

# Application Note



## IFR 3901 Frequently Asked Questions

by Clive Rodmell



The new IFR 3901 Digital Radio Test Set with TETRA System Options is the successor to the industry standard IFR 2968 for testing TETRA mobiles and base stations during design, manufacture, service and repair.

This application note answers common questions concerning the capabilities and configuration of the IFR 3901, and provides solutions to common problems that may arise during testing.

TETRA is a complex system with many features and a high degree of customization to suit the requirements of individual networks and groups of end users. The IFR 3901 is therefore a complex product providing configuration to match the mobiles and base stations under test and supporting the diversity of features and operational behavior. Inevitably the IFR 3901 requires some user familiarization and experience in order to achieve the greatest benefit from it. Further, since TETRA is a relatively new system, some of the test methods and TETRA terminology may be unfamiliar to new users. This application note aims to distil Aeroflex's practical experience with testing TETRA mobiles and base stations to assist IFR 3901 customers. Note that the term 'mobile' is used as a generic term throughout this application note to mean a radio terminal, whether vehicle mounted or hand portable.

This application note contains details and examples of certain procedures, but it is not a substitute for the IFR 3901 Operating Manual and Programming Manual. You should ensure that you have obtained and read the latest versions of these manuals relevant to the software version in your IFR 3901.

### Validity of information

The information given in this application note is given in good faith and was believed to be correct at the time of publication, October 2004. However, this information is likely to be subject to change over time as the TETRA standard continues to develop and networks and equipment become more mature. You are advised to periodically check our web site [www.aeroflex.com](http://www.aeroflex.com) for updated information. Your assistance in informing Aeroflex of any corrections, updates or additional questions would be much appreciated (<mailto:info-test@aeroflex.com>).

### Index to questions

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Use the index of questions below to determine whether your question is covered, then find the answer in the numbered Questions and Answers section.

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ters of a local TETRA BS?

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Q8.8: How can I test a TETRA mobile that uses authentication?

Q8.9: Will the IFR 3901 support authentication in a future upgrade?

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Q8.11: Will the IFR 3901 support mutual authentication in a future upgrade?

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Q9.2: Can the IFR 3901 receive TETRA base station signals off-air?

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Q9.4: Can I store and recall different TETRA system setups on the IFR 3901?

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Q9.6: Can I capture a 3901 screen image and use it in PC applications?

## QUESTIONS AND ANSWERS SECTION

### Section 1 Q&A: IFR 3901 versions and options

Q1.1: Do I have to return the IFR 3901 to Aeroflex for software upgrades ?

A1.1: No, this is not normally necessary. You can normally perform software upgrades yourself, by downloading new software into the IFR 3901 directly from the Aeroflex web site. If you are purchasing new software options, you will need to install the relevant software license file under UTILS: License.

Q1.2: If I purchase an IFR 3901 with only one of the TETRA system options can I add other options at a later date?

A1.2: Yes. The IFR 3901 can be purchased in one of the following configurations:

IFR 3901 + Option 110 TETRA MS + Option 111 TETRA BS

IFR 3901 + Option 110 TETRA MS

IFR 3901 + Option 111 TETRA BS

Further options can be purchased at a later date if not purchased initially. Please contact your local Aeroflex sales representative or distributor for a quotation.

Q1.3: Does the IFR 3901 have an option for 800 MHz TETRA systems?

A1.3: Yes, but it is not an optional extra. 800 MHz TETRA is included as standard with its own pre-defined channel plan (805-870 MHz). The IFR 3901 also includes as standard the ability to test any TETRA system at any frequency from 1 MHz up to 1 GHz.

Q1.4: Does the IFR 3901 include automatic testing?

A1.4: Yes. The Auto Test System is included as standard, for testing TETRA mobiles. Automatic test scripts can include functional tests (registration, call setup, call clear-down) as well as parametric tests (radio measurements).

Q1.5: Can the IFR 3901 test other radio systems besides TETRA?

A1.5: The TETRA MS and BS systems are the first system options available on the IFR 3901. Support for other radio systems will be announced in future. To be kept up to date with developments, periodically view the Aeroflex web site <http://www.aeroflex.com> and sign up for the Aeroflex email newsletter <http://www.aeroflex.com/aboutus/enewsletter/signup-form.cfm>.

Q1.6: Does the IFR 3901 support Tetrapol?

A1.6: No. Despite the similar sounding name, Tetrapol is not related to TETRA. Tetrapol is a proprietary FDMA PMR system from EADS-DSN Cogent (formerly Matra Communications) and is a completely different system from TETRA.

Q1.7: Can the IFR 3901 test US PMR/PAMR/SMR systems such as P25, EDACS, iDEN?

A1.7: Initially, the only systems available on the IFR 3901 are TETRA MS and TETRA BS. P25 (APCO Project 25) is currently supported on the IFR 2975 Radio Test Set. Refer to [www.p25.com](http://www.p25.com) for details. EDACS is supported on the IFR 2945A and COM 120C Radio Test Sets. iDEN is a proprietary system from Motorola, and is not currently supported by any Aeroflex Radio Test Set. Further system options for the IFR 3901 will be announced in future.

Q1.8: Can I have an IFR 2968 or an IFR 2975 upgraded to an IFR 3901?

A1.8: No, the IFR 3901 is a completely new platform, not a modification of existing test sets.

Q1.9: Is there an Aeroflex TETRA Test SIM available, as there is for GSM?

A1.9: No. TETRA mobiles do not currently use SIMs, although a few do include a SIM holder. Currently all TETRA mobiles have to be configured using programming and customization tools, although TETRA SIMs may be used in future. Currently there is no specification for a test version of the TETRA SIM as there is for GSM. This situation may change in future.

Q1.10: Does Aeroflex supply cables, connectors and adaptors for connecting to TETRA mobiles?

A1.10: Yes and no. A small number of standard cables and adaptors (N-type, TNC, BNC) are available as accessories (refer to the IFR 3901 data sheet or contact your local Aeroflex sales representative). For a wider selection of standard types you should consult your usual electrical distributor catalogs or specialist accessory suppliers. For proprietary connections you will normally need to contact the manufacturer or distributor of the mobile.

### Section 2 Q&A: Testing mobile and base station transmitters

Q2.1: How do I use the 3901 to control the mobile to transmit at a particular power level?

A2.1: TETRA mobiles use Open Loop Power Control (OLPC) in which the mobile calculates the power level at which to transmit, based on the strength of the signal received from the base station. A mobile that is close to a base station will receive a strong signal, consequently it can transmit at a low power level. When the mobile is connected to the IFR 3901, the power is determined by the strength of the received signal, i.e. the 3901 RF Generator Level, and by two of the parameters in the 3901 'CONFIG: System ID & Access Params' menu, "Access Parameter" and "Max Tx Level".

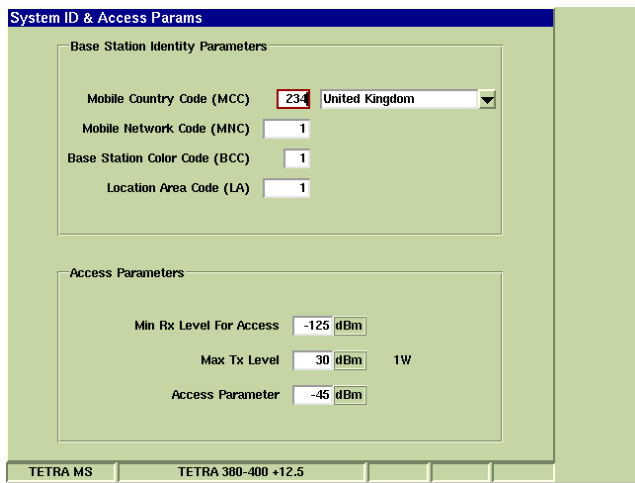


Figure 1 - CONFIG: System ID & Access Params tile

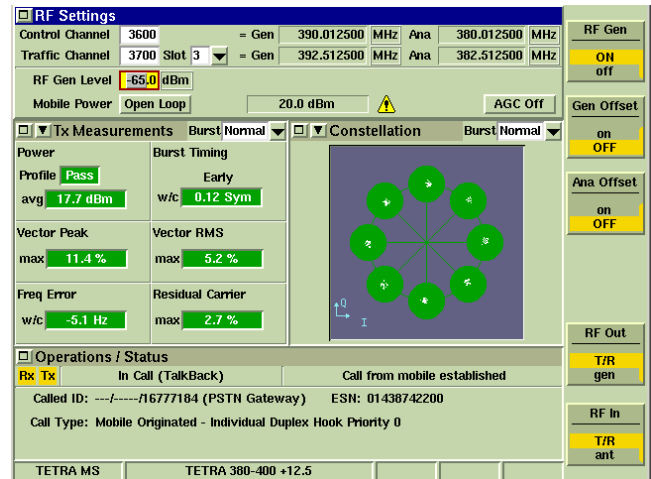


Figure 2 - Mobile Tx power measured at 20 dBm

The calculation is as follows:

- Take the 3901 RF Gen Level, which will be in -ve dBm, and make it +ve.
- Add the Access Parameter, which is in -ve dBm, range -53 dBm to -23 dBm.
- The result is the mobile's transmit power, subject to some modifications.

The calculated mobile transmit power is modified by the following conditions:

- The mobile is not allowed to transmit at a power level higher than Max Tx Level.
- The mobile cannot transmit at a power level higher than its power class, e.g. a Class 4 Mobile has a maximum power level of PL4 +30 dBm.
- The mobile cannot transmit at a power level lower than its minimum, i.e. PL7, 15 dBm.
- The mobile power is quantised to defined power level steps: PL1 +45 dBm, PL2 +40 dBm, PL3 +35 dBm, PL4 +30 dBm, PL5 +25 dBm, PL6 +20 dBm, PL 7+15 dBm.
- Some mobiles belong to an 'L' power class where their top power level is reduced by 2.5 dB, e.g. PL4L 27.5 dBm.

