STABILOCK 4031 4032

TETRA MS Test

Software Option 897 808

Operating Instructions

(62_tetra) Doc. Version: 0007-210-A

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Supplement to operating manual; file under Chapter 10

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☞ **For differences from former software versions:** see the Timeline at the end of this supplement.

Introduction

What TETRA stands for

TETRA is a wireless communication standard for Professional Mobile Radio (PMR) and Private Access Mobile Radio (PAMR) applications. It is a digital format, ie speech is transmitted as binary data rather than by an analog format as for instance using frequency modulation. This way, it is much more difficult to tap a radio communication.

The acronym TETRA stands for:

TErrestrial Trunked RAdio

If you are familiar with measurements in the analog world, eg MPT 1327 or LTR, you will notice some similarities as well as some new measurements. While RF power and frequency error are measurements important to any system, measuring a vector error or looking at the constellation display may be a new experience because these measurements are specific to the modulation format applied by TETRA, which is $\pi/4$ DQPSK.

This manual describes the measurements and tests on TETRA mobile stations supported by the TETRA MS Test option to the STABILOCK 4032. Although this option can also be used to test the transmitter of TETRA base stations, there is another option available, TETRA BS Test (software option 897 942), which is far better suited to test TETRA base stations.

What is tested EVERYWHERE?

The TETRA MS Test option allows you to

- perform transmitter tests on TETRA mobile stations as well as base stations.
- stimulate the TETRA mobile receiver with a T1 (standard TETRA test) signal.
- view the signalling protocol exchanged between the TETRA mobile station and the STABILOCK 4032.
- loop back the audio signal from the microphone to the loudspeaker for a quick go-nogo test.
- trace back the measurement results to the right unit under test, and to test the numerical keypad.

Measurements possible with TETRA – an overview

Registration	RF power
Call from mobile station	Frequency error
Call from base station	Residual carrier power
Peak and RMS vector error	Phase error
Timing error (alignment)	Power over time (graphics)
Constellation display (graphics)	Modulation spectrum (graphics)
Paging sensitivity	–

General Preparations

Hardware and firmware compatibility

Normally, if you ordered a new system or an upgrade to TETRA, you get your STABILOCK with all the necessary hardware and firmware installed. If this is the case, you can skip this section and proceed to Loading System Software.

If you want to run the TETRA system software on a unit where you do not know exactly whether it is prepared for TETRA, or if you encounter serious problems while running the TETRA system software, make sure the following conditions are met.

Call up the STATUS mask: AUX + DEF.SET + STATUS
.
Check the status of the related firmware versions (SOFTWARE VERSIONS):

STABILOCK 4031 without FEX	**STABILOCK 4032 without FEX**
Host-MCU ≥ 4.14	Host-MCU ≥ 6.14
CRT-MCU ≥ 2.59	CRT-MCU ≥ 2.59
RF/AF-MCU ≥ 3.07	RF/AF-MCU ≥ 5.07
STABILOCK 4031 with FEX	**STABILOCK 4032 with FEX**
Host-MCU ≥ 4.14	Host-MCU ≥ 6.14
CRT-MCU ≥ 2.59	CRT-MCU ≥ 2.59
RF/AF-MCU ≥ 4.13	RF/AF-MCU ≥ 6.13

Make sure the STATUS mask shows `DIG-MCU: D-AMPS`

Call up the OPTIONS mask. It must show either `Duplex + I/Q: installed` or `Duplex + FEX: installed`.

10

Loading system software

The TETRA MS Test system program is supplied on a memory card.

1) Insert the memory card in the slot on the STABILOCK.
2) Press [AUX] + (DATA) to start the loading procedure, which may take about a minute ([AUX] is a hardkey on the front panel, (DATA) is a softkey, the description of which appears on the screen after pressing [AUX]).
3) When the system program is fully loaded, the status line indicates "Loading finished".
4) Leave the card in place. In this way STABILOCK can store entered test parameters on the card, so that you do not have to enter them again the next time you call up the system program (de-activate write protection if it is set on the memory card).
5) To call up the TETRA basic mask, press [AUX] + (DATA). Fig. 10.1 shows the screen that appears then; it is called the TETRA basic test mask.

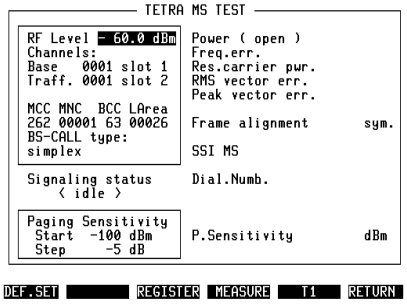


Fig. 10.1:
The basic test mask as it appears when the TETRA MS Test system program has been loaded.

Test Setup (Connectors)

Levels of less than –110 dBm may appear when testing (eg receiver measurements), so the entire setup must be proof against EMI pickup and not radiate any either. The following measures are recommended for this purpose:

- Use a double-shielded RF cable between the STABILOCK test set and the mobile.
- Terminate the RF DIRECT socket of the STABILOCK with 50 Ω while not in use.
- Make sure that all plug-ins of the test set (back panel) are screwed in tightly.
- Close vacant plug-in slots on the test set (back panel) with dummy panels.

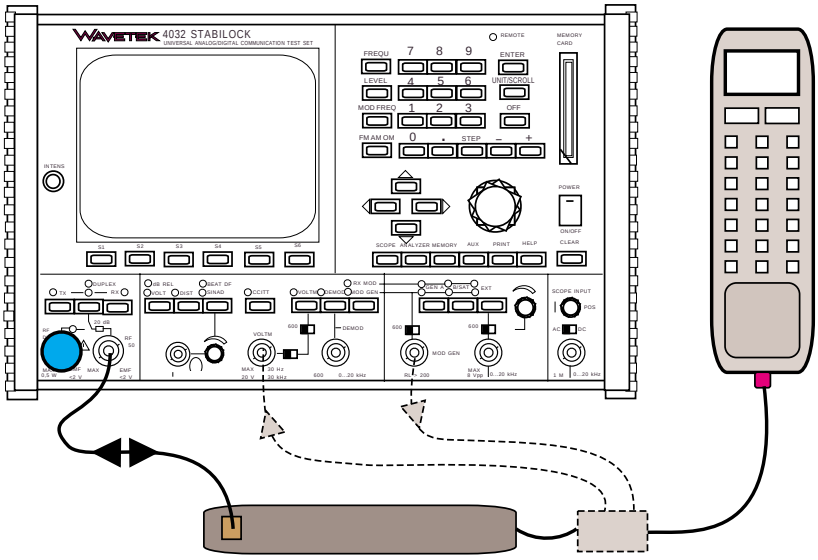


Fig. 10.2: Test setup with TETRA mobile station (handset and transceiver). The test adapter is not necessary for the described tests. The test adapter couples out the microphone signal and the loudspeaker signal so that the usual analog tests can also be performed on TETRA mobiles (e.g. SINAD).

☞ Use the supplied BNC/BNC cable (382 678) to connect socket Bu 103 of the IF unit (back panel) to socket Bu 103 of the D-AMPS unit (see appendix: "Connectors on the rear"). Without this connection no call can be set up to the mobile.
For other TETRA-specific connectors (eg synchronization port) see section "Connectors on the rear" in the appendix of this TETRA manual. For generally available connectors and functions (eg AF signal generator and analyzer), see chapter 4 of the STABILOCK manual.

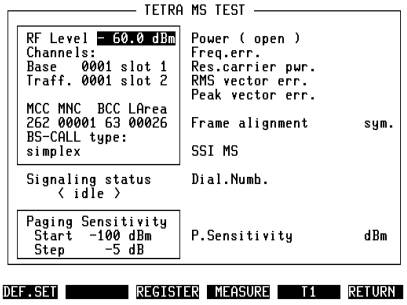
Parameters

This section acquaints you with the most important parameters that you need to set up prior to a test.

☞ Remember that if you leave the memory card in the memcard slot of the STABILOCK, the parameters are written onto the card so they are re-loaded automatically to the STABILOCK next time you load the system software. This way, you do not have to key them in each time.

Basic parameters on basic mask

Fig. 10.3:
The left-hand side of the screen shows input parameters as explained below.



`RF Level` The power level at which the STABILOCK transmits to the mobile station.

`Base channel` The channel number on which the Main Control Channel is transmitted by the STABILOCK, and which the mobile station uses to register and set up a call.

☞ The base channel timeslot number cannot be changed because in TETRA the main control channel is always allocated to timeslot 1.

`Traffic channel` The channel number on which the traffic channel (for voice transmission) shall be allocated. In synchronous mode (with call setup), base channel and traffic channel must be on the same channel.

`Traffic channel slot` The time slot number for the traffic channel. Allowable values are in the range from 1 to 4.

MCC	The Mobile Country Code of the simulated system. It is important to use the MCC of the home system of the mobile station under test. Some examples of valid MCCs are listed in section "MCC codes" in the appendix.
MNC	The Mobile Network Code of the simulated system. It is important to use the MNC of the home system of the mobile station under test.
BCC	The Base station Color Code to be used by the simulated system. Valid values are in the range from 1 to 63. This parameter is not critical to the success of a measurement.
Loc.Area	The Location Area Code determines the individual base station or cell within the network. Valid values are in the range from 0 to 16383. This parameter is not critical to the success of a measurement.
BS-CALL type	Four different choices are available: simplex, duplex, simplex direct through and duplex direct through. An error message will appear if a mobile does not support the latter three ones. The "direct through" choices directly demand the mobiles to the traffic channel without having the need of pressing a PTT button.
Start	The STABILOCK RF output level (dBm) where the search function "paging sensitivity" starts to work.
Step	Increment at which the RF output power level of the STABILOCK is decreased during the paging sensitivity test."

Basic parameters in DEF.SET

When you press (DEF.SET) from the TETRA basic mask, the display changes to the TETRA SETTINGS menu. Some parameters available there depend on the system for which the TETRA mobile station under test is programmed, other parameters allow you to select according to your personal preferences.

