Testing TETRA mobiles with the IFR 2968

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The IFR 2968 is the industry standard for the test, service and repair of all TETRA mobiles. Proven to be a valuable test instrument in production, development and service, it works with all TETRA mobiles as a result of IFR's participation in the development and testing of the TETRA Interoperability Profile (TIP). The IFR 2968 version 3.2 now has enhanced functionality for simple-to-use comprehensive testing.

Introduction

This application note takes you through the basics of configuring the IFR 2968 TETRA test set, registering the mobile to the test set, placing calls from the mobile to the test set and placing calls from the test set to the mobile. These operations result in the mobile transmitting and/or receiving so that you can make parametric measurements on its radio transmitter and/or receiver. The test set needs to be configured to match the configuration of the mobile under test as you are unlikely to be able to test the mobile if this is not done correctly.

The term "mobile" is used throughout this application note to mean any TETRA radio terminal that is used for communication, whether vehicle mounted or hand portable. In the context of testing on the IFR 2968, the term "mobile" should be taken as synonymous with any of the commonly used terms: "terminal", "radio", "radio terminal", "mobile", "mobile radio", "vehicle mount mobile", "carphone", "mobile phone", "phone", "portable", "hand portable", "hand-held", "handset", "handy", "mobile station", "MS".

The IFR 2968 TETRA test set not only tests the mobile's radio transmitter and receiver parameters, it also allows you to check the mobile's functional behaviour and configuration. TETRA mobiles support different types of calls, and the available functionality will depend on the particular make and model of mobile and the configuration programmed into it. Therefore the IFR 2968 permits a number of different call types to be exercised (private, group, phone, emergency) as well as status messages and short data text messages.

Once you are familiar with the operations that are necessary to configure the test set and operate the mobile and test set, you can simplify your routine test procedure and shorten your routine test time by using the IFR 2968's built-in automatic test programs. You can configure these to suit the requirements of your test procedure and the mobile under test.

There may be circumstances where you are unable to register the mobile and place calls, maybe because of lack of information or because the mobile has not been configured. To assist in such cases, the IFR 2968 allows you to test the mobile in a special test mode (T1 test mode) or in Direct Mode (DMO). These modes also test other aspects of the mobile that may not be possible in its normal mode of operation.

This application note is only a summary and example of procedures. For full operating details please refer to the following publications:

- 46882/324 IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10
- 46882/274 IFR 2965A/2966A/2967/2968 Operating Manual, Issue 13
- 46882/280 IFR 2965A/2966A/2967/2968 Programming Manual, Issue 12

Note: where references are made to specific numbered pages in these manuals, these apply to the printed versions. Electronic versions on CD-ROM may have slightly different page numbering.

Getting Started

Before you can test a TETRA mobile, you will need to make an RF connection between the TETRA mobile and the IFR 2968. See 'RF connection between the mobile and the IFR 2968' below.

Private radio systems such as TETRA are more network specific than public mobile phone systems such as GSM. TETRA mobiles are individually programmed with a configuration specific to the TETRA network and the user of the mobile. This configuration is normally performed as a file downloaded to the mobile from a PC application, and may be known as a 'code plug' or 'parameter file' or 'customization file'.

Before you can start testing TETRA mobiles you must set up a few essential network parameters on the IFR 2968. These parameters configure the test set to emulate the particular TETRA network for which the mobile has been configured, so that the mobile thinks that the test set is a real TETRA base station in its home network. If any of these parameters do not match the mobile's configuration the mobile is likely to ignore the IFR 2968 and not perform registration or call placement. See 'Essential Network Parameters' below.

RF connection between the mobile and the IFR 2968

Normally you should use the high power N-type socket on the test set in a single-port duplex configuration. Both LEDs should be lit next to the N-type socket (the higher of the two sockets); if not then repeatedly press the 'RF SELECT' hardkey to achieve this configuration. Ensure that you do this within SYSTEMS mode otherwise the setting may change subsequently.

Vehicle mounted mobiles normally have a standard type of RF connector for their antenna connection, typically BNC or TNC, which makes for straightforward connection to the test set.

Larger hand portables typically have a screw-in antenna with an SMA or TNC connection, so that you can unscrew the antenna and connect a lead to the test set. It may be necessary to use an adaptor on the antenna connection e.g. SMA to BNC. Note: the antenna connection on some hand portables has a shorter central pin than a standard SMA male connector, so you need to ensure that the SMA female adaptor that you screw in does not have a recessed body otherwise the central connections may not make contact. You may also be able to make an RF connection via an accessory connecting lead for a remote antenna. Ensure that the connecting lead is recognised by the mobile so that the mobile automatically switches over to the accessory antenna connection. If this does not occur, you may need to make a manual selection in the mobile's menu or via a configuration tool to select the antenna connection.

Smaller hand portables are likely to have a proprietary antenna connection and a separate proprietary RF test socket or accessory/programming connector incorporating an RF connection. There will normally be an internal electronic switch to select the antenna or the accessory/test connector, which may be driven by an accessory connecting lead or test lead. Alternatively, the manufacturer may supply a proprietary adaptor to replace the antenna. You should refer to the manufacturer or supplier for guidance on making an RF connection.

If your RF connecting lead has a known loss, you can configure the IFR 2968 to take this loss into account when setting its signal generator level and when measuring the mobile's transmitter power level. Press the HELP/SET-UP hardkey then the softkeys [SET-UP], [TEST OPTIONS], [rf port setup], then set the "RF Gen level offset" (mobile Rx level) and the "receiver level offset" (mobile Tx level) for the required compensation. Negative values compensate for an external loss, positive values compensate for an external gain.

If you cannot make a direct RF connection to the mobile, you will not be able to perform calibrated measurements of transmitter power level or receiver sensitivity. However, you may be able to perform a functional test using an off-air connection. Connect the test set to a suitable coupler or antenna via the TNC socket (the lower of the two sockets) and press the 'RF SELECT' hardkey until both LEDs are lit next to the TNC socket. Leave the mobile's antenna attached, and place the mobile in a stable position a short distance from the antenna, e.g. 10-20 cm, or located correctly within the coupler. Configure the 2968 with the off-air coupling loss (refer to the 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 2, Page 2 'RF connections'). If the coupling loss is unknown, try offset values of -30 dB initially and adjust as required.

Note: beware that by using an off-air connection the mobile may also receive real off-air signals, and that other users of the radio spectrum may receive the mobile's transmissions. You should set the IFR 2968 'System Parameters: Max Tx Level' parameter to 15 dBm to limit the mobile to its minimum power level. You are recommended to use a fully screened test chamber to ensure that you are not making unauthorized transmissions and causing interference. As a further safeguard if you are operating on the same frequency as a nearby TETRA base station, you should set the IFR 2968 'System Parameters: Base Colour Code' parameter to a different value from that used by the real base station, but not 00.