The 3901 indicates the calculated open loop Mobile Power in the RF Settings tile.

Q2.2: Why is the mobile power level approximately 5 dB too high or too low when I have set the 3901 RF Generator Level to the correct value for the power level required?

A2.2: Mobiles are permitted +/- 4 dB tolerance in measuring the RSSI (Received Signal Strength Indication), so it is not possible to guarantee a particular power level for a particular RF Gen level, except when the mobile is forced to the maximum or minimum power. If the 3901 signal generator is set at least 4 dB lower than the calculated value for maximum mobile power, the mobile should be using the maximum permitted power. If the 3901 signal generator is set at least 4 dB higher than the calculated value for minimum mobile power, the mobile should be using the minimum transmit power. For the intermediate power level steps, you can experiment with different RF Generator Level settings to achieve the required level. A warning triangle is shown next to the calculated open loop Mobile Power level when it is subject to this uncertainty.

Q2.3: Can I use the 3901 to control the mobile power directly, as with GSM?

A2.3: No. TETRA mobiles do not incorporate a direct power control mechanism, therefore the 3901 cannot directly command the mobile to a particular power level. However, some TETRA mobiles incorporate Closed Loop Power Control (CLPC) in which they will respond to a command to increase or decrease their power by one or more 5 dB power level steps. The 3901 can therefore be used first to force the mobile to minimum or maximum power level by using normal open loop power control, then to command the mobile to increase or decrease power from this known starting point. However, most TETRA mobiles do not support CLPC.

Q2.4: How do I ensure a repeatable method for testing mobiles on a particular power level?

A2.4: Use the Max Tx Level parameter on the 'CONFIG: System ID & Access Params' menu to limit the mobile power to the particular power level required. Set the RF Generator Level to a low enough level (e.g. -100 dBm) to force the mobile

to transmit at the maximum power level permitted.

If the Max Tx Level is changed, a TETRA mobile that is already registered to the test set or active in a call may not necessarily alter its power in response to the change, since this is not a parameter that a mobile would expect to change on a real base station. In this case it may be necessary to clear down the current call or even de-register and re-register the mobile to the test set for the parameter change to take effect. However, if the mobile is tested in T1 Test Mode using the 3901 TETRA MST1 System, the Max Tx Level can be used to directly control the mobile's transmit power (with RF Gen Level set to -100 dBm).

Q2.5: Can I test the mobile's transmitter on different frequencies?

A2.5: Yes. The control channel (MCCH) may have to be on a specific frequency (channel number) in order for the mobile to recognize the test set and perform registration. However, during a call setup, the mobile should obey an instruction from the IFR 3901 to transmit and receive on any traffic channel frequency (channel number) within the mobile's capabilities. When the mobile is idle on the control channel (MCCH) you can set the traffic channel (TCH) that will be used when a call is setup. Hence you can test the mobile's transmitter on different frequencies by clearing down a call, changing the traffic channel number and setting up a new call. Some TETRA mobiles also support handoff to a traffic channel on a different frequency during a call without the need to clear down the call and set up another call. Simply change the Traffic Channel number in the RF Settings tile during a duplex call and the mobile will be commanded by the test set to hand off to the new traffic channel. If the mobile does not support this operation, you will need to clear down the call and set up another call to a different traffic channel.

Q2.6: Can I test the mobile's transmitter over its entire receive / transmit frequency range?

A2.6: Yes, if the mobile has a flexible RF architecture that allows this operation. For example the 'TETRA 380-400 +12.5' channel plan can be used to test the mobile's receiver over the range 390 to 400 MHz, and the mobile's transmitter over the range 380 to 390 MHz. However, the IFR 3901 allows you to define a reverse channel plan so the mobile's receiver can be tested over the range 380 to 390 MHz and the mobile's transmitter over the range 390 to 400 MHz. Depending on the configuration of the mobile, you may be able to perform normal registration and call setup with a reverse channel plan, or you may need to use the TETRA MST1 System with the MS in T1 test mode to test on reverse frequencies. For further details, refer to 'Annex B: Configuring the IFR 3901 with a User Defined Channel Plan' in the application note 'Testing TETRA mobiles with the IFR 3901'.

Q2.7: Why do the TETRA mobile transmitter measurements stop after about a minute?

A2.7: The measurements do not stop, it is the mobile transmissions that have stopped. TETRA mobiles making group calls or simplex private calls normally incorporate an autonomous transmission timer which is typically one minute in duration so that the mobile stops transmitting even if the user is still holding the PTT pressed. TETRA mobiles do not normally incorporate a transmission timer when making duplex private calls or phone calls hence you should always setup a duplex call where possible (e.g. a phone call) when you want to examine transmitter measurements in detail. This also has the advantage of not requiring you to hold the PTT pressed.

Q2.8: Why does my TETRA mobile or base station exhibit excessive vector error?

A2.8: A number of causes can contribute to vector error performance exceeding the limits, so the 3901 provides further diagnostic displays to track down the cause of a vector error failure, including the constellation diagram, rotated vector diagram, and particularly the vector error vs. time displays with separate resolution of the phase error and magnitude error components. Vector error that is predominantly due to phase error may be a symptom of an unstable transmit frequency, i.e. the frequency error is varying during a single burst period, maybe because of oscillator settling problems. Vector error that is predominantly due to magnitude error may be a symptom of an unstable power level, i.e. the power is drooping during a single burst period, maybe because of an inadequate power supply. If the RMS vector error is low but the peak vector error is very high, this may be a symptom of incorrect power ramping by the mobile - check the power profile display. These functions are accessed by selecting the required display from the title bar selection [▼] for one or both of the measurement tiles - select Mod Accuracy or Power then the specific display type required. Further detail, including marker readings, is available by maximizing the tile. Refer to the IFR 3901 Operating Manual for details of using these functions: chapter 23 'Using the Measurements Tiles' and chapters 24, 25, 26 'Measurements Tiles'.

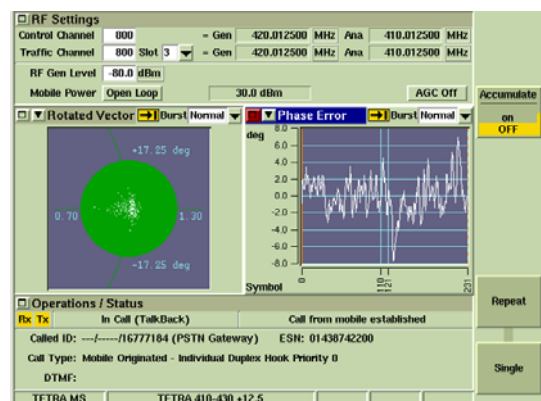


Figure 3 - Rotated Vector and Phase Error displays

Q2.9: Can the 3901 measure Adjacent Channel Power (ACP)?

A2.9: No. The 3901 performs the routine measurements of the on-channel transmitted signal. TETRA ACP is a specialized measurement for conformance testing and some manufacturing test applications, requiring very high spurious free dynamic range, which can only be performed by the IFR 2310 TETRA Signal Analyzer. Refer to the IFR 2310 data sheet for details of measurement of ACP and other specialized measurement functions.

However, the IFR 3901 can be useful in conjunction with the IFR 2310, with the TETRA mobile connected to both instruments via a power splitter. The 3901 is used to stimulate the mobile so that it can register and set up a call at a particular frequency and power level, while the 2310 is used to make the high dynamic range off-channel measurements.

Q2.10: Can the 3901 power measurement compensate for cable loss, attenuators, splitters?

A2.10: Yes. Level Offset values are set up in the 'CONFIG: Offsets' menu for each system. Note that the offsets are specific to each system, not common to the test set platform, so that you can configure separate compensation values for the different external connections used for base stations and mobiles, normal operation and T1 test mode operation. Negative values compensate for an external loss, positive values compensate for an external gain. You must enable each offset (ON) for it to take effect. If you are inserting and removing external hardware, you can leave the offset values set up and enable (ON) or disable (OFF) the offset from either the 'CONFIG: Offsets' menu or from the softkeys in the TEST screen.

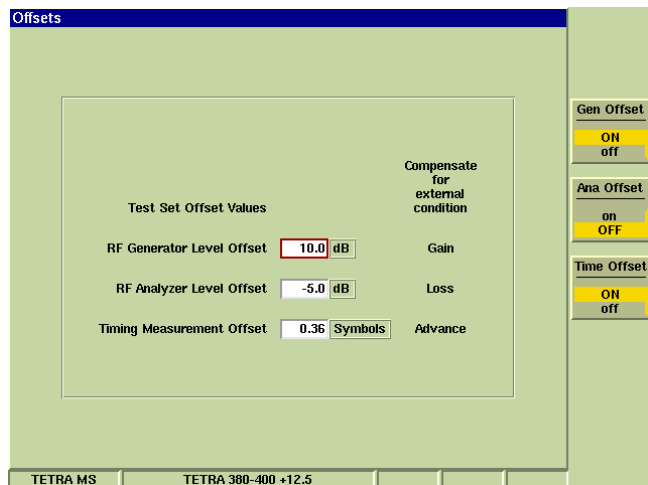


Figure 4 - CONFIG: Offsets tile

Q2.11: Why does the power reading show [+/-] next to it?

A2.11: This is a warning that the 3901 has been set to compensate for an external gain or loss (see A2.10 above). If the compensation is no longer required, disable it by toggling the appropriate softkey to OFF in either the TEST screen or the 'CONFIG: Offsets' menu.