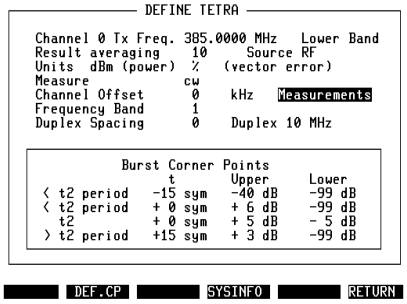


Fig. 10.4:
Some parameters that are not changed so often can be found on the DEF.SET mask.

`Channel 0 Tx Frequency`

This is the frequency (in MHz) on which the MS would transmit channel 0. You must enter the appropriate number even if the TETRA system at hand does not use channel number 0. The system software just calculates the required frequency from the Channel 0 TX Frequency and the channel number entered on the basic mask, assuming 25 kHz between adjacent channels. If you know a channel number, say n_1, and the corresponding frequency f_1, you can calculate the Channel 0 TX Frequency according to the following algorithm:

Channel 0 TX Frequency = f_1 – 25 kHz * n_1

Example:
If you know that channel 78 is on 386.9625 MHz, then Channel 0 TX Frequency is 385.0125 MHz.
The setup procedure for mobiles or networks conforming to a new method (radio interface standard ETS 300 392-2 edition 2) can be found in the appendix.

`Band`

Using the UNIT/SCROLL key, select whether the unit under test is transmitting in the upper or lower band, separated by the duplex spacing. The default for MS test is Lower Band. For base station testing, the Upper Band is the right choice because the base station usually transmits eg 10 MHz above the MS.

Example:
If Channel 0 TX Frequency is 380.0000 MHz, Lower Band is selected, Duplex is set to 10 MHz and the traffic channel number is 2, then the STABILOCK expects the equipment under test to transmit at 380.050 MHz and to receive the STABILOCK signal at 390.050 MHz.

`Result averaging`

This parameter applies to measurements on the MIN-MAX display. The AVG (average) value is calculated from the last N measurements; N is the value you enter in this input field (valid range is from 2 to 200).

`Units`

Select your preferential unit with the UNIT/SCROLL key. The measured RF power can be displayed either in dBm or Watt. The vector error can take on absolute or percentage values.

☞ Changing the power setting also changes the unit for all measurements outside TETRA. If you want to return to your own units after making TETRA measurements, leave the TETRA basic mask with the (RETURN) softkey, enter [AUX] + (DEF.SET), and select the preferred unit in the scroll field `RF POWER`.

`Source`

The connector to be used can be changed between RF and RF DIRECT using the [UNIT/SCROLL] key.
The normal input/output connector is RF. You can also perform measurements using the RF DIRECT connector, which allows for 20 dB higher RX and TX signals. Note, however, that measurement accuracy stated in the data sheet only applies to the RF connector.

`Measure`

This scroll field is used to select the mode for the MEASURE softkey, where you can take measurements from either continuous or discontinuous signals. You have to tell the STABILOCK if it is to expect BURST or CW (constant waveform) signals.

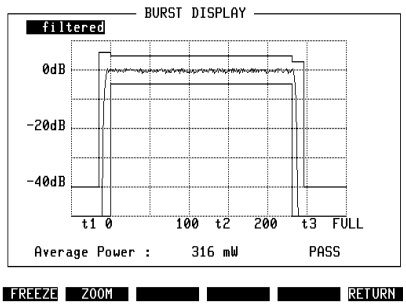
`Channel Offset`
`Frequency Band`
`Duplex Spacing`

These parameters are used in the protocol software to indicate parameter settings that are not generally defined yet. Please consult your network operator how to set up these fields.

☞ A new method how to use the parameters can be found in the appendix, and may be helpful if the correct parameters are unknown.

`Measurements or Trace`	The default setting, Measurement, allows you to perform measurements, either in synchronous (call) mode or asynchronous (measure) mode. If you change this scroll field to Sign.Trace instead, no measurements are available but normal call procedures can be made. You can then see the protocol trace on various layers. See chapter Signalling Trace in this manual.
`Duplex`	In trunked mode, receive and transmit frequency differ by a defined spacing called the duplex spacing. The default is 10 MHz because this is the most commonly used setting. Other values may be used such as 8 MHz or 45 MHz. Consult with your network operator or mobile manufacturer to find out the value used by the mobile phone under test.
`Upper` and `Lower Burst Corner Points`	These fields allow to enter the upper and lower limits represented in the burst template.

Fig. 10.5:
The figure shows where the input values take effect. If the measured curve is within the template, the display shows "PASS" on the lower right side, otherwise it indicates a "FAIL".



The different parts of the template are expressed in their time/power coordinates; five different time sections are defined, for each section the upper and lower power limit can be entered. The time sections are defined by the last point of the subsequent section and the time entered on the display. Time is counted in symbol periods (sym). All time points are relative to the start or end of T2 period, which is the time at which the useful part of the burst (containing the relevant information) occurs.

☞ T2 may be shorter or longer, depending on the type of burst. The displayed section is always adjusted to the correct length.

The usage of the entry fields is explained using the following example:

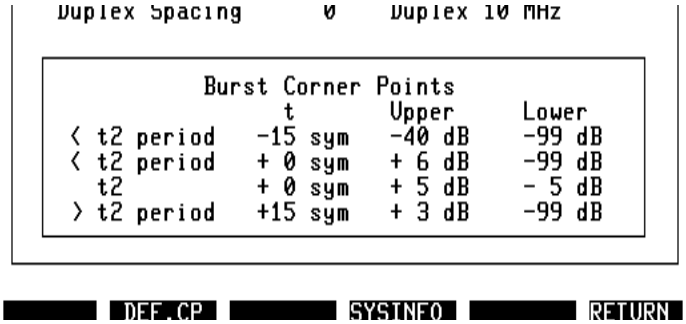


Fig. 10.6: The default settings for the Burst Corner Points in the DEF.SET mask.

In the first row denoted "< t2 period", the lower and upper power limits can be entered for the time between the left-most point (which is 50 symbol periods before T2 begins) and the time entered in the t column. In this example, the first part of the template spans from the left side up to 15 symbols before T2; so this first period is 35 symbols long. There is no lower limit (indicated by the lowest possible entry of –99 dB relative to the average power over the burst) and the upper limit is –40 dB.

In the second row denoted "< t2 period", the power limits can be entered for the time between the previous t entry value (–15 symbols with respect to the beginning of T2) and the time entered in the t column of this row. In the example above, this spans the 15 symbols before T2 starts and the upper limit is +6 dB; this period is the power ramp-up period.

In the third row, the limits for the T2 period can be entered. If t = 0 sym is entered for the time as in this example, this period ends at the end of T2. If the limits are required for a shorter or longer period than just T2, the appropriate value can be entered in the t column. Positive values denote a prolongued T2 section, negative values can be used to shorten the period.

The "> t2 period" row can be used to enter the template limits for the ramp-down section. In the example, the upper power limit is set to 3 dB because the mobile station may still keep the power up for a short time; the lower limit is set to –99 dB again to allow to reach the power-off state.

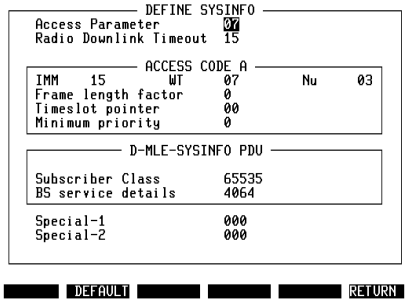
The fifth period is used for the power-off state. This period does not have its own entry values; the period takes from the time entered in the last t field until the end of the display. The power limits are taken from the very first row where the mobile station is expected to be in the same power-off state.

☞ In order to get back to the values pre-programmed by Wavetek, press (DEF.CP) (default corner points). The factory settings are then restored, see figure 10.6.

SYSINFO parameters in DEF.SET

The STABILOCK allows the TETRA mobile phone to register and set up calls. It does this by simulating a network, in particular by sending a main control channel with typical broadcast messages on the Synchronization Channel and the Broadcast Network Channel BNCH (D-MLE-SYSINFO). The STABILOCK is configured to transmit typical values that most TETRA mobile phones accept. If you want to test the mobile phone's behavior with different settings on the BCCH, you can do so by changing the parameters on the DEFINE SYSINFO mask. This mask is accessible from the DEF.SET screen by pushing the (SYSINFO) key, see figure 10.7.

Fig. 10.7:
The SYSINFO mask gives you access to network broadcast parameters. Use default values if in doubt.



The SYSINFO PDU on the MAC layer is defined in ETSI specification ETS 300 392-2 section 21.4.4.1. Some of the parameters are accessible from the DEF.SET mask and are explained on the previous pages: Main carrier (base channel), frequency band, offset, and duplex spacing.
The parameters accessible on this mask are grouped according to the information elements they are used in.

`Access Parameter` This parameter is used for adjustments (from –53 to –23 dBm) of the RXLEV_ACCESS_MIN parameter. The field is coded and valid inputs are in the range 0 to 15.

`Radio Downlink Timeout` This parameter indicates how many undecodable AACH messages the mobile station shall wait before dropping a call. The field is coded and valid inputs are in the range 0 to 15.

`ACCESS CODE A` The following block defines parameters to be sent in the "Default Definition For Access Code A" element in the SysInfo PDU on the MAC layer. SysInfo is sent on the Broadcast Network Channel BNCH. The parameters are defined in ETS 300 392-2 (editions 1 and 2) section 21.4.4.1.

`IMM` The Immediate parameter indicates after how many TDMA frames the mobile shall randomize a transmission retry. Valid input is in the range from 0 to 15.