Essential Network Parameters

The essential network parameters are:

- Channel Plan
- Control Channel
- Mobile Country Code (MCC)
- Mobile Network Code (MNC)

These parameters are explained below:

Channel Plan

The channel plan is the range of radio frequencies used by the mobile's transmitter (uplink) and the mobile's receiver (downlink), e.g. 380-400 MHz (TETRA 380 band) or 410-430 MHz (TETRA 410 band). The IFR 2968 provides a number of pre-defined channel plans covering the frequency bands TETRA 380, TETRA 410, TETRA 450, TETRA 800 and TETRA 870 (refer to Annex A for details). Normally you will be able to test a TETRA mobile by selecting the appropriate pre-defined channel plan. If this is not the case, the IFR 2968 allows you to define your own channel plan (refer to Annex B for details).

Pre-defined channel plan 'TETRA 380 MS' will be correct for most TETRA mobiles used for Emergency Services/Public Safety in Europe and some non-European countries. If this does not work, try the 'TETRA 380+0 MS' channel plan instead.

Pre-defined channel plan 'TETRA 410 MS' will be correct for many TETRA mobiles used for Public Transport, Utilities, Logistics and Commercial/PAMR users in Europe and some non-European countries (although some transport and utilities users with a Public Safety remit may be on the TETRA 380 band). If this does not work, try the 'TETRA 410+0 MS' channel plan instead. The pre-defined channel plan 'TETRA 410-6 MS' is known to be used in South Africa.

Pre-defined channel plan 'TETRA 800 MS' (or 'TETRA 800+0 MS') will be correct for many TETRA mobiles used in Asia Pacific countries and some other non-European countries.

The TETRA 450 and TETRA 870 bands were not known to be in use anywhere at the time of writing of this application note (July 2002).

Control Channel

TETRA control channels can be at any frequency (channel number) within the frequency band, in that the TETRA standard does not prescribe particular channel numbers to be reserved for control channels. However, individual TETRA systems may have their own definitions of channel numbers that are reserved for control channels. Some TETRA mobiles will scan all frequency channels within the band to look for a suitable control channel, others may be configured so that they only look at the channel numbers defined as control channels for their particular system. If you are testing a TETRA mobile that does not scan the band, you will need to ensure that the IFR 2968 control channel is set to a frequency (channel number) that the mobile has been configured to look at.

When you select a TETRA channel plan on the IFR 2968, the default setting for the control channel is the lowest frequency in the channel plan, since it is common practice for mobiles that scan to start at the lowest frequency and work up the band. The default setting for the traffic channel is 100 channels (2.5 MHz) higher than the control channel. Some TETRA mobiles may be supplied or configured in versions that only cover part of a frequency band. For example, some Public Safety mobiles use the TETRA 380 MS channel plan but only cover channels 3800 to 3999 (385 to 390 MHz MS Tx, 395 to 400 MHz MS Rx). For these mobiles you will need to set the control channel and traffic channel to channels that are covered, e.g. control channel 3800, traffic channel 3900.

Mobile Country Code (MCC)

The Mobile Country Code specifies the country of the mobile's home network, for example the MCC for the UK is 234. It is used in conjunction with the Mobile Network Code (see below). TETRA Mobile Country Code values can be found in Annex K of ETSI EN 300 392-2 v2.3.2.

Mobile Network Code (MNC)

The Mobile Network Code (MNC) specifies the home network for which the mobile has been configured, in conjunction with the Mobile Country Code (MCC). TETRA Mobile Network Code values are allocated by the radio communications regulatory authority in each country, for example within the UK the MNC allocated for the 'Airwave' public safety network is 00078.

TETRA base stations broadcast their MCC and MNC values regularly, and a TETRA mobile looks for a base station (or a test set) belonging to its home network, i.e. broadcasting the correct MCC and MNC values. Unless the mobile permits 'migration' onto another network, the test set MCC and MNC values must match those configured in the mobile.

Obtaining the Essential Network Parameters for your mobile

It is not always easy or obvious determining the essential network parameters for a particular TETRA mobile but this information must be obtained before you can test the mobile on a test set. There are a number of options which may be appropriate to the situation:

- Refer to the manufacturer or supplier of the mobile or the network operator or other body with responsibility for provision and programming of the mobile.
- Use menu functions or diagnostic menu functions on the mobile (if available) to display the network parameters.
- Use the mobile's programming tool (if available) to read the network parameters.
- If the mobile is known to work with a nearby base station, use the 2968 in base station test mode to determine the essential network parameters, and set up the 2968 in mobile test mode to match the real base station.

For further assistance, refer to IFR Application Note "IFR 2968 Frequently Asked Questions".

Factory Default Configuration

TETRA mobiles are normally configured with network and channel plan parameters after manufacture. If the mobile has not yet been configured for a particular network it may have a factory default configuration to allow factory final test, otherwise it may not be possible to perform any registration or call set-up operations. There may be significant differences between the factory default configuration and the normal configuration that is programmed into the mobile for operation on a TETRA network:

- The channel plan may be a proprietary numbering scheme not conforming to the ETSI/TIP channel numbering scheme. Typically the lowest supported frequency may have channel number 0000 or 0001, and frequency offsets may not be used. You will need to configure the IFR 2968 USER DEFINED channel plan with this scheme (see Annex B).
- The control channel may be pre-set to the lowest or middle frequency of the band, or some other factory default channel, or the mobile may default to scanning the band.
- The MCC and MNC values are likely to be proprietary test values not corresponding to real TETRA country and network code combinations.
- The subscriber identity (SSI) may be the same default value in every mobile.
- The mobile may not be configured with groups or gateway addresses, in which case some functions such as group calls or phone calls may not be possible.

Configuring the IFR 2968

Use the following sequence to configure the IFR 2968 with the essential network parameters:

Press the 'SYSTEMS' hardkey followed by the [softkeys] and the 'ENTER' ('dBm/rad') hardkey where required as follows:

[SYSTEM]

[TETRA mobile]

[SET-UP]

[System Params]

[channel plan] {as required} (e.g. TETRA 380MS)

[control channel] xxxx ENTER {if required} (otherwise use default e.g. 3600)

[traffic channel] xxxx ENTER ENTER {if required} (otherwise use default e.g. 3700)

[country code] xxx ENTER (e.g. UK = 234)

[network code] xxxxx ENTER (e.g. Airwave = 00078)

[MANUAL]

For full details of configuring the IFR 2968, refer to 46882/324 IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 3.

Testing the mobile

Once the IFR 2968 has been set-up to emulate a base station belonging to the mobile's home network, it is then possible to perform a number of tests on the mobile. These are performed in either [MANUAL] mode or [AUTO] mode. You are recommended to familiarize yourself with the mobile's operation using the IFR 2968 in MANUAL mode before configuring and running automatic test programs. Alternatively you may test the mobile in T1 test mode or Direct Mode. Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10 for details of T1 test mode (Chapter 4, pages 37 to 39) and Direct Mode (Chapter 6).

Before attempting any testing, ensure that the IFR 2968 has been powered on for at least 2 minutes (up to 10 minutes in cold conditions) so that its oven controlled frequency reference has time to warm up and stabilize. Ensure that the environmental conditions are within the rated range of operation for both the mobile and the test set.