Q2.12: Can the IFR 3901 measure directional ("through-line")

power?

A2.12: No. The accessory directional power head for the IFR 2968 cannot be used with the IFR 3901.

### Section 3 Q&A: Testing mobile and base station receivers

Q3.1: Can the IFR 3901 test the receiver sensitivity of TETRA mobiles?

A3.1: Yes. A variety of different test signals and test methods are provided in the IFR 3901 to support the capabilities and testing requirements of various TETRA mobiles.

- TETRA Test mode (TT) RF Loopback provides automatic or manual testing of receiver sensitivity (BER or MER / RBER) on the three different sensitivity class bits on the speech traffic channel (TCH/S), in a similar manner to the standard GSM method.

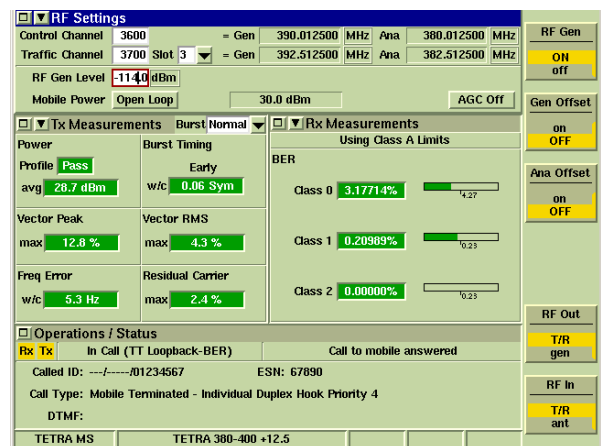


Figure 5 - Measuring receiver sensitivity using 'TT' RF loopback in the TETRA MS system

- Radio Conformance Test (T1) RF Loopback provides manual testing of receiver sensitivity on six different variants of the T1 signal (T1 types 1 (TCH/7.2), 2 (SCH/F), 3 (BSCH), 4 (TCH/2.4), 15 (TCH/S) and 17 (TCH/4.8)). The IFR 3901 generates the PRBS data and measures the BER, MER and PUEM (as appropriate) of the received signal returned by the mobile under test.



Figure 6 - Measuring receiver sensitivity using 'T1' RF loopback in the TETRA MS T1 system

- Radio Conformance Test (T1) signal generation provides the test source for a mobile to measure its own BER or MER, or for an external device to measure the BER / MER of the data recovered by the mobile under test. The IFR 3901 generates the PRBS data for six different T1 signal types as above.
- 1 kHz tone encoded speech signal generation provides manual testing of receiver sensitivity on the speech traffic channel (TCH/S) for mobiles that do not support loopback or where the user is unable to access the manufacturer's test functions for measuring BER.

Q3.2: How do I measure receiver sensitivity using 'TT' RF Loopback?

A3.2: In the Auto Test System, with a suitable test script, the IFR 3901 can perform the test(s) automatically. In the TETRA MS System (manual testing), you need to set up a duplex call and then select 'TT Loopback - BER' or 'TT Loopback - RBER'. Depending on the type of mobile, you may need to perform a Test Mode Registration beforehand. For further details, refer to the 3901 Operating Manual chapter 23 'Rx Measurements Tile' and 'Operations / Status Tile'.

Q3.3: Why does the mobile drop the call while measuring receiver sensitivity?

A3.3: You may have set the RF Gen Level too low for too long, or you may need to adjust the 'Min Rx Level For Access' parameter in the 'CONFIG: System ID & Access Params' menu. TETRA mobiles need to be able to receive information from the base station (test set) signal in order to maintain a call. If the RF generator level is reduced too far, the error rate may be too high for the mobile to reliably decode the base station (test set) signal. This should not normally be a problem at the reference sensitivity level (-112 dBm) with a correctly functioning mobile.

TETRA mobiles need to be able to receive a signal from the base station (test set) that meets or exceeds the 'Min Rx Level For Access'. The default value for this parameter on the IFR 3901 is -125 dBm and you should ensure that this value is set prior to performing receiver sensitivity tests, in order to avoid call dropping.

Q3.4: Why doesn't 'TT' RF Loopback work with my mobile?

A3.4: You may need to perform a Test Mode Registration beforehand so that the mobile is enabled to respond to the TT loopback commands. This may require you to perform an enabling action on the mobile (e.g. entering an access code) and to send a TT test mode confirmation from the IFR 3901. For further details, refer to the 3901 Operating Manual, chapter 23 'Operations / Status Tile'. Refer to the mobile manufacturer for specific details of enabling TT test mode on the mobile.

It may be that the mobile does not support TT test mode registration or TT RF Loopback, in which case you will not be able to perform BER/RBER /MER tests on the speech traffic channel and you will not be able to include receiver sensitivity testing in Auto Test scripts. Refer to the mobile manufacturer for further information.

Q3.5: How do I test receiver sensitivity if a mobile does not support TT RF Loopback?

A3.5: If the mobile does not support TT RF Loopback, you will not be able to test receiver sensitivity automatically as part of an Auto Test script and you will not be able to test it manually as part of normal functional and parametric testing using registration and call setup. To test the receiver you will need to select the TETRA MS T1 System on the IFR 3901 and set the mobile to operate in T1 test mode. If the mobile supports T1 Loopback, you can perform a manual measurement of sensitivity using the IFR 3901. If the mobile does not support T1 Loopback, you will need to use the mobile's internal BER/MER measurement or external BER / MER measurement using a suitable application program supplied by the mobile manufacturer. Refer to the 3901 Operating Manual, chapter 24, for details of operating the IFR 3901 in the TETRA MS T1 System. Refer to the mobile manufacturer for details of operating the mobile in T1 test mode and internal or external BER/MER measurement applications.

Q3.6: What is the difference between 'TT' test mode and 'T1' test mode?

A3.6: 'TT' (TETRA Test) is a mode of operation that may be implemented in a TETRA mobile, in which certain additional functions for testing are enabled, but otherwise the mobile operates as normal for registering and setting up calls. The mobile manufacturer may also decide to modify, restrict or disable certain functions when in TETRA Test mode, e.g. group attachments and security functions may be disabled and the mobile may adopt a special test identity rather than its normal network identity.

TT mode provides TT RF Loopback and Test Mode Registration. TT RF Loopback is operated by the IFR 3901 sending TETRA signaling commands to the mobile via the usual RF connection when the mobile is in a duplex call. Test Mode Registration is an additional signaling sequence performed after normal Registration, which confirms the use of TT test mode in the mobile and obtains information from the mobile that is essential for test automation (TEI, power class and receiver class).

T1 test mode is a special mode of operation that is required to be implemented in a TETRA mobile submitted for conformance testing according to ETSI EN 300 394-1 (TETRA Radio Conformance test specification). T1 test mode may also have applications in manufacturing or service testing. T1 test mode is a one way control mode, in which the IFR 3901 generates a signal to stimulate and control the mobile under test, but does not receive any signaling from the mobile. There is no protocol involved in T1 testing, other than the generation of the T1 signal control parameters. There is no registration and no call setup, and the mobile does not send any signaling information in T1 test mode.

Flags in the T1 signal control information can instruct the mobile to turn its transmitter on or off and to transmit normal bursts or control bursts at a specified power level. The control information also informs the mobile of the T1 signal type (TCH/7.2, SCH/F, BSCH, TCH/2.4, TCH/S or TCH/4.8) so that the mobile can receive

and decode the information accordingly. Another flag in the control information can instruct the mobile to re-transmit the received data (T1 RF Loopback).

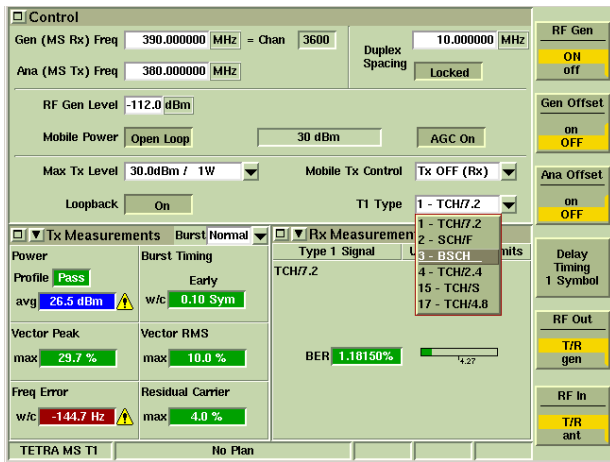


Figure 7 - TETRA MS T1 system showing T1 signal type selection

Q3.7: How do I access T1 test mode in the mobile under test?

A3.7: There is no standard mechanism for this and the mobile may not necessarily support T1 test mode. Typically you may need to know a special key sequence or you may need a PC application for configuring, aligning and testing the mobile. Access to such facilities may well be restricted by the mobile manufacturer and you should contact the mobile manufacturer or supplier to discuss the appropriate level of access to test and diagnostic facilities.

Q3.8: How do I test the mobile receiver if I have no access to TT loopback or T1 test mode?

A3.8: TT loopback or T1 test mode should always be used where possible since they provide the most objective and repeatable test of receiver performance. TT loopback is the most convenient as it can be automated. However, if the mobile does not support these modes, or if you cannot obtain access to the manufacturer's test modes, it is possible to perform an approximate test of receiver sensitivity using an external audio SINAD meter. For this you will need access to a suitable audio output from the mobile, typically a loudspeaker or accessory earpiece socket. Note that this will also test the quality of the mobile's audio circuitry.

If the mobile has adequate RF sensitivity, you should be able to determine that the SINAD is satisfactory at the reference sensitivity level. However, due to the use of the TETRA codec, the audio signal degradation at low RF levels behaves differently from analog RF signals. This method will not work well at RF levels below the reference sensitivity level as the BER of the TETRA signal increases, particularly when errors occur in the Class 1 bits or when errors in the Class 2 bits cause erasure of speech frames.