WT	The Waiting Time parameter indicates to the mobile station how long it may have to wait for response from the network. The valid entries are in the range from 0 to 15.
Nu	This parameter defines the allowable Number of random access transmissions on uplink, which can be in the range from 0 to 15.
Frame length factor	The Frame Length Factor indicates whether frame length definitions in this information element shall be multiplied by four. The flag is set to 1 in this case.
Timeslot pointer	The timeslot pointer is a bit map field indicating the timeslots which the MS shall monitor for ACCESS-ASSIGN messages. The bit map has a size of four bits, each representing a timeslot. Coding examples: timeslot 1: 0001 (binary) = 1 (decimal) timeslot 4: 1000 (binary) = 8 (decimal)
Minimum priority	This field defines the minimum priority for access. The value may be from the range 0 to 7.
D-MLE-SYSINFO PDU	This section contains parameters that are transmitted in the SYSINFO PDU from the MLE layer. The DPU description can be found in ETS 300 392-2 section 18.4.2.2.
Subscriber Class	The allowable subscriber class is a 16-bit field transmitted in the D-MLE-SYSINFO PDU. The valid input range is from 0 to 65535.
BS service details	This is a 12-bit field indicating services that the cell provides or which the cell requests from the mobile: Registration, de-registration, priority cell, minimum mode service, migration, roaming, TETRA voice, circuit mode data, CONP, SCLNP, air interface encryption, advanced link. These parameterse are coded into a decimal value in the range 0 to 4095. See ETS 300 392-2 section 18.5.2 for more details.
Special-1	This parameter is no longer used. The former necessary entry 002 for duplex calls now is covered by the new entry field "BS-CALL type" on the basic mask.
Special-2	This parameter is not currently used.

Modes of operation

The TETRA MS Test option supports four different modes of operation – transmitter measurements in asynchronous mode, T1 bit pattern generation and paging sensitivity search function for receiver tests, measurements in call mode, and the protocol trace.

Asynchronous measurements on the transmitter and receiver are useful when the mobile is not in normal state but in a test mode. If you can make your mobile under test transmit without a prior registration (location update) and a subsequent call setup, or if you want to test the TETRA receiver by means of a T1 signal transmitted by the STABILOCK, proceed with sections MEASURE and T1.

For measurements in normal mode, ie with location update (registration) and call setup, the REGISTER section is most helpful to you.

For training purposes, or if you experience problems with a particular phone in conjunction with the STABILOCK, it may be useful to have a look at the protocol being exchanged between the STABILOCK and the unit under test. In this case, you may want to proceed reading in the TRACE section.

MEASURE: Asynchronous transmitter measurements

In order to access the asynchronous transmitter measurements, the following settings are required:

- On the DEF.SET mask, the scroll field on the right hand side of the Channel Offset field can be in either of two states: Sign.Trace or Measurements. Use the UNIT/SCROLL key to switch to `Measurements`.
- Still on the DEF.SET mask, select `cw` in the Measure scroll field if you want to test a continuous signal, or select `burst` for a discontinuous signal.
- Make sure other relevant parameters on the DEF.SET mask are set accordingly: Channel 0 TX Frequency, Lower/Upper Band, Source, and Duplex spacing.

Once that the settings are made, you can start the asynchronous measurements by pushing the MEASURE key. The Measurements section explains in more detail how to access different types of measurements (such as power, modulation and frequency error, constellation and burst display) and how to interpret the results.

Measurements on a mobile station

The usual settings on a mobile station are: Lower Band, Source is RF, and burst measurements. The duplex spacing for carriers around 800/900 MHz is typically 45 MHz, and 10 MHz (for European systems) or 8 MHz (for systems in Australia and New Zealand), respectively, around 400 MHz.

In Measure mode, the STABILOCK transmits a normal Main Control Channel on the base channel and measures signals on the traffic channel. The carrier frequencies of both these channels are defined by the channel numbers entered on the basic mask and the Channel 0 TX Frequency on the Define Settings mask.

Any proprietary test modes may require that the MS receives a base station signal on the same channel, or may require that there is no signal at all. Since measurements are always performed on the selected "traffic channel", set the base channel accordingly, ie if the MS requires a base station signal then enter the same channel number in the "Base Channel" input field as in the "Traffic Channel" field, and press the MEASURE key. Depending on the MEASURE selection on the DEF.SET mask, the STABILOCK attempts to either measure discontinuous (burst) or continuous (CW) signals.

☞ In factory testing, this mode can be used to perform board level tests and measurements in a test mode.

☞ If you suspect that the unit under test is transmitting on the right frequency but no measurements appear after pressing the MEASURE key, see if the correct MEASURE mode has been selected on the DEF.SET mask.

Measurements on a base station

If you want to make a few transmitter tests on a base station, this section gives you some hints how to set up the STABILOCK with the TETRA MS Test option. For more comprehensive testing, including receiver tests and synchronization with the base station, the TETRA BS Test option is recommended.

In contrast to a mobile station, a base station is supposed to transmit always and continuously; it does not need to see a special T1 signal or a test mode to transmit. You can take the same transmitter measurements as for a mobile station, only few parameters need to be changed eg you need to make sure that the STABILOCK uses the correct frequency. Take care of the following input fields on the DEF.SET mask:

- Enter the Channel 0 TX Frequency.
- Make sure that you also select the UPPER Band for TX when testing a base station if you want to make use of the STABILOCK 4032 output signal.
- Finally, select "cw" signals in the MEASURE input field on the same mask.

As the base station does not require a signal from the mobile station for the transmitter tests, you may want to select the lowest possible value for the STABILOCK output power.

T1: The T1 generator

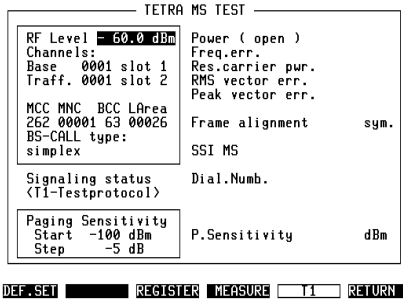
This is a mode of operation in which the mobile station reads a signal with a special data format (called "T1 signal") from the test equipment; the signal allows the MS to synchronize with the test equipment. The signal can be used to perform receiver measurements, assuming the data received in the mobile are evaluated by the mobile itself or forwarded to an external PRBS analyzer.

The T1 signal is a PRBS sequence on a logical channel supported by TETRA. For type approval, tests with the T1 signal are required on the following logical channels: TCH/7.2, SCH/F, SCH/HD, TCH/2.4. For receiver testing in the field, tests on TCH/7.2 are most appropriate because the data on this logical channel are not protected against degradation due to RF interference, fading and Doppler effect. The other logical channels carry redundancy; this helps the receiver detect reception errors and possibly correct them. Since the purpose of receiver measurements is to test the performance of the receiver itself, and not the error recovery software, the STABILOCK only supports tests on the unprotected TCH/7.2.

Outside the specified logical channel, the STABILOCK transmits a modified Broadcast Network Channel BNCH/T and a Base Synchronization Channel BSCH on frame 18 of each multiframe, in accordance with conformance testing specification ETS 300 394-1.
In order to start the T1 bit pattern generator, follow the procedure below:

- On the DEF.SET mask, the scroll field on the right hand side of the Channel Offset field can be in either of two states: Sign.Trace or Measurements. Use the UNIT/SCROLL key to switch to `Measurements`.
- Press the T1 key (Fig. 10.8). The RETURN key can be used to stop the generator again and to return to the basic menu.

Fig. 10.8:
The T1 bit pattern generator uses the parameters from the left-hand side of the basic, mask, especially the scrambling parameters MCC, MNC, and BCC.



☞ In all cases where a special testmode software (reading out BER value from the mobile) is not available, see also chapter "Paging sensitivity search function".

REGISTER: Setting up a call

Compared to the asynchronous (Measure) mode, there is an extended set of tests available using the TETRA protocol eg to register the mobile station with a virtual network (ie simulated by the STABILOCK) and to set up a call.

☞ This is the kind of test mostly performed in a service environment when there is no access to internal test modes. Setting up a call and taking measurements may give you the highest level of confidence that the equipment is working correctly.

In this mode, the STABILOCK simulates a network with certain parameters on a defined frequency channel. The MS under test will only find the frequency channel if it falls within a range of frequencies scanned by the MS. Also, it will only accept and register with the network if the parameters match those which are allowable for this particular MS. Therefore, correct entry of these parameters and frequencies is vital for successful testing.

☞ Please consult with your network operator and/or the manufacturer of the TETRA MS in order to learn the correct settings.

The following sub-sections explain how to use the STABILOCK in order to put the mobile under test into the call mode required for the tests.

☞ On the DEF.SET mask, the scroll field on the right hand side of the Channel Offset field can be in either of two states: Sign.Trace or Measurements. Make sure you start the tests in Measurement mode. Use the [UNIT/SCROLL] key to switch to `Measurements`.

Registration (Location Update procedure)

Why?
- Start the base station simulation in the STABILOCK.
- Test whether the mobile station can receive and decode the base station signal.
- Check whether the mobile station registers with the (simulated) base station properly.
- Prepare the mobile for calls and tests.

Requirements
- Mobile station is switched off.
- Mobile station is not in an "engineering mode".

How?
- Prepare for test (see section "General Preparations").
- Press (REGISTER) in the basic test mask.
- Wait until mobile station indicates "in service" or similar. Basic test mask indicates "Idle updated".

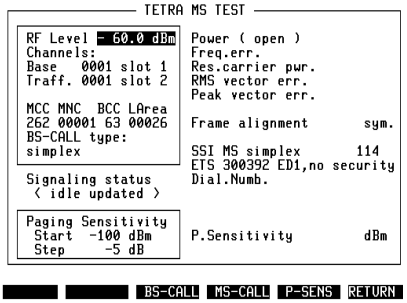
The identity of the MS is indicated on the right-hand side of the screen, in the "SSI MS" field. The simplex/duplex capability is shown as well, see Fig. 10.9.
More information about the MS under test is indicated on the right-hand side of the screen, below the "SSI MS" field. This includes the air interface standard version and the encryption capability.