For a vehicle-mount mobile, ensure that the power supply is adequate. General purpose variable voltage DC supplies are often not suitable, even though the average current consumption of the

mobile may be within the power supply's rated output. Specialist fixed voltage (12 V or 13.8 V) stabilized power supplies with high current ratings are usually the most suitable. A fully charged vehicle battery is an alternative. If there is any doubt about the mobile's performance, try testing with a higher rated power supply, or with the mobile installed in a vehicle.

For a hand-portable mobile, ensure that the battery charge level is adequate. If there is any doubt about the mobile's performance, fully charge the battery before testing the mobile.

Registration

Configure the IFR 2968 to match the configuration of the mobile under test and make an RF connection between the mobile and the test set. Power on the mobile; within a short period (typically 10 to 20 seconds) you should see an indication on the test set that the mobile has registered, and there may be other parameters displayed. For further details about registration refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, pages 9 to 12. The mobile is also likely to provide an indication that it has registered and is ready for use. Typically the signal strength is indicated and the mobile may indicate 'Ready' or 'In Service' (this may be an LED) and/or the currently selected group and/or the calling mode (e.g. group, private, phone).

If the IFR 2968 does not indicate that the mobile has registered, the mobile may indicate e.g. 'Searching', 'Connecting' or 'No Service' or a warning LED and typically will not display signal strength. Refer to Annex C for troubleshooting suggestions if the mobile does not register.

Placing a call from the mobile to the IFR 2968

The IFR 2968 supports the various different call types that can be placed by the mobile (Mobile Originated or MO calls), and indicates the type of call placed as well as the call parameters (e.g. called party ID). Group, private, phone (PSTN, PABX, ISDN), broadcast and emergency calls are supported, simplex and duplex (where applicable), hook signalling and direct set-up (where applicable), PTT operation (for simplex calls). For the purpose of making transmitter and receiver measurements, you should use a duplex call if possible. Mobile originated calls can normally be cleared down from either the mobile or the test set.

Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement Issue 10, chapter 4, pages 12 to 15 and 20 to 22, for detailed descriptions of mobile originated call operations. These descriptions contain generalized information about typical procedures for placing calls from TETRA mobiles to the IFR 2968. If this information is insufficient, refer to the mobile manufacturer's instruction manual for further information specific to the particular mobile.

You may find that the types of calls supported by the mobile and the method by which these calls are placed are dependent on the particular configuration programmed into the mobile. Some mobiles are configured to automatically revert to Group Call mode if you select Private Call mode or Phone Call mode and you do not place a call within a short timeout period. Refer to the mobile supplier or network operator for configuration information if required.

Placing a call from the IFR 2968 to the mobile

The IFR 2968 supports the various different call types that can be placed to the mobile (Mobile Terminated or MT calls). Group, private, phone (PSTN, PABX, ISDN), emergency and user-defined calls are supported, simplex and duplex (where applicable), hook signalling and direct set-up (where applicable), PTT operation (for simplex calls). For the purpose of making transmitter and receiver measurements, you should use a duplex call if possible. Mobile terminated calls can normally be cleared down from either the mobile or the test set.

Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement Issue 10, chapter 4, pages 12 and 16 to 22, for detailed descriptions of mobile terminated call operations. These descriptions contain generalized information about typical procedures for placing calls from the IFR 2968 to TETRA mobiles. If this information is insufficient, refer to the mobile manufacturer's instruction manual for further information specific to the particular mobile.

You may find that the types of calls supported by the mobile and the method by which these calls are received are dependent on the particular configuration programmed into the mobile. Refer to the mobile supplier or network operator for configuration information if required.

The IFR 2968 allows you to define the parameters for mobile terminated group calls, private (individual) calls, phone calls and emergency calls. Once these parameters have been set up, the different call types can be placed from the MANUAL screen, using the [call mobile] softkey followed by [group call], [private call], [phone call] or [emerg call].

The IFR 2968 also allows you to define your own type of call using any combination of the call set-up parameters, and to place this type of call using [call mobile] [user call]. This can be useful for combinations not covered by the standard call types, e.g. [phone call] is always a duplex call using hook signalling, but you could define [user call] to be a simplex phone call or to use direct set-up. You can also use the [user call] function for additional combinations that are covered by the standard call types, e.g. you may want to define both a simplex private call (using [private call]) and a duplex private call (using [user call]).

The call types are configured and defined using the following procedure:

[SET-UP]

[System Params]

[more]

[call types]

[group call] or [private call] or [phone call] or [emerg call] or [user defined]

{set up call parameters as required}

[return]

[MANUAL]

A TETRA mobile will normally only support a subset of the possible combinations of call types and parameters, usually dependent on its configuration as well as the inherent capabilities of the mobile design. If you attempt to place a call to a mobile of a type that the mobile does not support, the mobile may reject the call set-up, in which case the 2968 indicates "CALL REJECTED" and remains on the control channel (MCCH).

Alternatively, the mobile may offer to proceed with a variation of the call type that it does support, a process known as "call modification by the called party". Typically a mobile may modify a direct set-up call to a hook signalling call (the mobile alerts the user and waits for the user to answer) or it may modify a duplex call to a simplex call if it does not support duplex calls for the call type requested. In this case, the 2968 indicates (and accepts) the type of call offered by the mobile when the call is connected.

Analyzing Transmitter Parameters

Once in a call, with the TETRA mobile transmitting, the IFR 2968 performs measurements on the radio transmitter: power, power profile, timing error, frequency error and modulation accuracy (vector error). More detailed RF investigation can be undertaken by pressing the DUPLEX TEST hard key, followed by one of the [duplex test (Tx)] softkeys, which gives access to graphical diagnostic displays:

- vector diagram: constellation
- vector diagram: phase trajectory
- vector diagram: rotated vector display
- spectrum analyzer
- power profile analyzer: power vs. time
- vector analyzer: vector error vs. time
- vector analyzer: magnitude error vs. time
- vector analyzer: phase error vs. time

The [expand on off] softkey gives access to full screen displays with additional functions. There are two important things to note concerning DUPLEX TEST:

- The IFR 2968 does not respond to protocol signalling from the mobile whilst in DUPLEX TEST mode. Although the 2968 continues to generate a TETRA signal to keep the mobile in conversation, you must return to SYSTEMS MANUAL mode before releasing or pressing the PTT or clearing down the call.
- The RF settings made in SYSTEMS MANUAL mode take precedence over those made in DUPLEX TEST mode, hence when you return to SYSTEMS any changes you have made will be over-ridden by the SYSTEMS settings. However, the settings of the graphical diagnostic displays are not over-ridden, with the exception of the spectrum analyzer RF settings (reference frequency and reference level). Therefore you can toggle between the MANUAL mode display and a particular graphical diagnostic display just by pressing the DUPLEX TEST hard key once. A further press will take you to the top level DUPLEX TEST screen.

If possible you should set up a duplex call (e.g. a phone call) before analyzing the transmitter performance, particularly if using DUPLEX TEST for analysis over an extended period. Simplex calls have two disadvantages for transmitter analysis:

- The mobile's PTT has to be held pressed in order to keep it transmitting
- Mobiles normally employ an autonomous transmit timer, typically of 1 minute duration, which causes the mobile to cease transmitting even though the PTT is held pressed.