Q3.9: What is the difference between MER, BER and RBER?

A3.9: MER is Message Erasure Rate and it applies to TETRA channel types that include a parity check (e.g. the signaling

channels such as SCH/F and the Class 2 bits in the speech frame). BER is Bit Error Rate and it applies to TETRA channel types that do not include a parity check (e.g. circuit data channels such as TCH/7.2 and the Class 1 and Class 0 bits in the speech frame). When errors occur in the channels with parity checks, the whole message is discarded (erased); when errors occur in the channels without parity checks, one or more bits in the message are in error.

BER tests on e.g. TCH/7.2 are much quicker than MER tests and provide a direct test of the RF receiver performance. MER tests on e.g. SCH/F take much longer because for every 432 bits in TCH/7.2 there is only one message in SCH/F, so it takes 432 times longer to acquire the same number of samples on SCH/F. For example, the BS Class A TCH/7.2 BER test requires 5800 samples (bits) which takes less than one second; the BS Class A SCH/F MER test requires 6600 samples (messages) which takes 6 minutes and 36 seconds.

Hence the SCH/F MER test is normally only performed for R&D / conformance testing because it takes too long. Manufacturing, installation and maintenance testing normally uses the TCH/7.2 or TCH/S Class 0 BER test because it is much quicker and provides a direct test of the hardware. For performing acceptance tests / installation tests on base stations the much faster TCH/7.2 BER test is normally more suitable than the slow SCH/F MER test.

RBER (Residual Bit Error Rate) applies only to the speech traffic channel TCH/S, in which there are three different classes of bits with different levels of protection. If bit errors occur in the Class 2 bits, this will normally be detected by the parity check and two entire 30 ms speech frames will be erased. If RBER TT loopback is selected, the mobile is instructed to signal erased frames by substituting the loopback bits with all 1s in each speech frame hence it is only possible to measure BER of the Class 0 and Class 1 bits when frame erasure has not occurred. The Bit Error Rate, measured only in those frames where frame erasure has not occurred, is termed the Residual Bit Error Rate. If BER TT loopback is selected, the mobile always loops back the received bits and does not check for frame erasure. RBER measurement values are likely to be limited compared to BER values, since higher BER values in Class 0 and Class 1 bits are statistically more likely to be accompanied by bit errors (and hence frame erasure) in the Class 2 bits.

Q3.10: Which types of T1 test signals are generated for mobile testing?

A3.10: The 3901 generates the following T1 signals for mobile testing:

- T1 type 1: TCH/7.2 PRBS in TN1 FN1-17
- T1 type 2: SCH/F PRBS in TN1 FN1-17
- T1 type 3: BSCH PRBS + SCH/HD PRBS in TN1 FN1-17
- T1 type 4: TCH/2.4 PRBS in TN1 FN1-17
- T1 type 15: TCH/S PRBS in TN1 FN1-17
- T1 type 17: TCH/4.8 PRBS in TN1 FN1-17

All of these T1 signals have the following in common:

- AACH PRBS in BBK in TN1 FN1-18 in every multi-frame
- BSCH (T1 sync info) in SSN1 in TN1 FN18 in every multi-frame
- BNCH/T (T1 sys info) in SSN2 in TN1 FN18 in every multi-frame
- TCH/7.2 PRBS + AACH PRBS in TN2, TN3 and TN4 FN1-18

All T1 signals conform to ETSI EN 300 394-1 v2.3.1 subclause 5.3.2.1.

Q3.11: What is the content of the PRBS information generated by the IFR 3901 T1 signals?

A3.11: The IFR 3901 PRBS information conforms to ETSI EN 300 394-1 v2.3.1 subclauses 5.3.2.1 (T1 signal for mobile testing) and 5.3.2.2 (T1 signal for base station testing), which specify ITU-T O.153 511 bit PRBS.

The hex data below represents 944 bits of the standard 511 bit ITU-T O.153 PRBS, i.e. one complete sequence of 511 bits followed by 433 bits of the next repetition of the sequence. Read from left to right, i.e. binary sequence is 111111110000011110111110001 .....

```
ff83df17 32094ed1 e7cd8a91 c6d5c4c4 4021184e 5586f4dc
8a15a7ec 92df9353 3018ca34 bfa2c759 678fba0d 6dd82d7d
540a5797 7039d27a ea243385 ed9a1de1 ff07be2e 64129da3
cf9b1523 8dab8988 8042309c ab0de9b9 142b4fd9 25bf26a6
60319469 7f458eb2 cf1f741a dbb05afa a814af2e e073
```

This data is pure O.153 PRBS before it has been subjected to channel coding, scrambling and framing. Mobile and base station equipment performing internal or external self-measurement of BER should expect to receive this sequence (after de-scrambling and channel decoding) when there are no bit errors.

Q3.12: Can the 3901 generate PRBS for testing AACH, BSCH and SCH/HD channel types?

A3.12: Yes. The 3901 generates the T1 type 3 signal containing BSCH PRBS and SCH/HD PRBS data. The 3901 also measures BER and MER on all T1 signals if the mobile supports T1 loopback for those signals. The maximized Rx Measurements tile provides additional detail, including measurement of PUEM (Probability of Undetected Erroneous Measurement, specified for radio conformance testing).

Q3.13: Can the IFR 3901 test base station receivers?

A3.13: Yes. The IFR 3901 generates four different types of uplink T1 signals defined in ETSI EN 300 394-1 subclause 5.3.2.2 for testing base station receivers. T1 types 7 (TCH/7.2), 8 (SCH/F), 9 (STCH) and 10 (TCH/2.4) are generated for testing Bit Error Rate (BER), Message Erasure Rate (MER) and Probability of Undetected Erroneous Message (PUEM). The 3901 synchronizes the timing of its uplink T1 signal to that expected by the base station. Base stations may perform their own BER measurement on the uplink signal that they receive, using the IFR 3901 only as a synchronized signal generator. Alternatively, the BS may perform RF loopback on the T1 signal and the IFR 3901 will perform BER, MER and PUEM measurement (as appropriate) on

signals received and re-transmitted by the base station. If the base station is fully conformant to ETSI EN 300 394-1, the IFR 3901 can automatically generate the type of uplink T1 test signal indicated in the base station's downlink T1 signal.

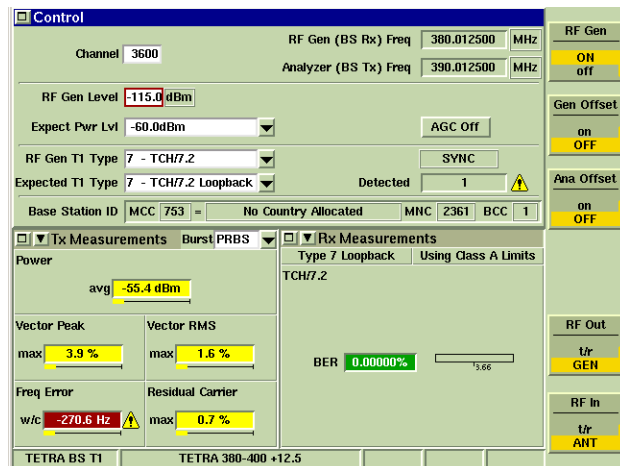


Figure 8 - TETRA BS T1 system performing BER measurement

The IFR 3901 also provides three additional signals that can be used for testing base station receivers in proprietary test modes:

- 18 Frame PRBS is similar to the T1 type 7 uplink TCH/7.2 signal except that the PRBS extends to all 18 frames in TN1, not just frames 1-17, and is therefore similar to the information in TN2-4. The PRBS data is subject to scrambling, and is carried in Normal Uplink Bursts with Normal Training Sequence 1.
- Framed PRBS is similar to 18 Frame PRBS except that the PRBS extends to all timeslots. Consequently there is no frame or multiframe structure, only a timeslot structure. The PRBS data is subject to scrambling, and is carried in Normal Uplink Bursts with Normal Training Sequence 1.
- Unframed PRBS contains pure PRBS data as shown in A3.11, and is not subject to scrambling or channel coding. There is no slot, frame or multiframe structure, and no burst formation. Each modulation symbol carries PRBS data at a rate of 36 kbit/s.

Q3.14: What is the synchronization connection between the base station and the IFR 3901?

A3.14: Two synchronization methods are provided in the IFR 3901.

The IFR 3901 can synchronize its timing to a synchronization pulse generated by the base station. The BS sync pulse is defined in ETSI EN 300 394-1 v2.3.1 subclause 4.1.1 (6th bullet point). The repetition rate is the multiframe rate (1.02s) but the pulse width is undefined - only the rise and fall times are defined (<50 ns). The 3901 can be triggered on either the rising edge or the falling edge of the pulse. It is the timing of this edge that matters, so if the timing is defined with respect to the rising edge then the timing of the falling edge (and hence the pulse width) is irrelevant. The synchronization pulse is connected to the IFR 3901 via the rear panel SYNC I/O BNC socket. For full details refer to the IFR 3901 Operating Manual TETRA, chapter 26 'Synchronization'.

The 3901 can also synchronize automatically to the signal generated by the BS. However, the automatic synchronization may only work for a BS that is generating a signal according to ETSI EN 300 394-1 subclause 5.2.1.2, and that is expecting to receive a signal according to ETSI EN 300 394-1 subclause 5.3.2.2.

Q3.15: How do I perform a test on a base station receiver with the IFR 3901?