☞ The MS identity consists of three fields: the Mobile Country Code MCC, the Mobile Network Code MNC, and the Short Subscriber Identity SSI. If the result shows only one code, this is the SSI and the mobile's MCC and MNC are identical with those of the simulated network. MCC and MNC can then be found on the left-hand side of the screen.

☞ The MS may conform to either edition 1 or 2 of the air interface standard ETS 300 392-2.

☞ The simplex/duplex capability does not refer to full or semi-duplex speech calls but to the capability of transmitting and receiving at the same time. Duplex capability is required for multislot speech/data calls.

Fig. 10.9:
Once the mobile is registered, calls from mobile or base station can be performed as well as a paging sensitivity search function.



Call from mobile station

Why?
- See if the mobile station can originate a call.
- Proper call setup is a requirement for further tests.

Requirements
- Mobile station is registered ("idle updated") and not in a call.

How?
- Dial a number on the mobile and press SEND key on mobile, or push the PTT. The mobile initiates a call on the main control channel and is then handed off to the selected traffic channel slot. The display shows "Traffic channel" on the left-hand side and measurement results on the right-hand side.

☞ You may originate a call to a group or to an individual subscriber, in full or semi-duplex mode. The dialed number is indicated on the right-hand side of the screen (Fig. 10.10).

☞ In semi-duplex mode, keep PTT pressed in order to maintain the call and to see measurement results.

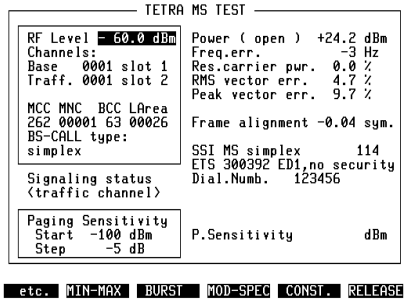


Fig. 10.10:
An MS-originated has been established, the dialed number is displayed along with measurement results.

Call from base station

Why?	❍ See if the mobile station can receive a call. ❍ Proper call setup is a requirement for further tests.
Requirements	❍ Mobile station is registered ("idle updated") and not in a call.
How?	❍ Prepare for test (see section "General Preparations"). ❍ Select a BS-CALL type which is supported by the mobile. ❍ Press (BS Call) in the basic test mask. The STABILOCK calls the mobile station on the main control channel. ❍ Answer the call (lift receiver or press PTT). STABILOCK directs mobile station to the selected traffic channel slot. The display shows "`traffic channel`" on the left-hand side and measurement results on the right-hand side.

☞ The STABILOCK will set up a call to the MS under test according to the selected type of BS-CALL (simplex, duplex, simplex direct through, duplex direct through). If the mobile does not support the selected call type, an error message is displayed and the call establishment is aborted. As a BS-CALL on full duplex mobiles directly can be choosen in the basic mask, the former Special-1 entry "002" is no longer needed

☞ In semi-duplex mode, keep PTT pressed in order to maintain the call and to see measurement results.

Paging sensitivity search function

Why?

- See if the receiver sensitivity of the mobile station is good enough.
- For all cases where you do not have access to the BER values calculated inside the mobile station.

Requirements

- Mobile station is registered ("idle updated") and not in a call.
- Source RF must be selected in the DEFINE TETRA mask.

How?

- Set the STABILOCK output level "Start" to a value some dB higher than the expected sensitivity value (default –100 dBm).
- Set the STABILOCK output level "Step" (default –2 dB).
- Press (P-SENS) in the basic test mask. The STABILOCK sets its output level to the Start value and transmits paging request messages to the mobile. As long as this message is acknowledged by the mobile, the STABILOCK will change its output level according to the Step value and continue sending paging request messages.
- When the mobile does not acknowledge the message within a certain period of time, the search function is finished, the last output level at which the mobile acknowledged the paging is displayed as `P-Sensitivity` value and the former RF level setting will be restored.

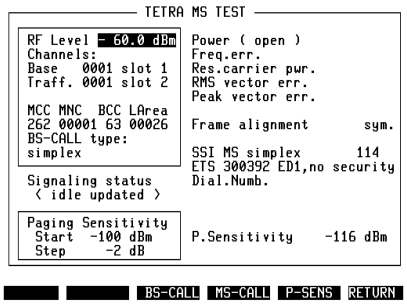


Fig. 10.11:
The basic test mask in < idle updated > state and a measured P.Sensitivity value of -116 dBm.

☞ Some types of mobiles do not support the freeze/revert open loop power control message, used in the search routine. In those cases you should first run a REGISTER with a STABILOCK RF level < –80 dBm (eg –100 dBm) before pressing (P-SENS).

Call cleardown

Why?
- Stop measurements on this mobile station.

Requirements
- Mobile station is on traffic channel (MS Call or BS Call pressed before).
- Screen shows basic test mask.

How?
- Release the PTT if applicable.
- Press the DISCONNECT key on the mobile.
- Press (RELEASE).

If the mobile station has not already sent a Disconnect message to the simulated network, the STABILOCK sends a message to the mobile station saying that the call is over and that the traffic channel should be released.
The mobile and the STABILOCK return to the "idle updated" state, the softkeys return to the previous state as indicated in Fig. 10.13.

☞ In order to set up a new call, you can press the (MS Call) or (BS Call) keys again.

☞ To test another MS, switch off the mobile and press (RETURN) to return to the idle state. You can then disconnect the previous mobile from the STABILOCK and connect another one.

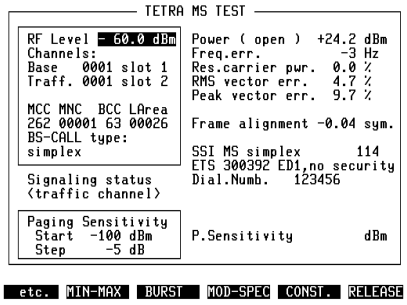


Fig. 10.12: Press the (RELEASE) key to end a call.

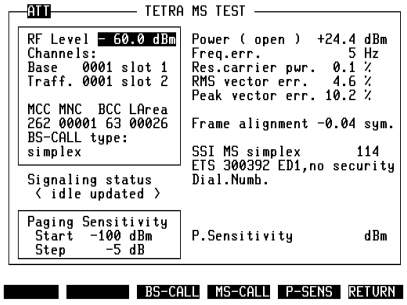


Fig. 10.13: TETRA basic test mask after Call cleardown.

10

TRACE: Protocol display

This mode allows for an offline trace of the protocol (signalling) between the STABILOCK and the MS. The STABILOCK has some built-in sequences that are required to register the MS with the network, set up a call, and to release the channel after the test. The STABILOCK captures the transmitted and received messages to an internal buffer and displays them when the test is stopped. This means that once the tracing is stopped and the results are viewed, no further messages are added to the display.

The supported signalling procedures are the same as in the call mode, see section "REGISTER: Setting up a call": Registration (location update), Call by MS, Call by BS, and Release.

The following steps are required to start the trace:

- On the DEF.SET mask, the scroll field on the right hand side of the Channel Offset field can be in either of two states: Sign.Trace or Measurements. Use the (UNIT/SCROLL) key to switch to `Sign.Trace` (see Fig. 10.14).
- Make sure other relevant parameters on the DEF.SET mask are set accordingly: Channel 0 TX Frequency, Lower/Upper Band, Source, and Duplex spacing.

Back on the basic mask, the softkey description changes to allow for Registration but not for asynchronous measurements or for the T1 generator. Push the (REGISTER) key to start the Location Update procedure (see Fig. 10.15). This is the initial procedure required for all subsequent procedures such as call setup.

☞ RF measurements are not possible in trace mode.

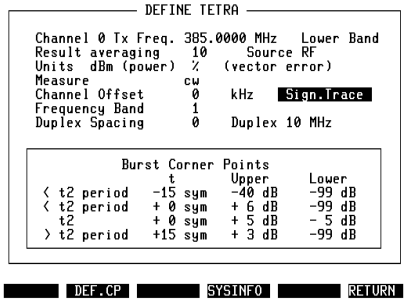


Fig. 10.14: Before you can start tracing the protocol, you need to switch from measurements to signalling trace.

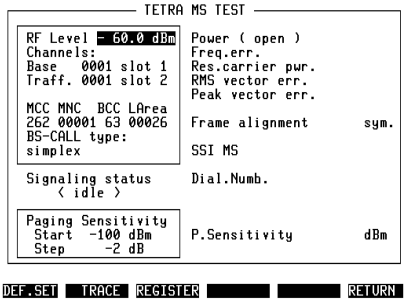


Fig. 10.15: In trace mode, the softkeys allow you to start a signalling procedure (eg Registration). The TRACE key should be pressed afterwards.

Once that you do not want to perform any new procedure but want to view the signalling exchange up to this point, push the (TRACE) key. The trace display appears with a time stamp of each message, the direction (D for downlink, ie the message is sent by the STABILOCK, or U for uplink), and the name of the message. The message naming follows that of the TETRA air interface standard. See Fig. 10.16 for an example.

The message names from the different layers are displayed; supported layers are Upper MAC (UMAC), Logical Link Control (LLC), Mobile Link Entity (MLE), and Layer 3 (L3) including Mobility Management MM and Circuit Mode Control Entity CMCE. Display of one and the same radio interface message on up to four different layers leads to a high number of messages on the screen. The STABILOCK provides filters so that only the upper layers are visible. The default filter is UMAC ie all messages are displayed. An example of a L3 trace is shown in Fig. 10.17.

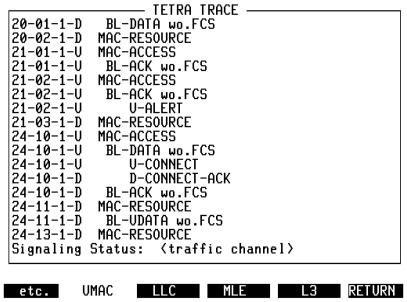


Fig. 10.16: After performing a signalling routine, the Trace softkey can be pressed and the exchange of signalling messages is shown.

