards Institute.

M

MCC Mobile country code, a number that uniquely identifies the country in which the network is located or the TETRA mobile station is registered. See section "Network parameters" on page 115 for a list of valid codes and their meaning.

MCCH Main control channel.

MER Message error rate.

MNC Mobile network code. Each TETRA network is uniquely identified by the combination of MCC and MNC. See "Mobile Network Code MNC" on page 117 for more details.

MS Mobile station. This term is used to denote the mobile radio in TETRA.

P

Power Class The power class determines the maximum power that the TETRA radio can transmit. See a list of power classes on page 113.

PTT Push to talk. The PTT is a button at the TETRA mobile station that switches the mobile from receive (listen) to transmit (talk) mode in simplex calls. It must be kept pressed as long as the users wants to transmit (talk).

R

Receiver classes Different performance requirements are specified for TETRA radios and base stations, depending on their intended purpose and application. TETRA specification EN 300 392-2 identifies four different receiver classes:

- Class B equipment is optimized for use in built-up and urban areas.
- Class A equipment is optimized for use in urban areas and in areas with hilly or mountainous terrain.
- Class D equipment has the same performance requirements as class A for $\pi/4$-DQPSK modulation, and is further optimized to enhance the performance of $\pi/8$-D8PSK modulation in hilly or mountainous terrain using equalisation or other techniques.
- Class E equipment comprises an equalizer and is specified for $\pi/4$-DQPSK modulation in static, TU50, HT200 (PACQ only) and EQ200 conditions. It is not applicable to BS equipment. Class E performance is specified only for $\pi/4$-DQPSK modulation.

S

SCH/F Synchronisation channel associated with a full rate channel.

SDS Short Data Service. With SDS, TETRA radios can send and receive short messages. This service is similar to, but more powerful than the Short Message Service (SMS) known from public cellular systems.

SSID The short subscriber ID (SSID) is a number used over the radio interface to identify individual TETRA mobile stations.

T

T1 signal Specification EN 300 394-1 defines a test signal T1 which is a scrambled downlink traffic channel containing a pseudo-random bit sequence (PRBS). The test system transmits this signal at a defined power level and the MS tries to demodulate and decode the signal. It is commonly used to test the receiver of the MS.

T2 signal ETSI specification EN 300 394-1 defines a test signal T2 to be a continuous, PRBS-modulated signal without training sequence. It is used as an interfering (unwanted) signal in large test systems and typically not required for service testing.

T3 signal ETSI specification EN 300 394-1 defines a test signal T3 to be a continuous, unmodulated, sinusoidal signal. It is used as an interfering (unwanted) signal in large test systems and typically not required for service testing.

TCH Traffic channel.

TDMA Time division multiple access, a technology that transfers several communication channels over one frequency carrier by multiplexing the channels into several time slots per frame. TETRA uses four time slots per frame, that means up to four calls can be made on one TETRA carrier. The base station transmits all four time slots in the downlink (to the TETRA mobile stations) while up to four mobiles transmit in turn. This requires precise synchronization in time. – Other access technologies include FDMA (frequency division multiple access), CDMA (code division multiple access) and OFDMA (orthogonal frequency division multiple access).

TEI The TETRA Equipment Identifier (TEI) is the electronic serial number of the TETRA radio. It consists of six-digit type approval code (TAC), a 2-digit final assembly code (FAC), a 6-digit electronic serial number (ESN) and a 1-digit spare number. Each digit is a hexadecimal number (from 0 to 9 or A to F).

TETRA Terrestrial Trunked Radio, the name of the ETSI standard.

TMO Trunked mode operation, the normal operating mode in which the TETRA radios communicate through a network including one or more base stations. The radio communication is performed on a pair of channels: the base station transmits signals, e.g. from another TETRA radio, on one channel while the TETRA radio transmits on another channel. – The alternative to TMO is DMO.

TS Time slot.

Publication History

Revision	Comment
0711-000-A	First version.
0808-120-A	Firmware version 1.20 description.
0905-150-A	Firmware version 1.50 description.

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