A3.15: This will depend on the type of base station. Typically you will need a control program or a terminal emulator running on a PC with a serial port connection to a test / control port on the base station. For some base stations you will need to connect a synchronization pulse lead between the base station and the IFR 3901 SYNC I/O BNC socket. For other base stations you will be able to synchronize the 3901 automatically to the signal generated by the base station. Ensure that the IFR 3901 TETRA BS T1 System 'CONFIG: System ID & Sync' menu item "Base Station Sync: Mode" is set to Pulse or Auto as appropriate. For full details refer to the IFR 3901 Operating Manual, chapter 26 'Synchronization'.

For the specific details of operating a particular base station in a receiver testing mode you should refer to the base station manufacturer.

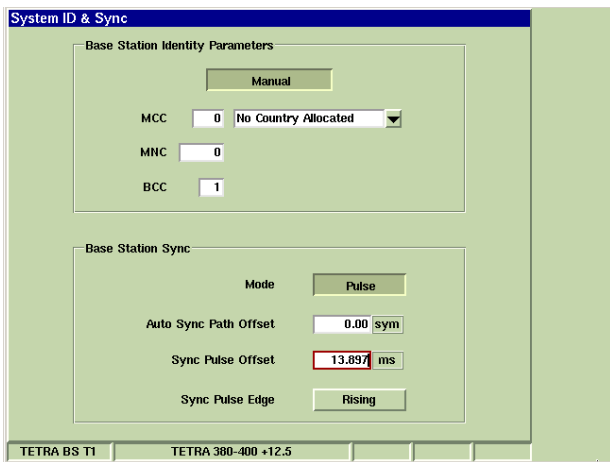


Figure 9 - CONFIG: System ID & Sync tile

Q3.16: What is the purpose of the TETRA BS T1 System 'CONFIG: System ID & Sync' menu parameters "Auto Sync Path Offset" and "Sync Pulse Offset"?

A3.16: The Auto Sync Path Offset defines a timing delay or advance in the generation of the IFR 3901 uplink T1 signal when it is synchronized to the downlink signal generated by the base station. With zero offset, the start of the IFR 3901 uplink T1 signal (frame 1, timeslot 1, symbol number 0) occurs exactly two timeslots after the start of the base station downlink T1 signal. However, base stations in a receiver testing mode may expect to receive the uplink signal later than this time (as with a mobile some distance from the base station). You should refer to the base station manufacturer for the required value of this parameter if you

are using auto-synchronization. This parameter is irrelevant if you are using pulse synchronization.

The Sync Pulse Offset defines the time between the rising or falling edge of the sync pulse and the start of the IFR 3901 uplink T1 signal (frame 1, timeslot 1, symbol number 0). The sync pulse output by the base station has an arbitrary, but fixed, relationship to the expected timing of the uplink T1 signal. You should refer to the base station manufacturer for the required value of this parameter if you are using pulse synchronization. This parameter is irrelevant if you are using auto-synchronization.

Q3.17: Why does the base station indicate a BER measurement of around 50% even though the IFR 3901 is synchronized and the signal level is above the reference sensitivity level?

A3.17: 50% BER is normally an indication that there is no correlation between the received data and the expected data, i.e. the received data appears to be completely random rather than the expected PRBS. This can occur because the receiver is not receiving the expected sequence, or because the receiver's comparison with the expected sequence is not synchronized to the received sequence. These problems can occur if the base station receiver and the 3901 signal generator are using different scrambling sequences. Scrambling is a TETRA process that is used on all traffic and signaling channels, which applies a particular bit pattern (the scrambling sequence) to invert some of the data bits. Scrambling is used to ensure that the modulation is randomized, and to guard against inadvertent co-channel reception from an unwanted base station using a different scrambling sequence.

Check the setting of the "Base Station Identity Parameters: Automatic / Manual" parameter in the TETRA BS T1 System 'CONFIG: System ID & Sync' menu. It is essential that the 3901 uplink T1 signal is scrambled with the same scrambling sequence that the base station is using to de-scramble the signal otherwise the data content of the signal will be uncorrelated with the PRBS that the base station is expecting to receive. If the base station conforms to ETSI EN 300 394-1, subclause 5.2.1.2, it indicates the expected scrambling sequence by means of the MCC, MNC and BCC parameters in its synchronization burst. If the IFR 3901 is set to "Base Station Identity Parameters: Automatic", it will automatically set the scrambling of its uplink signal according to these parameters in the signal received from the base station. However, if the base station does not conform to subclause 5.2.1.2, or if the base station receiver is to be tested separately from the base station transmitter, the IFR 3901 must be set to "Base Station Identity Parameters: Manual", and the required values of MCC, MNC and BCC must be set to match those expected by the base station.

After you have set the 3901 correctly for the required uplink scrambling, it may be necessary to re-start the BER measurement on the base station so that it can re-synchronize its BER measurement to the correct PRBS.

Note that the 3901 TETRA BS T1 System 'TEST: Control' tile display of 'Base Station ID' always shows the MCC, MNC and BCC values indicated by the base station synchronization burst,

whether or not the 3901 is automatically updating to these values.

Q3.18: Can the 3901 signal generator compensate for cable loss, attenuators, splitters, etc.?

A3.18: Yes. The compensation is configured for each system separately, not for the instrument as a whole, under the 'CONFIG: Offsets' menu in each system. Set the "RF Generator Level Offset" for the required compensation. Negative values compensate for an external loss, positive values compensate for an external gain. Toggle the [Gen Offset] softkey ON or OFF to enable or disable the effect of the offset, either in the 'CONFIG: Offsets' menu, or in the 'TEST: Control' tile.

Q3.19: Why does the signal generator level setting show [+/-] next to it?

A3.19: This is a warning that the 3901 has been set to compensate for an external gain or loss (see A3.18 above). If the compensation is no longer required, disable it by toggling the [Gen Offset] softkey to OFF.

Q3.20: Can I use the 3901 to test receiver selectivity?

A3.20: The 3901 can provide the T1 wanted signal used for performing tests of adjacent channel rejection, co-channel rejection, spurious response rejection, and blocking rejection, as defined in the TETRA radio conformance test specification ETSI EN 300 394-1. You will need additional equipment to generate the T2 interfering TETRA signal (e.g. IFR 3410 or IFR 2050T) and the T3 interfering CW signal (e.g. IFR 2040 series) and to combine the signals.

Q3.21: Can the IFR 3901 be used for dynamic (fading) sensitivity tests?

A3.21: The IFR 3901 can be used in conjunction with an external fading simulator to produce the signals for dynamic sensitivity tests. Aeroflex does not supply fading simulators and we are not in a position to evaluate or recommend third party fading simulators. However, the following companies are known to produce fading simulators:

Elektrobit ([www.elektrobit.com](http://www.elektrobit.com) or [www.propsim.com](http://www.propsim.com))

Sofimation ([www.sofimation.com](http://www.sofimation.com))

(The above is not necessarily a complete list.)

Normally you will need to select 2-port operation, with the signal generator output on the GEN port, and the mobile or base station transmitter connected to the T/R port. Focus on the TEST: Control tile (or the TEST: RF Settings tile) and use the softkeys to set RF Out to GEN and RF In to T/R. If the mobile or base station has a single antenna connection for Rx and Tx, you will need a combiner between the fading simulator output and the antenna connection (and possibly an attenuator to protect the fading simulator output). Fading simulators typically require a fairly high RF input level, hence the use of the 3901 GEN port, which can generate a TETRA signal at a maximum level of 0dBm. Normally the level of the faded signal is controlled by the fading simulator, not by the 3901 RF Gen Level which remains at the level required by the fading simulator input. Note that dynamic sensitivity tests require a much greater number of samples for statistical validity than do

static sensitivity tests which means that they are normally only performed for R&D or conformance testing purposes.

## Section 4 Q&A: Testing the audio performance of TETRA mobiles

Q4.1: Can I use an external audio source to modulate the 3901 TETRA signal for testing the mobile's audio circuitry and earpiece / loudspeaker?

A4.1: Not directly. Audio signals carried on a TETRA RF signal have to be digitized and encoded with a TETRA codec. The IFR 3901 does not incorporate a TETRA codec, and the cost of licensing the TETRA codec precludes Aeroflex from offering this as an option for the IFR 3901. However, testing with external audio sources is possible, see A4.3 below.

Q4.2: How can I test the mobile's audio circuitry with the 3901?

A4.2: The 3901 provides a "Talkback" function, i.e. it stores the digitized and encoded speech transmitted by the mobile and replays it to the mobile's receiver 2 seconds later. In a duplex call, this is a continuous process. In a simplex call, the last 2 seconds of speech is stored and played back repeatedly. This avoids the need for the 3901 to include a TETRA codec, since the speech is stored and re-transmitted in its already encoded form.

The Talkback facility can be used for testing with external audio sources by setting up a duplex call and testing transmit and receive audio functions together. Connect the required external audio source to the mobile's audio input, e.g. an accessory remote microphone input, and set the 3901 to talk-back mode. The audio input to the mobile should be heard or received at the mobile audio output after a 2s delay, subject to any degradations introduced in the mobile's audio input / output circuitry and TETRA codec.

Alternatively, you can use the 3901's TETRA encoded 1 kHz test tone for testing the mobile's audio receive performance in isolation, which can be useful in determining the source of a problem (receive or transmit) if the combined audio transmit / receive performance is poor.

Q4.3: What is the IFR 3901 generating when it is set to 'test tone'?

A4.3: It is generating a TETRA encoded version of a 1 kHz tone, representing a level of approximately 12 dB below the theoretical maximum output level. The test tone is pre-computed data that is stored in the 3901, hence the frequency and level are fixed. It is not generated in real time from an audio signal since the 3901 does not have a TETRA codec.