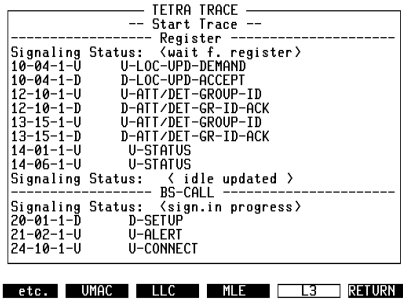


Fig. 10.17: Lower layer information can be suppressed by pushing a softkey for the higher layers, eg L3.

The trace may be longer than fits onto the screen. In order to scroll line by line, move the Cursor-Left and Cursor-Right keys. To skip a whole page, use the Cursor-Up and Cursor-Down keys.

The whole trace can be printed to the default printer (the printer settings can be adjusted on the General Parameters mask). If an appropriate printer is attached, you can generate a print-out by pushing the keys (etc.), (PRNT ALL).

Measurements

This section explains the basic TETRA measurements that are supported in the STABILOCK, in both asynchronous (Measure) and call mode. Where a measurement applies to call mode only, this is indicated.

Measurements under remote control

Measurements can be controlled either manually, or by AUTORUN programs or through the GPIB (IEEE-488 bus). Chapter 8 of the STABILOCK 4032 user manual details the general approach for GPIB control – connecting a PC, selecting the GPIB address, changing between masks, setting values for the input variables, reading measurement results. This section describes how to initiate single-shot TETRA measurements under AUTORUN or GPIB control. The following sections describe the measurements and the format of result fields.

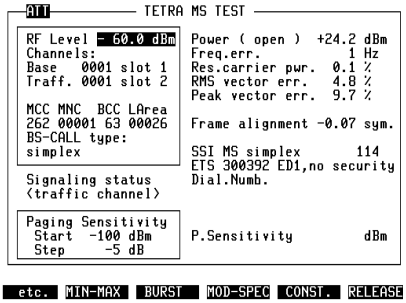
In remote mode, the STABILOCK can perform single-shot measurements, as opposed to continuous measurements in manual mode. In order to initiate a new measurement, the following command is needed:

```
SPECIalMEAS
```

On graphical displays, the measurements are stopped after each result has been returned to the controlling PC until a new `SPECIalMEAS` command has been issued. On screens with purely numerical results, measurements run continuously but return results to the controlling PC upon a `SPECIalMEAS` command.
Once a measurement has been initiated with `SPECIalMEAS`, results can be fetched with the `RESULTx` command, where x and the resulting output format is detailed below for each measurement separately; see appropriate box entitled "Test results under remote control".

Quality measurements from the basic mask

Fig. 10.18:
In call mode, quality measurements are frequently updated on the right-hand side of the screen. More results are available using the softkeys. Finally, the call can be finished using the Release softkey.



☞ The expression ATT on the left-hand side of the mask title line points to a preattenuation setting >0.0 dB, entered in the mask GENERAL PARAMETERS (key sequence AUX + (DEF.PAR)). A preattenuation setting will affect the RF level setting as well as the TX power calculation on the basic mask and all subsequent TETRA measurement masks.

On the right-hand side of the TETRA basic mask, you can see some result fields. In the case of transmitter measurements, the following fields are frequently updated with measurement results:

Result field	Meaning	MS limit according to TETRA specifications
Power	This field shows the RF power as received at the input connector of the STABILOCK. If burst measurements have been selected, this value is the average power over the burst, calculated at the decision points of the symbols ie in the middle of each symbol.	The power may vary by ±2.0 dB at the highest and by ±2.5 dB at all other levels from the nominal value. The nominal level can be set in 5 dB steps from 15 dBm to 45 dBm (depending on the power class of the mobile station).
Freq.err.	The frequency deviation from the nominal carrier frequency is presented in Hertz (Hz).	±0.2 ppm, ie ±76 Hz at a frequency of 380 MHz.
Res.carrier pwr.	This is the power offset from the origin (in the I-Q plane). It is displayed as a percentage of the nominal power.	5%
RMS vector err.	The vector error is the magnitude of the vector from the ideal vector position (in the I-Q plane) to the measured point. The RMS vector error expresses an average over the whole burst (or the portion of the continuous signal that is measured).	0.100

`Peak vector err.`	This is the peak value of the vector error from all symbols over the whole burst or period.	0.300
`Frame alignment`	Normally, the mobile station tunes its timing to the one it receives from the base station. This measurement shows the timing error in the MS transmission. If the MS signal is not synchronized to the signal transmitted by the STABILOCK, the result field shows "------".	±0.25 symbol periods
`P-Sensitivity`	At the displayed RF level (dBm) the mobile was able to decode a Paging Request command for a last time and successfully acknowledged it. This value can be used as a measure of the mobile receiver sensitivity.	–

Test results under remote control		
IEEE command	String position	Result
`RESULt1`	`12345678901234567890` `aaaaaaaaa;bbbbb;****`	a = TX power (incl. dimension) b = Freq. error (Hz) * = reserved
`RESULt2`	`12345678901234567890` `aaaaa;bbbbb;ccccc;**`	a = Residual carrier power (%) b = RMS vector error c = Peak vector error * = reserved
`RESULt3`	`12345678901234567890` `aaaaa;bbbbb;ccccc;**`	a = reserved b = reserved c = Frame alignment (symbols) * = Reserved
`RESULt4`	`12345678901234567890` `aaaaaaaa;bbbbbbbb;cd`	a = TEI b = SSI c = MS type: 0=simplex, 1=duplex d = ETS information 0=ETS 300 392 ED1, no security 1=ETS 300 392 ED1, 300 392-7 ED2 2=ETS 300 392 ED2, 300 392-7 ED2
`RESULt5`	`12345678901234567890` `aaaaaaaaaaaaaaaaaaaa`	a = dialed number (MS-CALL), left justified, remaining characters = spaces
`RESULtB`	`12345678901234567890` `aaaaaaaa;**********`	a = Value of paging sensitivity, eg "-116 dBm" * = reserved
`RESULtC`	`12345678901234567890` `aaaaaaaaaaaaaaaaaaaa`	a = Burst type in case of MEASURE (eg "continuous" or "full slot burst", left justified, remaining characters = spaces

Power versus time

Why?
- ❍ Visual assessment of the burst.
- ❍ Measurement of transmit power during the burst.
- ❍ Test whether the mobile ramps up and down correctly at the burst edges.

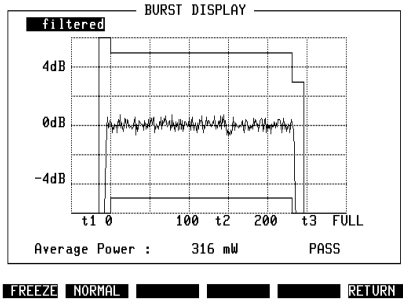
Requirements
- ❍ Quality measurements must have been started, either by pressing (MEASURE) or by pressing one of the CALL keys.

How?
- ❍ Press (BURST).
- ❍ The display can be toggled between filtered and unfiltered measurements. The term "filtered" refers to the TETRA filter which is usually required. If you want to see the "raw" data, you can switch to the unfiltered data display using (UNIT/SCROLL) key.
- ❍ Press (ZOOM) to see a close-up of the active part of the burst (see Fig. 10.19).
- ❍ Press (FREEZE) to stop updating the measurement results, then use (CONTIN) to continue.
- ❍ Select (RETURN) to get back to quality measurements on basic test mask.

The display shows the power at each symbol's decision point (or point of maximum effect), which is the centre of the symbol.

A PASS/FAIL indication is given depending on whether the power signal fits into the template. The template itself is user-selectable ie if you require a different template layout, define your own corner points on the DEF.SET mask.

Fig. 10.19:
Burst power zoomed to the range from –4 dB to +4 dB.



☞ Note that only the upper 40 to 50 dB of the rising and falling edges are displayed.

After call setup, only normal uplink bursts from a traffic channel are displayed. In MEASURE mode, with BURST selected in the DEF.SET mask, the STABILOCK can measure and display either full-slot bursts or half-slot bursts (control uplink bursts).

☞ Half-slot bursts can only be measured if no full-slot bursts occur. The first burst received after starting a measurement determines the type of burst expected in all subsequent measurements.

Test results under remote control		
IEEE Command	String position	Result
`RESULt1`	`12345678901234567890` `aaaaaaaaa;**********`	a = TX power (incl. dimension) * = Reserved
`RESULt2`	`12345678901234567890` `abcd**************`	a-d = Specific Pass/Fail

Constellation display

Why?

- Test the modulation characteristics of the mobile. For this purpose, the test set offers fast visual judgement of the modulation quality with the constellation display (graphical representation of the modulation quality) plus comprehensive indication of the measured figures on the numerical display.

Requirements

- Quality measurements must have been started, either by pressing (MEASURE) or by pressing one of the CALL keys.

How?

- Press (CONST) key. The screen changes to the constellation display (Fig. 10.20).
- In the Limit entry field, you can set a percentual range (5% to 30% in steps of 1%) for measurement deviation from ideal values. The circles are displayed if you set the Circles entry field to ON and if ACCUM mode is selected (see Fig. 10.21).
- In the Spider lines entry field, you can toggle the display of spider lines on and off. The spider lines aer small crosses marking the positions of the respective nominal points (Fig. 10.20).
- Use the softkeys (DOTS), (LINES) or (ACCUM), respectively, to select different display modes (as explained in the box below).
- Press (FREEZE) to stop updating the measurement results, then use (CONTIN) to continue.
- Select (RETURN) to get back to quality measurements on the basic test mask.