You can also test the mobile's transmitter performance at different power levels. Normally this is controlled by altering the test set RF GEN LEVEL so that the mobile adjusts its power level in response using Open Loop Power Control (OLPC). Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, Page 8 'Mobile Power'.

If you are unable to achieve registration and call set-up with the mobile, you may be able to test its transmitter performance in Direct Mode Operation (DMO). In this mode, the mobile transmits autonomously when the PTT is pressed, without registering to a base station (or test set). You will need to select Direct Mode on the mobile. You will also need to select the 'TETRA DIRECT MODE' system on the IFR 2968 (requires Option 32). Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 6 for full details of testing mobiles in Direct Mode.

Transmitter performance can also be measured with the mobile in T1 Test Mode, if the mobile supports this mode and you have access to it. You will need to select T1 Test Mode on the mobile. You will also need to select T1 Test Mode on the IFR 2968 (in the MANUAL screen press the [more] softkey then the [T1 test] softkey). Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, Pages 6 and 36 to 39 for full details of testing mobiles in T1 Test Mode.

Testing Receiver Parameters

Testing a mobile's receiver requires that an RF signal is generated with known baseband content, so that the mobile can receive, demodulate and process the RF signal to recover the baseband signal. The recovered baseband signal is then analyzed to determine how well the mobile has recovered the baseband content from the RF signal. Normally this is performed with the RF signal generator at a low level, typically the Reference Sensitivity Level, to determine whether the mobile's receiver has adequate sensitivity.

Note: before performing receiver sensitivity tests, ensure that the IFR 2968 ‘minimum Rx level’ parameter is set to its lowest value of -125 dBm ([SET-UP], [System Params], [more], [min Rx level]). If this parameter is set to a higher value there is a risk that the mobile will drop the channel during sensitivity testing when the IFR 2968

RF GEN LEVEL is reduced to a level lower than the value indicated in this parameter.

The traditional model for analogue radio systems uses a 1 kHz sine wave modulated onto the RF carrier; the mobile recovers this as a baseband audio signal, and the signal is connected to the test set audio input for distortion or SINAD measurement. The model for digital radio systems (such as TETRA) uses digital data modulated onto the RF carrier, usually a Pseudo Random Binary Sequence (PRBS). To avoid the complications of obtaining a baseband digital data output from the mobile for analysis, the usual method for digital radio systems is for the mobile to re-transmit the recovered digital data to the test set, known as "RF Loopback". Analysis consists of bit-by-bit comparison of the recovered digital data with the original PRBS data to determine the number of bit errors; the proportion of bits in error out of the total number of bits is known as the Bit Error Ratio (BER).

The IFR 2968 tests the receiver sensitivity of TETRA mobiles by measuring BER on the digital data that is normally used to convey the digitized TETRA speech signal. To do this you need to set up a duplex call either from the mobile to the test set or from the test set to the mobile. Set up a phone call or a private duplex call to or from the mobile, whichever is most convenient and permitted by the mobile's configuration. Now press the [BER TT loopbk] softkey to command the mobile into 'TT (TETRA Test mode) Loopback'. The test set will show 'MODE: ENTERING LOOPBACK' followed by 'MODE: TT LOOPBACK (BER)'. The test set will now generate PRBS data and will measure BER on the recovered digital data that is re-transmitted by the mobile.

Reduce the test set RF GEN LEVEL to a low level so that the mobile receiver introduces errors to the recovered data; typically you can expect the 'Class 0' bits to show an error of 3.5% to 5% when the RF GEN LEVEL is somewhere in the range -112 dBm to -115 dBm. Restore the RF GEN LEVEL to a 'safe' level of e.g. -75 dBm before attempting other operations so that the mobile can reliably receive the signal from the test set.

The digitized TETRA speech signal assigns the data bits to different 'classes' depending on how important they are to the overall speech quality. The 'Class 0' bits have the lowest impact on speech quality when they are in error, hence they have no protection against errors and provide a direct assessment of the RF receiver performance. The 'Class 1' bits and 'Class 2' bits have a greater impact on speech quality when subject to errors, hence they are protected in transmission. You should find that these bits exhibit a lower BER than the unprotected Class 0 bits.

As an alternative to [BER TT loopbk], you can command the mobile into 'TT LOOPBACK (RBER)' mode by pressing the [RBER TT loopbk] softkey. In this mode, the mobile does not tolerate any errors in the Class 2 bits (the most important bits) in the digital speech signal. When Class 2 bit errors are detected, the mobile indicates that it has discarded a whole 60 ms block of speech data, known as 'Message Erasure'. In TT Loopback (RBER) mode, the test set measures the 'Message Erasure Rate' (MER) and also measures the BER in blocks of speech data that have not been erased (the Residual BER or RBER).

Some TETRA mobiles require that you perform special operations on both the mobile and the test set to enable the use of the loopback modes. If these enabling operations have not been done before you command the mobile into loopback, you will see 'MODE: ENTERING LOOPBACK' for a few seconds followed by 'MODE: CONVERSATION' and 'STATUS: FAILED TO ENTER TT LOOPBACK'. Some TETRA mobiles do not support these loopback modes, in which case you will also see these messages if you attempt to command the mobile into loopback.

For further information on receiver testing using TT Loopback, refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, pages 6, 34, 36, 37 and 41.

If the mobile does not support TT loopback, it may be possible to perform an approximate measurement of its receiver sensitivity by means of an audio test method similar to a conventional analogue SINAD test. Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, pages 34 and 35 for details of this method.

If the mobile supports 'T1' test mode, it is also possible to test its receiver sensitivity in this mode, with or without the use of RF Loopback. Refer to IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4, pages 6, 34 and 37 to 39 for details of using T1 test mode.

Testing on different frequencies

You may wish to assess the mobile's transmitter and/or receiver performance at different frequencies, for example at the lowest, middle and highest frequencies that the mobile supports. The IFR 2968 allows you to place the Control Channel and Traffic Channel on different frequencies. When you place a call, the test set assigns the mobile to the specified traffic channel, and the mobile transmitter and/or receiver measurements are made at the Traffic Channel Tx/Rx frequencies. When you have finished testing on this channel, clear down the call, change the Traffic Channel number and place another call; you can now make measurements at the Tx/Rx frequencies of the new Traffic Channel. Do not change the Control Channel number unless you want the mobile to search for a new Control Channel on a different frequency.

Functional Testing and checking the mobile's configuration

The IFR 2968 TETRA test set not only tests the mobile's radio transmitter and receiver parameters, it also allows you to check the mobile's functional behaviour and configuration. You can also perform a subjective/functional test of the overall audio and RF operation of the complete mobile by using the 'talk-back' facility in the test set. When you select 'talk-back' mode, the test set stores the digitized speech transmitted by the mobile and re-transmits it to the mobile after a 2 second delay, sufficient time for you to say "hello hello hello" or "testing testing 1 2 3" for example. You can judge the overall quality of the transmitted and received speech by listening to your own speech.