The 1 kHz test tone that the 3901 generates is the result of extensive simulation work to obtain the best result; however, TETRA mobiles will not necessarily be able to reproduce a perfect steady 1 kHz tone from this data. TETRA codecs are not good with steady tones, and are subject to level fluctuations.

Q4.4: Can I use the 3901 TETRA test tone for audio SINAD measurements?

A4.4: Yes, using an external audio SINAD meter. Although the 1 kHz tone may be reproduced in a TETRA receiver with some amplitude fluctuations, it generally results in a SINAD >26 dB, particularly when measured through a CCITT

psophometric filter. This can be a useful work-around if the mobile under test does not provide access to a means of measuring Bit Error Rate for testing RF receiver sensitivity.

## Section 5 Q&A: Functional testing of TETRA mobiles

Q5.1: Can the IFR 3901 test text messaging, as with SMS text messages in GSM?

A5.1: Yes. The TETRA equivalent of SMS is known as SDS-TL (Short Data Service - Transport Layer) and it handles text messaging in a similar (but not identical) manner to GSM. TETRA mobiles can send and receive text messages using either the standard TETRA 8-bit text coding scheme or the GSM-compatible 7-bit text coding scheme. GSM 7-bit text coding enables TETRA mobiles on TETRA networks to send or receive text messages to or from GSM mobiles on GSM networks. The IFR 3901 can send and receive text messages using either 7-bit or 8-bit text coding. SDS-TL is also used for other applications besides text messaging and the IFR 3901 allows you to send and receive your own user-defined content. Use the 'CONFIG: Messages: SDS Type 4 - Other SDS-TL' menu to configure the message content and Protocol ID for your application and the IFR 3901 will handle the SDS-TL protocol (headers, message numbers, acknowledgements). Alternatively, the 'CONFIG: Messages: SDS Type 4 Hex Message' allows you complete control of the SDS message as hexadecimal data. For details refer to the 3901 Operating Manual, chapter 23 'Messages'.

The screenshot shows a configuration window for 'Messages' with the following details:

- Message Type: SDS Type 4 - Other SDS-TL
- Group/Individual: Individual
- Calling Party SSI: 742200 (Hex: B5338) - Test Set
- Protocol Identifier: 130 (Hex: 82) - SDS-TL Text Messaging
- Report Type: Received
- Report Size: Standard
- User Data: 01546869732053445320747970652034206F74686572206D65737361676520696E20686578207761732073656E742062792074686520546573742053657420616E6E4206973206F6E652068736E47265420616E420747765674792063686172616374657273206C6F6E6720656E4696E672068657265
- Calling Party ESN: 01438742200 (Not Included)

Figure 10 - CONFIG: Messages: SDS Type 4 - Other SDS-TL tile

Q5.2: Can the IFR 3901 support 16-bit UCS2 and Cyrillic text messages?

A5.2: Yes, but it will not encode / decode or display these alphabets - use the 'SDS Type 4 - Other SDS-TL' or 'SDS Type 4 - Hex Message' to send messages in these formats. Set the Protocol Identifier to 130 (82 hex) for SDS-TL text messages. Set the first byte of the User Data field to the value of the text coding scheme (see ETSI EN 300 392-2 sub-clause 29.5.4.1) e.g. 5 (ISO Cyrillic), 18 (Cyrillic I), 24 (Russian / Cyrillic II) or 26 (ISO UCS-2 16-bit). A message sent by the mobile in any format other than standard 8-bit

or 7-bit text will be displayed as hex data and a Protocol Identifier. Select the yellow envelope icon on the Operations / Status tile title bar to see the message details, or look at the Protocol History tile.

Q5.3: What is the 'Other Protocol Actions: Commanded Registration' function used for?

A5.3: This is a TETRA function in which the network requests information from a TETRA mobile that has already registered to the network. N.B. it does not and can not force a TETRA mobile to register to the IFR 3901 when the essential network parameters do not match the mobile (see A6.4 and A6.10 below). The commanded registration function requests the mobile to re-register and supply its full ITSi (MCC, MNC, SSI) and report its group attachments.

Q5.4: What is the 'TETRA Test Mode Confirm' function used for?

A5.4: 'TETRA Test Mode Confirm' is used for mobiles that implement the 'TETRA Test' (TT) mode for performing an extended (test mode) registration, and the [TETRA Test Mode Confirm] softkey should be pressed after TT test mode has been enabled on the mobile and the mobile has registered to the IFR 3901. It requests the mobile to supply its TEI, power class and receiver class, as well as confirming the TT test mode selection on the mobile, thus enabling it to use TT BER / RBER loopback during a duplex call for measuring receiver sensitivity. For details refer to the 3901 Operating Manual, chapter 23 'Operations / Status Tile'.

Q5.5: What is the 'CONFIG: Mobile Parameters' menu used for?

A5.5: This menu has four items: SSI, GSSI, Power Class and Receiver Class. For explanation, refer to the 3901 Operating Manual, chapter 23 'Mobile Parameters'. Each item has a 'Fixed' value field, a 'Reported' value field and 'radio buttons' to select 'Use Fixed' or 'Use Reported'. The 'Reported' values are obtained from the mobile at registration or test mode registration. You can override these values by entering values in the 'Fixed' fields and selecting 'Use Fixed'. Additionally, if you have selected 'Use Reported' for an item but the mobile has not reported a value for that item then the 'Fixed' value is used as a substitute.

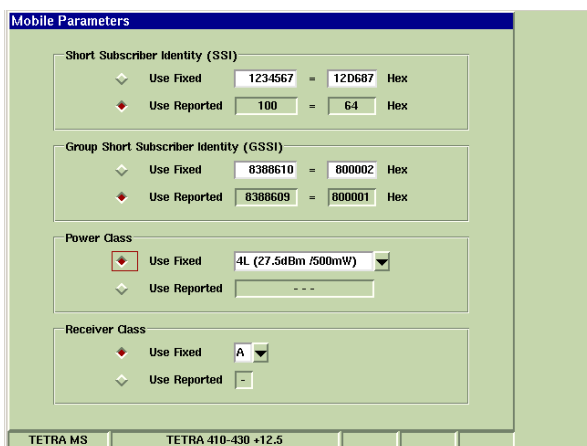


Figure 11 - CONFIG: Mobile Parameters tile

- SSI: normally reported by the mobile at registration, so a 'Fixed' value does not need to be entered. The 3901 uses the Mobile SSI when making private or phone calls to the mobile, so if you enter and use a different 'Fixed' value then the mobile should not respond to the call setup.
- GSSI: normally reported by the mobile's attachment of the selected group at registration, or subsequently, so a 'Fixed' value does not need to be entered. The 3901 uses the Mobile GSSI when making group calls to the mobile, so if you enter and use a different 'Fixed' value that does not match one of the mobile's attached groups then the mobile should not respond to the call setup.
- Power class: reported by the mobile if it responds to a TT test mode extended registration (TETRA Test Mode Confirm command), otherwise the 'Fixed' value should be entered and used to match the power class of the mobile under test. If the mobile responds to the TETRA Test Mode Confirm command but does not supply the correct Power Class value, you should also use the 'Fixed' value. This parameter is used to determine the maximum power level expected from the mobile using open loop power control and it is used with Tx Measurements limit checking to determine the level for the mobile high power level test pass/fail.
- Receiver class: reported by the mobile if it responds to a TT test mode extended registration (TETRA Test Mode Confirm command), otherwise the 'Fixed' value should be entered and used to match the receiver class of the mobile under test. If the mobile responds to the TETRA Test Mode Confirm command but does not supply the correct Receiver Class value, you should also use the 'Fixed' value. This parameter is used with Rx Measurements limit checking to determine the BER / RBER / MER limits to be applied to the receiver sensitivity tests.

Q5.6: Does the IFR 3901 test DGNA (Dynamic Group Number Assignment)?

A5.6: No. The IFR 3901 generally supports only those protocol functions that are required to enable the test set to perform parametric tests on the mobile, or to obtain useful information about the configuration and capabilities of the mobile. The IFR 3901 also endeavors to support protocol functions that can be initiated by the mobile under normal conditions and to either implement the requested function or to reject the mobile's request cleanly. DGNA is only initiated by the network, not the mobile, and does not enable parametric testing, nor does it obtain useful information from the mobile.

Q5.7: Does the IFR 3901 test TETRA Packet Data?

A5.7: No. The IFR 3901 supports the TETRA Core Services and also TETRA Short Data Service (SDS). These services are supported by most TETRA mobiles and they also fulfil the requirements of enabling parametric testing and obtaining useful information from the mobile.

Q5.8: What is the 'CONFIG: Call Timers & Trunking' menu used for ?

A5.8: This menu controls the method and timings of the

autonomous actions of the test set when a call is set up and during the call. Most of the items on the menu are only applicable to simplex calls; however the Test Set Answer Mode / Time and Test Set Call Abort Mode / Time also apply to duplex calls. During a simplex call, either the mobile is transmitting or the test set is transmitting (and the mobile is receiving) or neither party is transmitting (the call is in the quiet state). The first seven parameters on this menu concern the test set operation when the call is in the quiet state. If you set 'Test Set Transmit Mode' to 'Timed', when the mobile stops transmitting the test set will wait for a user-defined period (the 'Quiet Time') then transmit for a user-defined period (the 'Transmit Time') then stop transmitting. If you set the transmit mode to 'Continuous', the test set will transmit whenever the mobile is not transmitting so there will be no quiet state. If you set the transmit mode to 'None', the test set will not make any autonomous transmission but you can manually start and stop the test set transmission using the softkey in the Operations / Status tile. For full details, refer to the IFR 3901 Operating Manual, chapter 23 'Call Timers & Trunking'.