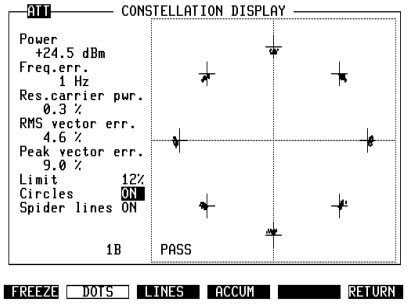


Fig. 10.20: Constellation display (can be selected using the (CONST) after measurements have been started on the basic test mask). On the left-hand side, there are useful numerical results; see section "Quality measurements" for explanations.

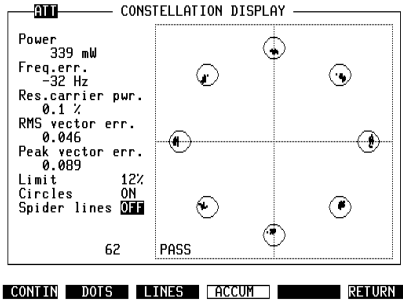
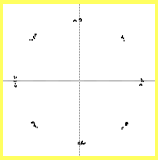


Fig. 10.21: Circles according to the user-defined limit show you where the peak vector error fails.

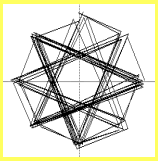
10

Available display modes

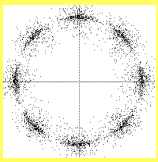
DOTS, the points of maximum effect (POMEs) are shown for one timeslot. This display, for a well adjusted transmitter, shows eight tightly limited accumulations of dots, offset by 45°. Before the points from a new measurement (next burst or timeslot) are displayed, the recent results are deleted.



LINES, consecutive points of maximum effect are connected. From this display it is possible to deduce the symbol contents (data stream). In addition, you can detect phase errors very clearly. But, in practical terms, this display is just a pretty show.



ACCUMulated, corresponds to the dots display but without their being deleted before each new measurement. This makes it possible to trace seldom occurring outliers (phase and magnitude).



Test results under remote control		
IEEE Command	String position	Result
`RESULt1`	`12345678901234567890` `aaaaaaaaa;bbbbb;****`	a = TX power (incl. dimension) b = Freq. error (Hz) * = Reserved
`RESULt2`	`12345678901234567890` `aaaaa;bbbbb;ccccc;**`	a = Residual carrier power. (%) b = RMS vector error c = Peak vector error * = Reserved

Modulation spectrum

Why? Test whether the modulation spectrum of the mobile maintains the permissible levels within the 25 kHz channel spacing (otherwise there is adjacent channel interference).

Requirements Quality measurements must have been started, either by pressing MEASURE or by pressing one of the CALL keys.

How?

- Press (MOD-SPEC) key.
- Select in the scroll field at the top whether the modulation spectrum is to be shown unfiltered (you see the signal on the input of the test set) or filtered (after the receive filter).
- Move the cursor to the field below and select – using the (UNIT/SCROLL) – whether you want to see normal measurements (burst by burst), or averaged measurements, or a peak measurement (Max Hold).
- Press (FREEZE) to stop updating the measurement results, then use (CONTIN) to continue.
- Press (RETURN) to get back to quality measurements on basic test mask.

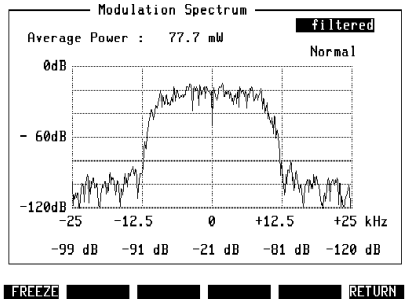


Fig. 10.22:
Modulation spectrum, with power over the burst. The values below the graph indicate the relative power at the frequencies offset by 0, ±12.5 kHz, ±25 kHz from the centre frequency. Current settings are filtered measurement and normal display which can be changed, e.g. to averaged measurements.

Test results under remote control		
IEEE Command	String position	Result
RESULt1	12345678901234567890 aaaaaaaaa;**********	a = TX power (incl. dimension) * = Reserved
RESULt2	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Rel. power at –25 kHz b = Rel. power at –12.5 kHz c = Rel. power at 0 kHz * = Reserved
RESULt3	12345678901234567890 aaaaa;bbbbb;********	a = Rel. power at +12.5 kHz b = Rel. power at +25 kHz * = Reserved

Statistical evaluation (Min-Max)

Why?
- Read the average value of measurement results.
- Identify short-term deviations.

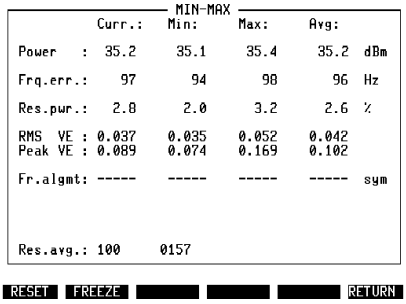
Requirements
- Quality measurements must have been started, either by pressing MEASURE or by pressing one of the CALL keys.

How?
- Press (MINMAX) key.
- Press (FREEZE) to stop updating the measurement results, then use (CONTIN) to continue.
- Press (RESET) to re-start the averaging process and the minimum and maximum value hold.
- Select (RETURN) to get back to quality measurements on basic test mask.

The Min-Max screen (see Fig. 10.23) shows all the different numerical measurements with current (recent) results in the left-hand column. The two columns in the middle indicate the minimum and maximum results achieved since either the statistical measurements were invoked or since the (RESET) key was last pressed.

The last N values are averaged and the result is displayed in the right-hand column. The value N can be set in the DEF.SET mask (see parameter "Result averaging" in section "Basic parameters in DEF.SET").

Fig. 10.23:
Typical Min-Max screen. The averaging takes place over the last 100 measurements as displayed in the bottom line (Res.avg). In this example, 157 measurements were taken since the start of the test.



☞ While running in remote mode multiple measurements will be done until the number of "Res.avg." is reached. The parameter "Result averaging" can be changed in the DEFINE TETRA mask.

Test results under remote control		
IEEE Command	String position	Result
RESULt1	12345678901234567890 aaaaaaaaa;bbbbb;****	a = TX power (incl. dimension) b = Freq. error (Hz) * = Reserved
RESULt2	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Residual carrier power (%) b = RMS vector error c = Peak vector error * = Reserved
RESULt3	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Reserved b = Reserved c = Frame alignment (symbols) * = Reserved
RESULt6	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = TX power Min. b = TX power Max. c = TX power Avg. * = Reserved
RESULt7	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Freq. error (Hz) Min. b = Freq. error (Hz) Max. c = Freq. error (Hz) Avg. * = Reserved
RESULt8	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Res. carrier power (%) Min. b = Res. carrier power (%) Max. c = Res. carrier power (%) Avg. * = Reserved
RESULt9	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = RMS vector error Min. b = RMS vector error Max. c = RMS vector error Avg. * = Reserved
RESULtA	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Peak vector error Min. b = Peak vector error Max. c = Peak vector error Avg. * = Reserved
RESULtD	12345678901234567890 aaaaa;bbbbb;ccccc;**	a = Frame algnmt. (symb.) Min. b = Frame algnmt. (symb.) Max. c = Frame algnmt. (symb.) Avg. * = Reserved

AF (speech) loopback

Why?

- Provides an overall check of all components of the MS, including the microphone and loudspeaker, while the mobile station is transmitting on a traffic channel.

Requirements

- Mobile station is on traffic channel ((MS Call) or (BS Call) pressed before).
- Screen shows basic test mask.

How?

- Press (ETC), then AF-LOOP softkey.
- In full duplex mode, talk into the microphone; you will hear your own voice with a short delay. The STABILOCK will indicate "`speech loopback`" in the Signalling Status field.
- In semi-duplex mode, talk into the microphone while the message "`speech recording`" appears in the Signalling Status field. The STABILOCK records about three seconds of the speech signal. When recording is completed, you are asked to "Release PTT" in the status line; the STABILOCK will then start the "Speech loopback" ie you can hear the recorded speech in the loudspeaker of the MS. The signal is replayed repetitively.
- Select (RELEASE) to conclude the measurements and to return to the basic test mask. If you want to perform more RF tests, re-start the call (eg press PTT button on the mobile).

AF signal generator and voltmeter access

Why?

- Some parts, eg the microphone and loudspeaker, may require adjustments based on analog AF signals and respective measurements while the mobile station is transmitting on a traffic channel.

Requirements

- Mobile station is on traffic channel (MS Call or BS Call pressed before).
- Screen shows basic test mask.

How?

- Press ETC, then AUDIO softkey.
- Set frequency and voltage level of the sinusoidal AF signal to be transmitted by the STABILOCK 4032, and take signal from the MOD GEN outlet at the front.
- Use the VOLTM input connector to feed a sinusoidal AF signal into the STABILOCK 4032, and see measured frequency as well as power level on the right-hand display.
- Select RETURN to get back to RF quality measurements on basic test mask.

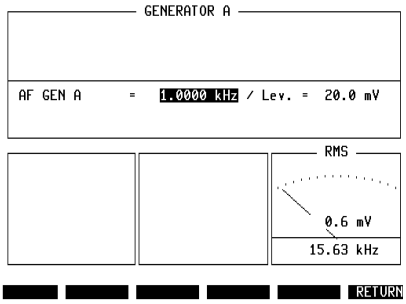


Fig. 10.24:
The AF mask allows to setup an audio signal on the MOD GEN connector, and to perform analog measurements presented at the VOLTMeter connector. Both are BNC type connectors which can be found on the front panel.