By attempting to place different types of calls from the mobile to the

test set you can check that the mobile has been correctly configured to enable the required call types to be placed using appropriate parameters. During a phone call you can press keys on the mobile's numeric keypad to check whether it has been configured to send DTMF digits (indicated on the test set). By attempting to place different types of calls from the test set to the mobile you can check that the mobile has been correctly configured to accept, reject or modify the required call types. You can also check that the mobile has been correctly configured with the required talk groups if the mobile attaches multiple groups at registration. You can view all of the attached groups by pressing the softkeys [show detail] [groups] after the mobile has performed registration and group attachment.

You can also check that the mobile's configuration permits it to send and receive status messages and SDS text messages. In the case of status messages, you can check that the mobile has been correctly configured to interpret the values of received status messages (by displaying the required text indication associated with the status value). To send messages to the mobile, press the [send message] softkey in the MANUAL screen, followed by either [status message] or [SDS-TL text]. To configure the parameters of these messages, press [SET-UP] [System Params] [more] [more] [message]. To view the details of messages sent by the mobile to the test set, press [show detail] then [status message] or [SDS message].

When you place or receive a simplex call on the mobile, the test set can simulate another user talking when you are not pressing the PTT on the mobile. This can either be continuous (the mobile receives from the other user for all of the time that you are not pressing the PTT) or timed (the test set simulates the other user talking (PTT press) and being quiet (PTT release) for configurable periods). Alternatively you can select no simulated 'other user' transmissions. To configure these operations, press [SET-UP] [System Params] [more] [trunk type] [Tx trunked] [more] [call timers].

For full details of all of the above functional testing capabilities, refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 4.

Automatic Testing of TETRA Mobiles

The IFR 2968 MANUAL mode offers you the flexibility to perform a number of operations with the mobile and become familiar with its operation, capabilities and configuration. The DUPLEX TEST mode provides you with detailed analysis of the mobile's performance, which can be particularly useful for diagnozing faults or out-of-specification measurements. However, for mobiles that work correctly and are within specifications, the requirement is normally just to verify this quickly and easily. The IFR 2968 AUTORUN mode allows you to perform routine testing on TETRA mobiles easily and repeatably.

The IFR 2968 provides two automatic test programs - 'COMPREHENSIVE TESTING' and 'CALL PROCESSING ONLY'. You can also define your own test program and download it to the test set. However, the test programs provided are highly configurable so they should suit most requirements. Comprehensive testing includes functional tests as well as parametric tests. Call Processing Only testing omits the parametric tests.

Typically a test program starts with a power-on registration by the mobile - this is a necessary precursor to other operations, and obtains the mobile's SSI to identify the mobile tested. The test program then normally includes at least one call set-up operation (typically one mobile originated call and one mobile terminated call, preferably duplex) to provide some functional testing and to place the mobile on a traffic channel transmitting and receiving so that parametric measurements can be made on the mobile's transmitter and receiver. You can also perform the subjective 'talk-back' test if required when a call is set up. All operations requiring user intervention are completed first, so that the parametric measurements can then run unattended. Normally the test program will end with the call cleared down from the test set, avoiding the need for user intervention at the end of the test.

Each test in the test program produces a result and a pass /fail assessment against limits. At the end of the test program an overall pass/fail verdict is produced. The test results can be printed out and/or stored for future reference.

Once you have suitably configured the AUTORUN parameters to suit your test requirements and the capability /configuration of the mobile type being tested, you should be able to test mobiles automatically. However, you are advised to become familiar with the configuration requirements of MANUAL test mode first so that you understand the parameters that need to be configured for AUTORUN. All of the parameters in [SET-UP] [System Params] apply to AUTORUN as well as MANUAL. Additionally, you should ensure that you have correctly set the 'POWER CLASS' parameter in [SET-UP] [Mobile Params] so that the automatic test program knows what the mobile's maximum power level is supposed to be.

You should also review the parameters for each of the individual tests that are listed in the [SET-UP] [Autorun Params] menu to determine that the test conditions and test limits suit your test requirements. The Comprehensive Testing program includes a number of functional tests and parametric tests, but you can simply tailor the program by switching individual tests ON or OFF. The IFR 2968 allows you to include up to six call set-up and cleardown tests in a test program. If you are particularly concerned with checking that the mobile's configuration allows the different types of calls to be handled correctly, then you can include for example a group call, a private call and a telephone call in each direction (to and from the test set). If you simply want a quick means of enabling parametric measurements then switch off five of the CALL tests and just include e.g. a Phone Call from the test set to the mobile.

To perform an automatic test, simply go to [AUTO] mode and press [start]. The test set will prompt you for the actions that you need to perform with the mobile, such as powering it on, placing calls, clearing down calls, answering calls, and verifying satisfactory speech quality. In the event of a test failing, the test set can if required pause the test program to allow you to look at the problem in more detail in MANUAL mode or DUPLEX TEST mode. Alternatively you can allow the test program to run to completion and examine any failures afterwards.

If your mobile supports TETRA Test mode (TT) RF Loopback and Test Mode registration, you can include these in your AUTORUN program to enhance your automated testing. By selecting the 'TT TEST MODE' test instead of the 'REGISTRATION' test for a compatible mobile, you will not only enable the use of TT RF Loopback in the mobile, you will also obtain three parameters from the mobile that are essential for test automation. The mobile's TETRA Equipment Identity (TEI) is an electronic hardware serial number that uniquely identifies the hardware under test, whereas the SSI is only a programmable user identity that can be changed and may not be unique. The mobile's Power Class informs the test program of the mobile's maximum power capability and avoids you having to enter this value manually in the [SET-UP] [Mobile Params] menu. The mobile's Receiver Class informs the test program of the appropriate test limits to apply to the receiver BER/MER/RBER tests depending on the classification of the receiver as Class A, Class B or Class E.

If your mobile supports TT Loopback, you can include up to 6 different Rx BER/MER/RBER tests in your test program. Normally a single test of Rx BER Class 0 is appropriate for routine testing of receiver sensitivity. If your mobile does not support TT Loopback, you cannot test the mobile's receiver sensitivity in an automatic test program, since the test set does not have control over the mobile and does not have access to the mobile's received data for performing a bit error comparison.

For full details of configuring and operating automatic test programs, refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10. Chapter 3, pages 35 to 38, shows you how to use the configuration menus. Chapter 7 shows you how to run automatic test programs and describes the test programs and the individual tests within the programs. Chapter 11, pages 7 to 17, provides the reference information for the test parameters and the test programs.

When you have achieved a satisfactory configuration for automatically testing a particular type of mobile, you can save the configuration to a named store on a memory card. Full details are in the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 10.

Summary

This application note has taken you through the basics of configuring the IFR 2968 TETRA Radio Test Set and testing TETRA mobiles in MANUAL mode, DUPLEX TEST mode and AUTORUN mode. TETRA mobiles are more complex than GSM mobile phones and are highly network-specific and configuration-dependent, therefore this application note cannot provide you with all of the information that you might require for testing TETRA mobiles. Some of the necessary information must be obtained from the manufacturer or supplier of the mobile, or the operator of the network for which the mobile has been configured.