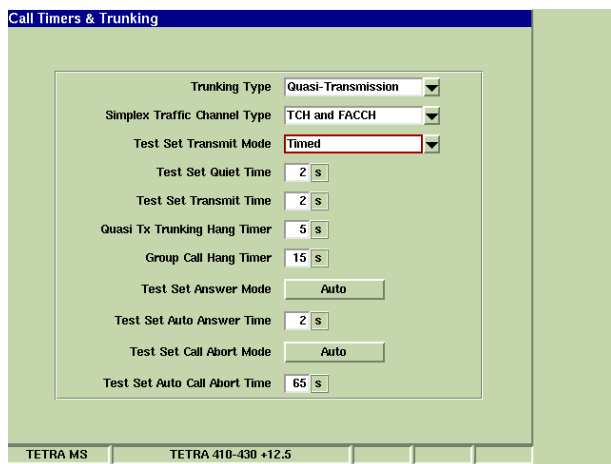


Figure 12 - CONFIG: Call Timers & Trunking tile

Q5.9: Does the IFR 3901 support FACCH (Fast Associated Control Channel) ?

A5.9: Yes. If you set the 'CONFIG: Call Timers & Trunking' parameter 'Trunking Type' to 'Message' or 'Quasi-Transmission', the IFR 3901 generates a FACCH when the call is in the quiet state. The FACCH is on the same frequency and timeslot as the traffic channel but the channel configuration changes to a control channel that is present on all 18 frames. If you set 'Trunking Type' to 'Transmission', the IFR 3901 returns the mobile to the Main Control Channel (MCCH) frequency and timeslot when the call is in the quiet state. If you set the parameter 'Simplex Traffic Channel Type' to 'TCH and FACCH', the IFR 3901 receives an uplink FACCH when the test set is transmitting traffic hence the mobile can send signaling to the test set at any time, not just on frame 18 (SACCH).

Q5.10: What are the 'Hang Timer' parameters used for ?

A5.10: Two separate 'Hang Timers' are defined, 'Group Call Hang

Timer' and 'Quasi Tx Trunking Hang Timer'. Both timers are concerned with limiting the duration of the quiet state during a simplex call. The Group Call Hang Timer only applies to group calls; if the duration of the quiet state exceeds the value of the timer, the test set automatically clears down the call (simulating real base station conditions). The Quasi Tx Trunking Hang Timer only applies to simplex calls, and only when the Trunking Type is Quasi-Transmission. If the duration of the quiet state on the FACCH exceeds the value of the timer, the test set returns the mobile to the Main Control Channel (MCCH) frequency and timeslot. The call is still active, in the same state as when Transmission Trunking is used. Quasi-Transmission trunking is mainly intended for use with Private (Individual) Calls and some mobiles may not support this operation when in a group call. If this is the case with the mobile that you are testing, set the 'Group Call Hang Timer' to a shorter duration than the 'Quasi Tx Trunking Hang Timer' to avoid the problem.

Q5.11: What are the 'Test Set Answer' and 'Test Set Call Abort' parameters used for ?

A5.11: 'Test Set Answer Mode' and 'Test Set Auto Answer Time' allow you to control how the test set will respond to a Mobile Originated call (from the mobile to the test set). Normally the mode should be set to 'Auto' so that the test set answers the call without further action from you; this allows you to set up calls from the mobile when you are not focussed on the Operations / Status tile. The 'Auto Answer Time' controls how long the test set waits before answering, during which time you should hear an 'alerting tone' on the mobile. This parameter can be set to 0s for immediate answer.

'Test Set Call Abort Mode' and 'Test Set Auto Call Abort Time' allow you to control how long the test set will wait for you to answer a Mobile Terminated call (from the test set to the mobile). If the timer expires, the test set will simulate the calling party hanging up and the mobile may indicate a 'missed call'. If you set a long time (e.g. 65s) or an indefinite wait (Manual Mode), the mobile may time out and reject the call setup.

Q5.12: Is it possible to see the mobile classmark information ?

A5.12: Yes. Mobile Classmark information is obtained at registration, and can be viewed in the 'Protocol: Mobile Classmark' tile. The minimized tile abbreviates some of the information for reasons of space. The maximized tile provides expanded descriptions. Mobile Classmark information is also available in the 'Protocol: History' tile.

Q5.13: When a mobile registers and attaches multiple groups, each group identity is immediately over-written by the next one. Is it possible to see this information?

A5.13: Yes. Select the 'Protocol: Groups' tile to see a scrollable display of up to 40 groups. The minimized tile offers a choice of decimal or hexadecimal display format; the maximized tile shows both formats. Use the rotary knob (or a mouse) to scroll up and down if there is a long list.

Group's information is also available in the 'Protocol: History' tile.

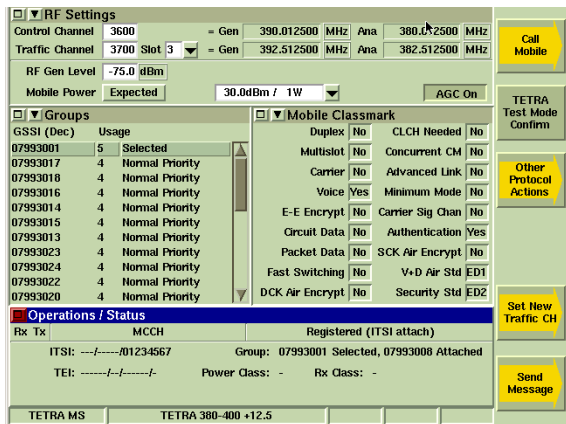


Figure 13 - Protocol: Groups and Protocol: Mobile Classmark tiles

Q5.14: When a mobile sends a text message, the IFR 3901 only shows the first few characters. Is it possible to see the whole message?

A5.14: Yes. Select the yellow envelope icon on the Operations / Status tile title bar to see SDS-TL text messages in full up to 160 characters. The IFR 3901 also shows other details associated with the message and the intended destination address of the message. This information is also available in the 'Protocol: History' tile.

Q5.15: Is it possible to change the time and date information that is sent when the IFR 3901 sends an SDS-TL text message to a mobile?

A5.15: Yes. The IFR 3901 obtains the time and date information from its real time clock, which can be set up in the 'UTILS: I/O Settings: Clock' menu. The sending of time and date information is enabled and disabled in the 'CONFIG: Messages: SDS Type 4 - SDS-TL Text' menu (Time Stamp Included / Not Included). Note that the year does not form part of the time stamp information defined in the SDS-TL protocol and is not sent by the IFR 3901.

Q5.16: Why can't I make group calls when the mobile is registered and the PTT pressed?

A5.16: TETRA mobiles can only make and receive group calls to or from groups that they have successfully attached to the network. Normally a TETRA mobile will attach one or more groups at registration and you will be able to subsequently change the currently selected group. Ensure that the 3901 is not displaying "Group: No Group Selected". If it is, this could be because the mobile group selection is explicitly set to 'NO GROUP' or because the mobile has not been configured with any group identities. Select the 'Protocol: Groups' tile to see details of the groups attached by the mobile. Use the mobile's group selector knob or buttons or menu functions to select a group. Depending on the mobile, you may need to explicitly set group mode in order to make group calls.

## Section 6 Q&A: Compatibility with TETRA mobiles and networks

Q6.1: Which TETRA mobiles can be tested by the IFR 3901?

A6.1: Prior to the launch of the IFR 3900 series (October 2004), the following mobiles had specifically been tested and demonstrated to work with the IFR 3901:

Cleartone CM9000 vehicle mount

Motorola MTH 650 hand portable

Motorola MTP 700 hand portable

Nokia THR 850 hand portable

Nokia THR 880 hand portable

Teltronic MDT-400 vehicle mount

The following mobiles have been tested and demonstrated to work with Aeroflex's previous TETRA test set, the IFR 2968. These had not been re-tested on the IFR 3901 prior to its launch but Aeroflex does not anticipate any particular problems with testing these mobiles on the IFR 3901:

Motorola MTM 300 vehicle mount

Motorola MTP 200/300 hand portable

Motorola MTH 300/300s hand portable

Motorola MTH 500 hand portable

Motorola MTM 700 vehicle mount

Nokia TMR 400/400E/420 vehicle mount

Nokia THR 400/420E hand portable

Nokia THR 600/600E hand portable

Nokia TMR 880 vehicle mount

OTE/Marconi Elettra VT vehicle mount

OTE/Marconi PUMA-T hand portable

OTE/Marconi PUMA-T2 hand portable

Simoco/Sepura SRM 1000 vehicle mount

Simoco/Sepura SRP 1000 hand portable

Simoco/Sepura SRP 2000 small hand portable

Thales Vector covert radio

Note: The above lists are not necessarily complete, and do not necessarily confirm full compatibility with every function on every mobile; however, all of the above mobiles should at least perform registration and call setup with the IFR 3901 so that parametric measurements can be made. Where available, mobiles have been tested in different versions covering the 380-400 MHz public safety band, the 410-430 MHz commercial band and the 805-870 MHz Asia Pacific band.

Some TETRA mobiles are available in enhanced versions typically incorporating a color display and/or an integral GPS receiver, e.g. Motorola MTH 800, Nokia THR 880i, Sepura SRP 2000 sGPS,

Sepura SRP 3000. Other variants may include motorcycle mounting or aircraft mounting of vehicle mount mobiles. Although these variants have not been tested on the IFR 3901, Aeroflex is not aware of any specific problems with testing these variants on the IFR 2968, the predecessor to the IFR 3901.

Aeroflex is not aware of any particular problems with testing TETRA mobiles from Niros and DeTeWe on the IFR 2968, and therefore expects that these makes can also be tested on the IFR 3901.

Q6.2: How do I make an RF connection between the IFR 3901 and the mobile?