Troubleshooting

Problem	Solution
MEASURE mode: No results!	a) No signal is available at the connector. Check if the signal is applied to the same connector as indicated in the DEF.SET menu (RF or RF-DIR). b) The signal source is on a different frequency than expected. Check the actual TX frequency of the mobile station using the Spectrum ANALYZER, and set channel number and Channel 0 TX Frequency accordingly.
MEASURE mode: Result fields indicate "-----" only.	a) The signal may be unmodulated, or modulated with a modulation format other than that of TETRA. b) The RF power may be too low. On the RF connector, apply at least –15 dBm or 0.03 mW. Check the mobile station's power level using the Spectrum ANALYZER.
CALL mode – MS does not register: The MS does not register with the STABILOCK 4032 (no "idle updated" indication in "Signalling status" field after pressing (REGISTER) key).	a) Wrong frequency: You need to find out the channels that are used by the system which the MS is programmed for. Enter the channel 0 frequency in the DEF.SET mask. b) Setup for wrong connector: Check if the signal is applied to the same connector as indicated in the DEF.SET menu (RF or RF-DIR; the RF-DIR socket provides 20 dB higher input/output level). c) Wrong MCC (mobile country code) and/or MNC (mobile network code): Select MCC according to the country in which the MS is used. A list of MCC's is provided in the appendix of this manual. Select MNC according to the number of the network (if the code is unknown

RS-232-C interface

Application Notes

If STABILOCK is fitted with the D-AMPS module, the "RS-232/Centronics Interface" hardware option cannot be installed in slot 6 (as noted on the according rear panel), but slot 8 also can be used if still free. To allow data communication with other units or printout on conventional printers, the D-AMPS module also has a fully functional RS-232-C interface (socket Bu 105).

Requirements for operation

The RS-232-C interface of the D-AMPS module will only work if your Communication Test Set satisfies the following requirements:

STABILOCK 4031	HOST-MCU ≥ 3.83
STABILOCK 4032	HOST-MCU ≥ 5.03
STABILOCK 4032 MS	HOST-MCU ≥ 4.03
RS-232-C driver software	DIG-MCU ≥ 1.20

If the STATUS mask (called up with [AUX] + (DEF.PAR) + (STATUS)) shows an older status, a software update will be necessary.

☞ Do not start the TETRA MS Test system program: the RS-232-C interface of the D-AMPS module will *not* work properly if the TETRA MS Test system program is called up at the same time.

Control commands and transmission protocol

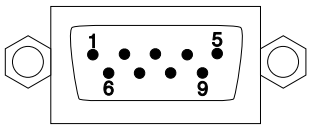
The RS-232-C interface of the D-AMPS module offers exactly the same functions as the RS-232-C interface of the hardware option "RS-232/Centronics Interface". All control commands for the interface are explained in Chapter 8 under the IEEE section "Special commands". Setting the transmission protocol (baud rate, number of data bits, parity, handshake, etc.) is explained in Chapter 4, section "General Parameters".

Special features

Special operating parameters for the RS-232-C interface are normally assigned with the commands WRITE[3000...] or SLAVE3000... (see Chapter 8). Replace control sequence 3000 by control sequence **2010** if you want to assign the RS-232-C interface of the D-AMPS module special operating parameters.

Example: not WRITE[300012...] but WRITE[201012...].

Pinning of RS-232-C interface



Bu 105					
Pin 1	=	DCD	Pin 5	=	GND
Pin 2	=	RXD	Pin 6	=	nc
Pin 3	=	TXD	Pin 7	=	RTS
Pin 4	=	DTR	Pin 8	=	CTS
			Pin 9	=	nc

Appendix

TETRA power levels and power control

Each TETRA MS belongs to a power class, which defines the maximum RF output power capability. In addition, the MS is capable of adapting its power level in 5-dB steps to the external requirements. Two mechanisms are available: Open loop and closed loop power control.

In *open loop power control*, the MS adjusts its transmit power based on the signal quality it receives on the downlink from the BS. The weaker the signal from the BS, the more 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 mobile station.

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 more or less RF power than it is capable.

☞ The TETRA option of the STABILOCK does not yet support this mechanism to control the RF output power level of the MS under test. It is planned, however, to add this feature in a future software version.

The following tables list the power classes and power levels of a TETRA MS:

MS power step level	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	40 dBm	35 dBm	30 dBm
2 (40 dBm)	40 dBm	40 dBm	35 dBm	30 dBm
3 (35 dBm)	35 dBm	35 dBm	35 dBm	30 dBm
4 (30 dBm)	30 dBm	30 dBm	30 dBm	30 dBm
5 (25 dBm)	25 dBm	25 dBm	25 dBm	25 dBm
6 (20 dBm)	20 dBm	20 dBm	20 dBm	20 dBm
7 (15 dBm)	15 dBm	15 dBm	15 dBm	15 dBm

MS power step level	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	37.5 dBm	32.5 dBm	27.5 dBm
2 (40 dBm)	40 dBm	37.5 dBm	32.5 dBm	27.5 dBm
3 (35 dBm)	35 dBm	35 dBm	32.5 dBm	27.5 dBm
4 (30 dBm)	30 dBm	30 dBm	30 dBm	27.5 dBm
5 (25 dBm)	25 dBm	25 dBm	25 dBm	25 dBm
6 (20 dBm)	20 dBm	20 dBm	20 dBm	20 dBm
7 (15 dBm)	15 dBm	15 dBm	15 dBm	15 dBm

The following table lists the nominal power levels of a TETRA base station:

BS power class	Nominal power level
1 (40 W)	46 dBm
2 (25 W)	44 dBm
3 (15 W)	42 dBm
4 (10 W)	40 dBm
5 (6.3 W)	38 dBm
6 (4 W)	36 dBm
7 (2.5 W)	34 dBm
8 (1.6 W)	32 dBm
9 (1 W)	30 dBm
10 (0.6 W)	28 dBm

New channel numbering system

Edition 2 of the radio interface standard ETS 300 392-2 defines how values for the frequency band, duplex spacing and channel number parameters are assigned (see Annex F of the afore-mentioned standard). This definition makes a difference between the radio channel number and the carrier number. In the STABILOCK context, if the STABILOCK requires an entry of a "channel number" then this always means the "carrier number" mentioned in Annex F.
The actual downlink carrier frequency is defined as:
DL carrier freq. = base freq. + (carrier number * 25 kHz) + offset
or
DL carrier freq. = freq.band * 100 MHz + (carrier number * 25 kHz) + offset
where

- the base frequency is a multiple of 100 MHz; the frequency band N is determined by base frequency = N * 100 MHz.
- the carrier number is the actual channel number (eg base channel or traffic channel).
- offset is one of the values 0 kHz, -6.25 kHz, +6.25 kHz, +12.5 kHz.

In addition, the UL carrier frequency is determined by the DL carrier frequency and the duplex spacing:
UL carrier freq. = DL carrier freq. - duplex spacing
The duplex spacing (in MHz) is coded into the SYSINFO message as a value in the range from 0 to 7, the coding has so far been standardized as follows:

Frequency band	base freq.	Duplex = 0	Duplex = 1	Duplex = 2	Duplex = 3	Duplex = 4	Duplex = 5	Duplex = 5	Duplex = 6
0				0					
1	100 MHz	1.6	4.5	0					
2	200 MHz	10		0					
3	300 MHz	10		0	8				
4	400 MHz	10		0	8				
5	500 MHz	10		0					
6	600 MHz	10		0					
7	700 MHz			0					
8	800 MHz		45	0	18				
9	900 MHz		45	0	18	39			

☞ Note that the base frequency (which is defined as a multiple of 100 MHz) refers to the downlink frequency. The Channel 0 TX Frequency in the DEF.SET mask, however, refers to the uplink. Therefore, the entry in this field is calculated according to the following formula:
Channel 0 TX Frequency = base frequency - duplex spacing

Example 1: The uplink TX frequency is 410.025 MHz, the duplex spacing is 10 MHz. This means that the downlink TX frequency is 420.025 MHz. The above formulae lead to the following values:
Channel 0 TX Frequency = 390.0000 MHz
channel offset = 0 kHz
frequency band = 4
duplex code = 0
channel number = 801

Example 2: The uplink TX frequency is 380.3125 MHz, the duplex spacing is 10 MHz. This means that the downlink TX frequency is 390.3125 MHz. The above formulae lead to the following values:
Channel 0 TX Frequency = 290.0125 MHz
channel offset = 12.5 kHz
frequency band = 3
duplex code = 0
channel number = 3612

Using different TETRA parameter setups

In daily use, there are typical parameter sets that are applicable to certain types of mobiles, eg. because they are programmed for specific TETRA networks. To avoid typing in the complete set of parameters each time, different parameter sets can be stored on a memory card. Remember that your STABILOCK came with a blank memory card which can be used for this purpose. The procedures how to store and load parameter sets is described below, as well as in section 7 (MEMORY Mask) in this manual.

General remarks

You can store a setup file with up to 10 individual parameter sets. If this does not suffice, a new file can be generated holding another 10 parameter sets, and so on.
The setup file has to be stored on a memory card for user data, not on a System Card. The memory card holding the TETRA MS Test software is such a system card, so it cannot be used for setups. A different memory card, such as the card that has been delivered with the STABILOCK as a standard accessory, should be used.
The setup file has the same name as the system option for which it stores parameters, but a different filename extension. In the case of TETRA MS Test, the setup filename is TETRA-MS.SYD. If you need a second or third parameter setup file, the name will be the same; when loading a file, use the cursor to identify which one you want.

Storing a setup in a new file

1) Within the system option (TETRA MS Test), set the parameters as you want to store them.
2) Insert the memory card for your user data.
3) Call up the MEMORY mask with (MEMORY).
4) Move the cursor bar to a vacant location in the file list.
5) Press (STORE). The softkeys will change to "STORE WHAT?" - "SYS-DATA", "AUTORUN", "PICTURE", "EXECUTE".
6) Select (SYS-DATA); a sub-directory for ten setups appears.
7) Press (ENTER) on one of the lines; the softkeys change to alphanumerics to allow entry of a filename.
8) Enter a filename with the softkeys (for characters) and/or the numerical keys, and confirm with (ENTER). The current system parameters from the TETRA MS Test screens are now stored in this new file.