Further information on the IFR 2968 can be found in:

- 46882/324 IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10
- 46882/274 IFR 2965A/2966A/2967/2968 Operating Manual, Issue 13
- 46882/280 IFR 2965A/2966A/2967/2968 Programming Manual, Issue 12
- Application Note "IFR 2968 Frequently Asked Questions"

The following annexes provide further detailed application information:

- Annex A is an explanation and definition of the IFR 2968 pre-defined channel plans.
- Annex B provides explanations and step-by-step descriptions of how to set up your own user-defined channel plan for mobiles that do not conform to any of the pre-defined plans.
- Annex C is a troubleshooting guide for when a mobile does not register to the test set.

ANNEX A: TETRA CHANNEL PLANS

Explanation of channel plans

The channel plan maps the uplink (MS Tx) frequency and the downlink (MS Rx) frequency to a channel number. This is necessary because the TETRA signalling protocol uses channel numbers rather than explicit frequencies to assign TETRA mobiles to frequency channels. It is thus essential that the mobile and the base station (or the test set) each have the same understanding of how channel numbers map to frequencies. TETRA mobiles and base stations conforming to the TIP (TETRA Interoperability Profile) use the standard channel numbering scheme defined in ETSI TS 100 392-15. This is implemented in the IFR 2968 pre-defined channel plans.

Channel numbers map to frequencies with a 25 kHz channel spacing, hence the frequencies are integer multiples of 25 kHz, subject to a possible frequency offset. The channel plan also defines how the TETRA channel frequencies are located (offset) within the frequency band:

- If the channel boundaries are at integer multiples of 25 kHz, the centre frequency is offset by +12.5 kHz from the frequency indicated by the channel number (offset channel plan).
- If the channel centre frequencies are at multiples of 25 kHz, the centre frequency has zero offset from the frequency indicated by the channel number (zero offset channel plan).

The IFR 2968 supports both options, as well as the less common 6.25 kHz offsets.

PRE-DEFINED TETRA CHANNEL PLANS IN THE IFR 2968

TETRA 380 MS/TETRA 380+0 MS

Uplink 380 MHz to 390 MHz (Mobile Transmit)

Downlink 390 MHz to 400 MHz (Mobile Receive)

Duplex Spacing 10.00000 MHz

Offset +12.500 kHz (TETRA 380 MS)/0 Hz (TETRA 380+0 MS)

Channel Numbers 3600 to 3999 (TETRA 380 MS)/3600 to 4000 (TETRA 380+0 MS)

TETRA 410 MS/TETRA 410+0 MS/TETRA 410-6 MS

Uplink 410 MHz to 420 MHz (Mobile Transmit)

Downlink 420 MHz to 430 MHz (Mobile Receive)

Duplex Spacing 10.00000 MHz

Offset +12.500 kHz (TETRA 410 MS)/0 Hz (TETRA 410+0 MS)/ -6.25 kHz (TETRA 410-6MS)

Channel Numbers 0800 to 1199 (410)/0800 to 1200 (410+0)/0801 to 1200 (410-6)

TETRA 450 MS/TETRA 450+0 MS

Uplink 450 MHz to 460 MHz (Mobile Transmit)

Downlink 460 MHz to 470 MHz (Mobile Receive)

Duplex Spacing 10.00000 MHz

Offset +12.500 kHz (TETRA 450 MS)/0 Hz (TETRA 450+0 MS)

Channel Numbers 2400 to 2799 (TETRA 450 MS)/2400 to 2800 (TETRA 450+0 MS)

TETRA 800 MS/TETRA 800+0 MS

Uplink 805 MHz to 825 MHz (Mobile Transmit) note

Downlink 850 MHz to 870 MHz (Mobile Receive) note

Duplex Spacing 45.00000 MHz

Offset +12.500 kHz (TETRA 800 MS)/0 Hz (TETRA 800+0 MS)

Channel Numbers 2000 to 2799 (TETRA 800 MS)/2000 to 2800 (TETRA 800+0 MS) note

Note: TETRA is not usually deployed below 806 MHz Uplink /851 MHz Downlink / Channel Number 2040, hence the IFR 2968 default Control Channel is 2040 rather than 2000.

TETRA 870 MS / TETRA 870+0 MS

Uplink 870 MHz to 876 MHz (Mobile Transmit)

Downlink 915 MHz to 921 MHz (Mobile Receive)

Duplex Spacing 45.00000 MHz

Offset +12.500 kHz (TETRA 870 MS)/0 Hz (TETRA 870+0 MS)

Channel Numbers 0600 to 0839 (TETRA 870 MS)/0600 to 0840 (TETRA 870+0 MS)

Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 11, Page 1, for full details of the standard channel plans supported by the IFR 2968.

Annex B: Configuring the IFR 2968 with a User Defined Channel Plan

The parameters described below are automatically configured by selecting one of the standard channel plans pre-defined on the IFR 2968. If the mobile does not conform to one of the pre-defined channel plans you will need to configure the IFR 2968 USER DEFINED channel plan with the details of the channel plan used by the mobile.

There are two aspects to the channel plan configuration:

- System Information (SYS INFO) parameters are used to supply information in the IFR 2968's control channel signal to tell the mobile about the channel plan.
- Channel Block parameters tell the IFR 2968 how to map channel numbers to frequencies.

When you are using one of the pre-defined channel plans, the IFR 2968 takes care of all of these parameters for you. When you are using the USER DEFINED channel plan, it is your responsibility to set up both the SYS INFO parameters and the Channel Block parameters in a manner that makes sense to the mobile under test. The IFR 2968 intentionally does not make any linkage between the two sets of parameters, which allows you full flexibility in defining your own system; however this means that you must set all of the parameters correctly.

Some TETRA radios have a flexible RF architecture and are capable of setting their receiver and transmitter frequencies independently at any frequencies within their supported frequency range, sometimes over an extended range covering more than one channel plan, e.g. 380 MHz to 430 MHz for both receiver and transmitter. Such mobiles typically obey all of the SYS INFO parameters, where possible. Other mobiles have fixed separate receiver and transmitter frequency ranges with a fixed duplex spacing; such mobiles may ignore some or all of the SYS INFO parameters.

SYS INFO PARAMETERS:

Frequency Band (SYS INFO)

Specifies the reference frequency for the frequency band being used, range 0 to 15. For channel plans conforming to the ETSI standard (ETSI TS 100 392-15), this parameter specifies the 100 MHz block that contains the downlink frequencies. For example for the 380 to 400 MHz band, the reference frequency is 300 MHz and thus the value of the Frequency Band (SYS INFO) parameter is 3. The IFR 2968 shows the ETSI standard interpretation of this parameter. For a proprietary channel numbering scheme, the correct value of this parameter may be zero or 'don't care'.

Offset (SYS INFO)

Specifies the channel centre frequency offset, range 0 to 3. For channel plans conforming to the ETSI standard (ETSI EN 300 392-2) this parameter is interpreted as the following offsets from integer multiples of 25 kHz: 0 = No Offset, 1 = +6.25 kHz, 2 = -6.25 kHz, 3 = +12.5 kHz. For example, if the centre frequency of the first channel is 380.012500 MHz, the value of the Offset (SYS INFO) parameter is 3, indicating +12.5 kHz offset from 380.000000 MHz. The IFR 2968 shows the ETSI standard interpretation of this parameter. For a proprietary channel numbering scheme, the correct value of this parameter may be zero or 'don't care'.

Duplex Spacing (SYS INFO)

Specifies the separation between the downlink (mobile Rx) frequency and the uplink (mobile Tx) frequency, range 0 to 7. For channel plans conforming to the ETSI standard (ETSI TS 100 392-15), the interpretation of this parameter is partly dependent on the value of the Frequency Band (SYS INFO) parameter. Typical values used are 0 (10 MHz) in 380 MHz or 410 MHz systems, and 1 (45 MHz) in 800 MHz or 870 MHz systems, although many other values are defined in the ETSI standard: 0 Hz, 1.6 MHz, 4.5 MHz, 5 MHz, 7 MHz, 8 MHz, 10 MHz, 18 MHz, 30 MHz, 39 MHz, 45 MHz. The IFR 2968 shows the ETSI standard interpretation of this parameter in conjunction with the frequency band, hence you should set the Frequency Band (SYS INFO) parameter before setting Duplex Spacing (SYS INFO). For a proprietary channel numbering scheme, the correct value of this parameter may be zero or 'don't care'.

Reverse Operation (SYS INFO)

Specifies whether the uplink (mobile transmit) frequency is above or below the downlink (mobile receive) frequency, range 0 or 1. For channel plans conforming to the ETSI standard (ETSI EN 300 392-2), the interpretation of this parameter is: 0 (normal) means that the uplink (mobile transmit) frequency is lower than the downlink (mobile receive) frequency, i.e. the duplex spacing is subtracted from the downlink frequency to obtain the uplink frequency; 1 (reverse) means that the uplink frequency is higher than the downlink frequency, i.e. the duplex spacing is added to the downlink frequency to obtain the uplink frequency. The IFR 2968 shows the ETSI standard interpretation of the parameter. For a proprietary channel numbering scheme, the correct value of this parameter may be zero or 'don't care'.

CHANNEL BLOCK PARAMETERS:

Channel Block 1 parameters:

Normally you will only need to define parameters for Channel Block 1. Unless you use the other channel blocks, check that Channel Blocks 2 to 8 are all EXCLUDED.

Channel Block Included

Set this parameter to INCLUDED for Channel Block 1 - this informs the IFR 2968 that there is valid channel information in Channel Block 1.

Lowest Channel number

Set this parameter to the lowest channel number that your channel plan uses. Normally this will correspond to the channel that is the lowest frequency; however if you have a complicated channel plan, the lowest channel number is not necessarily the lowest frequency channel. See Annex A for examples of channel numbers used in the pre-defined channel plans.

Highest Channel number

Set this parameter to the highest channel number that your channel plan uses. When you enter a channel number for Control Channel

or Traffic Channel, the test set will only allow you to enter a number within the range Lowest Channel number to Highest Channel number.

Lowest Tx Frequency

This parameter establishes the mapping between channel numbers and frequencies for your User Defined channel plan, and it is essential that this parameter is defined correctly. Two points are particularly important to note:

- Enter the mobile Tx frequency that corresponds to the lowest channel number. Note that the ETSI standard opted to use the mobile Rx frequency as the basis of the calculation, whereas the IFR 2968, by established practice, uses the mobile Tx frequency.
- The mobile Tx frequency that you enter must be the exact centre frequency of the lowest numbered channel. Remember that there is intentionally no linkage between the SYS INFO parameters and the channel block parameters. If your channel plan uses an offset from the 25 kHz multiples, it is not sufficient just to set the offset in OFFSET (SYS INFO), you must include the offset in the Channel Block Lowest Tx Frequency parameter so that it is the actual mobile transmitter frequency that you want the test set to be tuned to, e.g. for the lowest channel in TETRA 380 with 12.5 kHz offset enter 380.012500 MHz.

Duplex Offset

This parameter defines the linkage between the mobile Tx frequency and the mobile Rx frequency. The IFR 2968 uses this value to set its signal generator frequency to the mobile Rx frequency (mobile Rx frequency = mobile Tx frequency + Duplex Offset). Typically this value will be 10.000000 MHz or 45.000000 MHz, e.g. for the lowest channel in TETRA 380 (12.5 kHz offset), mobile Rx frequency = (380.012500 MHz + 10.000000 MHz) = 390.012500 MHz.

You can also define a reverse channel plan, by entering a negative value for this parameter. Remember that there is intentionally no linkage between the SYS INFO parameters and the channel block parameters. If your channel plan uses reverse duplex, it is not sufficient just to set the REVERSE OPERATION (SYS INFO) parameter to REVERSE, you must set the Channel Block Duplex Offset parameter to a negative value so that the IFR 2968 will set its signal generator frequency (mobile Rx frequency) lower than the mobile Tx frequency.

Channel Spacing

This parameter defines how the IFR 2968 calculates the mobile Tx frequency that corresponds to a particular channel number n according to the formula:

mobile Tx frequency (channel n) = (n - lowest channel number) x channel spacing + lowest channel Tx frequency

Normally this parameter is set to 25.000 kHz, the TETRA channel spacing, so that each increment of the channel number increases the mobile Tx and Rx frequencies by 25 kHz. You can if required define a backwards channel plan by setting a negative channel spacing, so that incrementing the channel number reduces the mobile Tx and Rx frequencies.

Channel Blocks 2 to 8

Normally you will not need to use more than one channel block, so channel blocks 2 to 8 should all be set to EXCLUDED so that the IFR 2968 ignores them. However, if your channel plan has a fragmented numbering scheme then you can define it using additional channel blocks. Typically a fragmented numbering scheme arises when additional channels are added to an existing channel plan at frequencies below the original lowest frequency. An example of this is GSM 900, where the original channels in the P-GSM band are numbered 1 to 124, and additional channels were later added (the E-GSM band below the P-GSM band) numbered 975 to 1023 and 0. Numbering fragmentation should not occur if the ETSI standard channel numbering scheme is used, since channel numbers 0000 to 4000 are defined as the bottom and top of a 100 MHz band, so all frequencies are covered.

Note: a particular TETRA system may have gaps in its allocation of frequency channels rather than being allocated a contiguous block of spectrum, but you do not need to define separate channel blocks if the channel numbering includes the non-allocated channels. You may however wish to define separate non-contiguous channel blocks if you wish the IFR 2968 to restrict your Control Channel and Traffic Channel selections to allocated channels.

Configuring the IFR 2968 with the User Defined Channel Plan parameters

Follow the sequence below to configure a user defined channel plan. Note that 'ENTER' is the 'dBm/rad' hardkey and softkeys are shown as [softkey]. The example values define a plan identical to the predefined TETRA 380 MS channel plan.