Storing a setup in an existing file

1) Within the system option (TETRA MS Test), set the parameters as you want to store them.
2) Insert the memory card for your user data.
3) Call up the MEMORY mask with (MEMORY).
4) Move the cursor bar to an existing TETRA-MS.SYD file from the file list.
5) Press (STORE). A sub-directory with setups appears.
6) Select a vacant or an occupied setup and press (ENTER). If you selected an occupied setup, the STABILOCK will ask you whether to "OVERWRITE ???" the existing file. Confirm with (YES) if you want to do so; the old setup on the memory card is now overwritten by system parameters from the TETRA MS Test screens.
7) If you selected a vacant setup, enter a filename as described above ("Storing a setup in a new file"). Confirm with (ENTER) to store the parameters in the new setup location.

Recalling a setup

1) Make sure the system option software (TETRA MS Test) is loaded to the STABILOCK.
2) Insert the memory card with your system data setup file.
3) Press MEMORY to see the directory of the memory card.
4) Move the cursor bar to the file from which to load the setup parameters.
5) Press (RECALL); the sub-directory is then displayed.
6) Select one of the files using the cursor keys, and press (RECALL) once again.
7) Press (AUX), (DATA) to enter the system option software. The TETRA basic mask appears, with the parameters loaded from the memory card.

What is TETRA anyway?

TETRA is a wireless communication standard for Professional Mobile Radio (PMR) and Private Access Mobile Radio (PAMR) applications, eg for public safety organizations. Fast call setup times, closed user groups rather than calls into the public switched telephone network, and group calls are some of the features that make TETRA different from standards for public use like GSM. Both duplex and simplex operation are supported – simplex meaning you have to press a button while talking (the button is called PTT = "press to talk").

The standard comprises specifications for various applications and technologies, as there are trunked mode (TMO), packet data (PDO), and direct mode (DMO) operation. But most applications are expected to use TMO and DMO to exchange speech and data; this part of the specification is called Voice + Data (V+D).

This version of the 4032 option supports signalling protocols for TMO supporting simplex mode calls. TX measurements are supported for all the different TETRA standards.

Some background information on TETRA

TETRA is a trunked radio standard defined by ETSI, the European Telecommunications Standards Institute. The scope, however, is not restricted to use within Europe. Its primary use is for companies and organizations with frequent radio communication needs; police organizations, transportation companies, taxis are some examples of potential users. Of course, every organization and company could have their own set of frequencies and infrastructure (base stations, repeaters). This is expensive both in terms of money (especially if the area cannot be covered by one base station) and spectrum (which is limited). A trunked radio network operator may instead offer services (air time) to many companies, thus managing and administering some part of the spectrum and provide a regional or national network with interfaces to international trunked networks and the public switched telephone network.

The main advantages of a trunked network, when comparing it to cellular systems like GSM, are the fast call setup (in simplex operation, you just press a push-button and talk; the radio and the system will find an empty channel immediately with virtually no delay) and the possibility of group calls. Also, emergency services prefer to have a radio network of their own: in case of disaster relief, cellular channels are usually blocked because everybody outside the emergency services is already trying to make phone calls over the cellular network.

Technically speaking, TETRA is a system applying the Time Division Multiple Access (TDMA) method (plus the possibility of having multiple frequencies in addition). This means, several users share one frequency: speech and data are transmitted in digital format and multiplexed into timeslots. All of the four different TETRA timeslots on one carrier bear different channels, so there can be as much

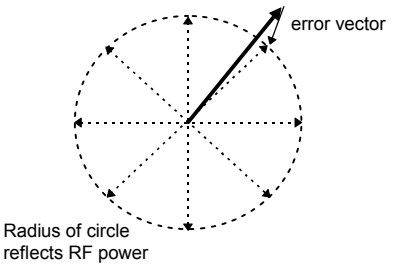
as four different calls on one 25 kHz carrier frequency (One channel within the system must carry the Main Control Channel, referenced here as the Base channel).

Speech is digitized and compressed into less than 4.6 kbit/s. Data channels support up to 7.2 kbit/s; the standard allows to allocate up to four timeslots for one transmission so that data rates up to 28.8 kbit/s can pass the TETRA air interface. This is comparable to today's modems on the fixed-line telephone system.

The modulation format is $\pi/4$ DQPSK (differential quaternary phase-shift keying). This modulation method shifts phase in steps of $\pm\pi/4$ or $\pm 3\pi/4$ depending on the symbol to transmit. With each phase change you can transmit one symbol containing two bits. In a vector diagram of the modulation signal, the ideal positions of the eight possible signal vector states are on a circle (see Fig. 10.25). The error vector is the line drawn between the ideal signal vector and the real (measured) signal vector. Modulation accuracy is determined by measuring the RMS (root mean square) difference between the real signal and the ideal signal. For this the magnitude of the individual vector error on each symbol in a slot is measured; the RMS vector error gives the square root of the sum of squares divided by the number of symbols in the slot.

TETRA uses error-tolerant modulation and coding formats. The information to be transmitted (eg speech) is usually coded adding some redundant information like CRC. This information can be used to identify reception errors and to reconstruct the correct bit stream with a highly sophisticated bit error correction algorithm. But if the correction function is operating at its limits (eg because transmitter and receiver are far from each other so that the signal quality is very low), speech quality could suddenly turn from good to bad. Therefore, well-adusted modulators are still necessary.

Fig. 10.25:
Representation of the modulation in the vector plane.



Other parameters that must lie within their respective limits are residual carrier power and, of course, the frequency error and the RF power. The residual carrier power is the I and Q imbalance of the modulator. In the figure above, it would mean that the circle is not around the coordinate origin but slightly shifted. It could also result in some residual carrier power outside the burst (when the MS is supposed to remain "silent").

Since TETRA uses several timeslots, care must be taken to transmit exactly in the correct timeslot; otherwise the call of the mobile transmitting in the neighbouring timeslot is disturbed. The Timing Alignment measurement is provided therefore.

MCC codes

The Mobile Country Code (MCC) is usually defined by the ITU (recommendation E.212). ETSI, however, decided to have an own list of country codes for TETRA. This list is maintained by the TETRA MOU and can be viewed on the Internet (www.tetramou.com).

The following list is an excerpt from the complete list.

Albania	276	Iceland	274
Australia	505	India	404
Austria	232	Ireland	272
Belgium	206	Italy	222
China	460	Netherlands	204
Croatia	219	New Zealand	530
Czech Republic	230	Norway	242
Denmark	238	Portugal	268
Finland	244	Romania	226
France	208	Russia	250
Germany	262	Singapore	525
Gibraltar	266	Slovak Republic	231
Greece	202	Spain	214
Hong Kong	454	Sweden	240
Hungary	216	United Kingdom	234

Connectors on the rear

On the rear of the D-AMPS module (slot 5/6), you can find various connectors. This section explains what they can be used for.

☞ Not all of these signals are available all the time. If you require some of them and you do not find them operational, please contact Wavetek for a special application software.

Socket	Signal	Dir.	Ri	Vmax	Application
Bu 103	IF	in	270 Ω	±14 V	External IF signal feed from Bu 103 on slot 3
Bu 104	AF	in	3 kΩ (approx.)	±5 V	Reserved
Bu 105	RS-232	in/out			For external control, see section "RS-232 interface" in this option manual
Bu 106	AUX				
Pin 1	AnalogInI	in	3 kΩ	±5 V	\ Input for external I/Q signal
Pin 2	AnalogInQ	in	3 kΩ	±5 V	/ (TX, IF)
Pin 3	GND				
Pin 4	GND				
Pin 5	GND				
Pin 6	GND				
Pin 7	ITXout	out			\ Analog I/Q TX signals
Pin 8	QTXout	out			/ output
Pin 9	GND				
Pin 10	GND				
Pin 11	GND				
Pin 12	GND				
Pin 13	QoutM	out			\ RX signal, I/Q
Pin 14	IoutM	out			/
Pin 15	ext Q	in	5 kΩ	2.5 V ±2.5 V_p	\ Input from fading simulator
Pin 16	ext I	in	5 kΩ	2.5 V ±2.5 V_p	/
Pin 17	GND				
Pin 18	QRX	out		2.5 V ±2.5 V_p	\ Output to fading simulator
Pin 19	IRX	out		2.5 V ±2.5 V_p	/ (RX I/Q signals)
Pin 20	GND				
Pin 21	Vcc				
Pin 22	GND				
Pin 23	–15 V				
Pin 24	GND				
Pin 25	+15 V				
Bu 107	SYNC	in	TTL	TTL	External synchronization, negative pulse > 125 ns
Bu 108	SYNC	out			External synchronization

Timeline

The chronological timeline tells you what modifications have been made to the software (SW) and the operating instructions. After a software update the timeline helps you to find out quickly about all major changes (see code) in the updated operating instructions that are supplied.

Code: C = Correction, IN = Important Note, NF = New Feature

SW	Doc. Version	Δ pages	Code	Changes
1.00	9804-100-A	no	–	First edition
2.00	0005-200-A	–	NF	Access to more SYSINFO parameters
		10-47	NF	Duplex spacing selectable
		10-28	NF	Protocol trace capability
		10-25	NF	Duplex calls supported
		10-21	NF	T1 signal generator included
		10-40	NF	Speech loopback supported
		10-35	NF	Enhanced constellation display
		10-49	NF	Different TETRA parameter setups supported
2.10	0007-210-A	10-26	NF	Paging sensitivity search function
		10-35	NF	Faster and wider circles in constellation display
		10-13	NF	User selection "abs", "%" for vector error results
		–	NF	Group assignment for Nokia equipment
		–	NF	Support for duplex calls with Nokia THR-600
		10-11	NF	User selection between BS-CALL types
		10-32	NF	GPIB control: result field for MS infos
		–	C	GPIB control: call establishments corrected