SYSTEMS

[SYSTEM] [TETRA mobile]

[SET-UP] [System Params]

[channel plan] [USER DEFINED]

[user defined]

[plan title] {VARIABLE [enter char] as required} [entry complet] (e.g. "TETRA 380 MS")

SYS INFO parameters:

[freq band] [x x00 MHz] (e.g. [3 300 MHz])

[offset] [x x.xx kHz] (e.g. [3 +12.5 kHz])

[duplex spacing] [x x.x MHz] (e.g. [0 10.0 MHz])

[reverse op] [0 normal] or [1 reverse] (e.g. [0 normal])

Channel Block parameters:

[channel block 1]

[channel block] [include]

[lowest channel] xxxx ENTER (e.g. 3600)

[highest channel] xxxx ENTER (e.g. 3999)

Note: the test set will not accept entry of lowest channel higher than highest channel - enter the highest channel first if its existing setting is below the required lowest channel

[lowest tx freq] xxx.xxxxx MHz (e.g. 380.012500 MHz)

[duplex offset] xx.xxxxxx MHz (e.g. 10.000000 MHz)

[channel spacing] xx.xxx kHz (e.g. 25.000 kHz)

[return]

[return]

[MANUAL]

This procedure is defined in detail on pages 39 to 42 of chapter 3 of the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, issue 10.

Checking the configuration

Defining your own channel plan is complicated and you are advised to check that you have done it correctly, i.e. that the frequencies set by the IFR 2968 for the lowest and highest channels correspond to your channel plan. Remember that the TETRA frequency channel assignment is signalled using only the channel number, not the explicit frequencies, so it is essential that you have configured the test set to interpret channel numbers exactly the same as the mobile.

Go to MANUAL mode and set the Control Channel to your channel plan's lowest channel number (e.g. 3600). Go to DUPLEX TEST mode and check that the IFR 2968 GEN FREQ is set to the correct mobile Rx frequency (e.g. 390.012500 MHz) and that the IFR 2968 Tx FREQ is set to the correct mobile Tx frequency (e.g. 380.012500 MHz). Return to SYSTEMS, set the Control Channel to your channel plan's highest channel number (e.g. 3999). Go to DUPLEX TEST mode and check that the IFR 2968 GEN FREQ is set to the correct mobile Rx frequency (e.g. 399.987500 MHz) and that the IFR 2968 Tx FREQ is set to the correct mobile Tx frequency (e.g. 389.987500 MHz). If these values are correct, then you have correctly set the Channel Block parameters on the IFR 2968.

Return to SYSTEMS MANUAL and set the Control Channel and Traffic Channel as required. Test that you have successfully configured your channel plan (including the SYS INFO parameters) by performing registration and call placement with your mobile on the IFR 2968.

Annex C: Troubleshooting when a mobile does not register

1. Ensure that the IFR 2968 has been powered up for sufficient time (typically 2 to 10 minutes) to allow its reference oscillator (OCXO) to warm up and stabilize at the correct frequency before attempting to test a mobile.

2. Check that the mobile is properly connected to the 2968 and that the lead or connector is suitable and not damaged. If you are using an accessory remote antenna connection, or an RF test connection, check that the mobile has recognized and switched over to using this connection automatically, otherwise you may need to select it manually.

3. Check that the IFR 2968 RF ports are configured correctly. Usually this will be the N-type connector (the '150 W MAX' connector) in single port duplex configuration (both LEDs adjacent to the N-type connector should be lit).

4. Check that the RF Gen level is at a reasonable level (e.g. -80 dBm to -50 dBm) and that it is not below the value of the 'System Parameters: minimum Rx level for access' parameter in the test set.

5. Check that any allowances for cable loss have been entered correctly on the 2968 (-ve values for loss).

6. Check that the IFR 2968 does not show '[*]' next to the RF GEN LEVEL setting or the BURST POWER reading unless you wish to compensate for external loss or gain. To remove level compensation, press the 'HELP/SET-UP' hardkey followed by softkeys [SET-UP] [TEST OPTIONS] [rf port setup] [set offset]: enter 0 dB for both offsets.

7. Check that you have set the correct Channel Plan, taking account of whether it is an offset channel plan or not. If in doubt, try offset and non-offset channel plans, or even different frequency bands if there is any uncertainty.

8. Check whether the mobile operates on all frequencies within the channel plan or not. If the mobile uses e.g. only the upper 5 MHz part of the band you will need to set the IFR 2968 control channel and traffic channel so that they lie within the mobile's supported band.

9. Check that you have set the correct Mobile Country Code (MCC) and Mobile Network Code (MNC) values to match the mobile's configuration.

10. Check whether the mobile has been programmed with its correct configuration for operation on a TETRA network, or whether it only has a factory default configuration.

11. Confirm that the parameters explained in 'Configuring the IFR 2968' are set correctly.

12. Check that the mobile has not inadvertently been set to Direct Mode. TETRA mobiles normally retain their Direct Mode setting when they are switched off, and the mobile's display indication may be only subtly different from its normal trunked mode display.

13. Check that the mobile is not picking up a real TETRA base station and registering to that rather than to the test set. Refer to the IFR 2968 Phase 3.2 Operating Manual TETRA Supplement, Issue 10, Chapter 2, Page 2, "RF Interference" and "Note".

14. Ensure that the 'System Parameters: Base station Colour Code (BCC)' parameter is not set to zero, since this value signifies the use of pre-defined scrambling, which some mobiles do not support.

15. If the mobile scans the frequency band for a control channel, allow sufficient time for it to do this (maybe up to 20 seconds).

16. If the mobile does not scan the frequency band, ensure that the IFR 2968 is set to one of the frequency channels in the mobile's search list.

17. Ensure that the 2968 indicates "MODE: MCCH", to confirm that you are transmitting a control channel. If not, press the [restart MCCH] softkey.

18. Ensure that the "POWER ON REGISTRATION" flag is set to "REQUIRED", which forces the terminal to perform an ITSI Attach Registration. Ensure that the "AIR INTERFACE ENCRYPTION" flag is set to "NOT AVAILABLE". These settings can be altered by:

[SET-UP]

[System Params]

[more] [base service]

[registn] [require]

[more]

[air encrypt] [not availbl]

[return]

[MANUAL]

19. Check the mobile's display messages, signal strength /status icons and LEDs for any indications that it has seen the 2968 signal and may be attempting to register. However, TETRA mobiles commonly do not indicate the presence of a TETRA base station signal unless it satisfies the requirements for the mobile to register to it. You may be able to obtain more information from the mobile's diagnostic menus, if the mobile has such menus and if you are able to access them.

20. If the radio is known to work with a nearby base station, use the 2968 in base station test mode (requires Option 31 TETRA base station test) to determine the essential network parameters, and set up the 2968 in mobile test mode to match the real base station. This procedure is described in detail in the 'compatibility' section of IFR Application Note "IFR 2968 Frequently Asked Questions".

If the mobile still does not register after you have followed the above suggestions, the mobile may be faulty, or you may need to consult the manufacturer, supplier or network operator for further information and assistance.

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