A6.2: Vehicle mounted mobiles will typically have a standard RF connector such as BNC or TNC, for which connectors and adaptors are readily available from third party suppliers. Hand portable mobiles may require a proprietary antenna adaptor or RF test lead, which you may only be able to obtain from the mobile manufacturer. For some mobiles, the manufacturer's car kit is the only means of making an RF connection. Normally you should connect to the IFR 3901 N-type duplex 'T/R' socket and ensure that the LED above this socket is lit and the LEDs above the GEN and ANT ports are unlit. For further details refer to 'RF connection between the mobile and the IFR 3901' in the application note 'Testing TETRA mobiles with the IFR 3901'.

Q6.3: What is the significance of "TIP" and which version does the IFR 3901 comply with?

A6.3: TIP (TETRA Interoperability Profile) is very significant for Aeroflex as well as for the TETRA mobile and infrastructure manufacturers. It provides a common interpretation and implementation of the TETRA Air Interface to ensure that mobiles from multiple manufacturers operate on infrastructure from multiple manufacturers. For Aeroflex, it is the means to ensure that mobiles from multiple manufacturers operate on the IFR 3901. Aeroflex participates in the TETRA MoU TIP specification working group and IOP testing to ensure that Aeroflex TETRA test sets (IFR 2968, IFR 3901) are compatible with TETRA mobiles from all manufacturers. For more information on Interoperability (IOP) refer to [www.tetramou.com](http://www.tetramou.com) (see under 'TETRA facts' and 'Interoperability').

TIP versions: Originally the TIP was just one specification (now called 'Core Services'), and was enhanced by the publication of new versions ('TIPv1', 'TIPv2', 'TIPv3'). Now that the TIP comprises a large number of separate parts, these are individually numbered and references to one version number e.g. 'TIPv3' are now obsolete. The IFR 3901 complies with the following TIP specifications:

TTR 001-01 v4.8.1 February 2003: Part 1: Core Services

TTR 001-02 v1.0.1 August 2001: Part 2: Short Data Service (SDS)

TTR 001-06 v1.0.0 June 2001: Part 6: Air Interface Migration

TTR 001-08 v1.0.0 October 2001: Part 8: Testing Requirements

Q6.4: I have a TETRA mobile that claims to be TIP compliant, and

the IFR 3901 claims to be able to test it so why doesn't the mobile register to the 3901 when I switch it on?

A6.4: TETRA mobiles normally only register to base stations belonging to their home network for which they have been configured (programmed). Therefore the IFR 3901 must be set up to exactly match the essential parameters of the home network otherwise the mobile is likely to ignore the test set. The essential parameters are as follows:

- Channel Plan: the frequency band and method of numbering the frequency channels
- Channel Plan Frequency Offset: typically 12.5 kHz offset or 0 Hz offset
- Control Channel: particular control channel frequency if the mobile does not scan the band
- Country Code (MCC) and Network Code (MNC): these identify the home network

For further details refer to the 3901 Operating Manual chapter 23 'System ID & Access Parameters'. You may need to contact the mobile manufacturer or network operator to obtain the essential parameter information. Country Code (MCC) values are published in ETSI EN 300 392-2 v2.4.1 Annex K, and the IFR 3901 'CONFIG: System ID & Access Params' menu also provides this information. Network Code (MNC) values are normally allocated by the radio regulation authority in each country and these values are not necessarily published.

Q6.5: The essential network parameters have been set correctly but the mobile still does not register to the IFR 3901. Is there anything else that needs to be checked?

A6.5: Refer to 'Annex C: Troubleshooting when a mobile does not register' in the Aeroflex application note 'Testing TETRA mobiles with the IFR 3901' for further assistance.

Q6.6: The mobile registers to the IFR 3901 but call setup fails. What is wrong?

A6.6: Ensure that the traffic channel frequency (channel number) is within the range of frequencies supported by the mobile. It is particularly important to check this if the mobile only supports part of a frequency band. For example, the 'TETRA 380-400 +12.5' channel plan covers channels 3600 to 3999 (380-390 MHz mobile transmit, 390-400 MHz mobile receive); a mobile that only covers 385-390 MHz mobile transmit/395-400 MHz mobile receive will only cover the channels 3800 to 3999. Ensure that both the control channel and the traffic channel are within the mobile's supported frequency range. You may prefer to define a User Defined channel plan covering only the mobile's supported frequency range so that you can only select channels within the supported frequency range.

Q6.7: Why is the IFR 3901 so particular about the network parameters?

A6.7: The IFR 3901 is not particular at all however TETRA mobiles are particular. Until the essential parameters are set up on the test set (channel plan, offset, control channel, MCC,

MNC), a TETRA mobile will normally ignore the test set completely and not send any signaling to the test set. Normally a mobile will not provide any indication to the user that it has found a TETRA base station signal unless the essential parameters are set correctly.

Q6.8: Why can't the IFR 3901 set the network parameters itself automatically?

A6.8: In theory, the 3901 could try all of the parameter values in turn until the mobile responds. However, with 999 possible country codes and 9999 possible network codes this is not a practical proposition. For each of the 10 million combinations, the 3901 would need to wait several seconds to give the mobile time to find the signal - having found a TETRA signal with the wrong MCC / MNC values, the mobile is not going to keep listening to the signal in case the values change, it will go off and search for signals with the correct values. If the channel plan (frequency band and offset) is unknown, this would increase the combinations further and if the mobile does not scan the band then all 16000 frequency channels and offsets in the band would have to be tried each with all 10 million combinations of MCC /MNC.

Q6.9: GSM radio test sets don't require the correct network parameters to be set. Why is this necessary for TETRA mobiles on the IFR 3901?

A6.9: A GSM phone attempts to register onto other networks (roaming) if it doesn't find its home network. Some TETRA mobiles also implement this behavior, which is known as 'migration' in TETRA rather than 'roaming'. TETRA migration is a two stage process in which the mobile identifies itself to the other network as a 'visitor' and is assigned a visitor's identity for use on the other network, which it can then use to register and make / receive calls on the visited network. As part of this process the mobile provides the identity of its home network and its own identity.

Mobiles that implement migration can register to the test set as a visitor and provide the identity of their home network. Thus you can obtain the mobile's home network identity, re-configure the 3901 with the correct identity and test the mobile as normal. However a TETRA mobile supporting migration will not necessarily attempt to register to any network - mobiles may be configured with lists of other networks with which they are allowed to attempt migration in which case you will still need to know these values and configure the test set accordingly. In any case, the IFR 3901 always needs to be configured with the correct channel plan and offset required by the mobile.

All GSM mobiles use SIMs (Subscriber Identity Modules), and it is common practice to test GSM mobiles using Test SIMs, which provide the mobile with a test identity (IMSI) of 001/01/0123456789 when the SIM is inserted instead of the normal network subscription SIM. Many TETRA mobiles now have holders to physically accept a SIM but SIMs are not in common use and there is no definition for a TETRA Test SIM. The nearest equivalent that is currently available in TETRA mobiles is the use of TETRA Test (TT) mode registration in which the mobile assumes

a home network identity of 001/00001 when TETRA Test mode is enabled on the mobile.

Q6.10: How do I find out the network parameters for a particular mobile?

A6.10: There are a number of options that 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.
- Check whether the mobile has actually been configured for a particular network or whether it contains a factory default configuration.
- If the mobile is known to work with a nearby base station, use the 3901 in the TETRA BS System to determine the essential network parameters and set up the 3901 in the TETRA MS System to match the real base station. See A6.11 below for details of how to do this.

Q6.11: How do I set up the 3901 to match the network parameters of a local TETRA BS?

A6.11: The following method can be used for setting up the 3901 to match the network parameters of a local TETRA base station that a TETRA mobile is known to work with, providing that the base station is reasonably close (e.g. 2 km) and you have an antenna that can receive a clean RF signal at a reasonable level (typically -90 dBm or higher).

First, use a spectrum analyzer (e.g. IFR 2398) to determine the frequency of the base station. Use the spectrum analyzer markers to locate the frequency of the base station signal. Initially set a wide span to cover the possible frequency range (e.g. Center-Span mode Center Freq 405 MHz span 50 MHz will cover the range 380 MHz to 430 MHz, or use Start-Stop mode). Use the spectrum analyzer 'peak find' and 'set ref to marker' functions to home in on the local base station signal. Repeat this process with reduced span widths until the characteristic TETRA modulated signal is centered on a span of 50 kHz. Make a note of the Center Freq, adjusting it as required so that it is an exact multiple of 6.25 kHz, e.g. 392.712500 MHz. Repeat the process if there were other TETRA signals visible initially, making a note of their frequencies. Now use the 3901 in the TETRA BS System to receive the base station signal(s) that you have located (CONFIG: Systems, TETRA, BS; requires Option 111 TETRA BS). Select channel plan No Plan (CONFIG: Channel Plan). Ensure that your antenna is connected to the ANT port and that the ANT port is selected as the RF Input (RF Input softkey in RF Settings tile). Initially set the Expected Power in the RF Settings tile to -80 dBm.

Secondly, set the 3901 RF Analyzer frequency to the frequency of the base station signal(s) that you have located. You may need to experiment with the expected power level with IAGC Off or IAGC

On] depending on the level and variability of the signal. The 3901 should receive, demodulate and decode the base station signal and display the Mobile Country Code (MCC), Mobile Network Code (MNC), Base station Color Code (BCC) and Location Area (LA) values in the Operations / Status tile. Make a note of the MCC, MNC and BCC values for each base station frequency. The 3901 RF Settings tile (with Channel Plan = No Plan) shows your entered RF Analyzer Frequency as the nearest equivalent channel number (assuming an ETSI standard channel numbering scheme). Make a note of the channel number for each base station signal.

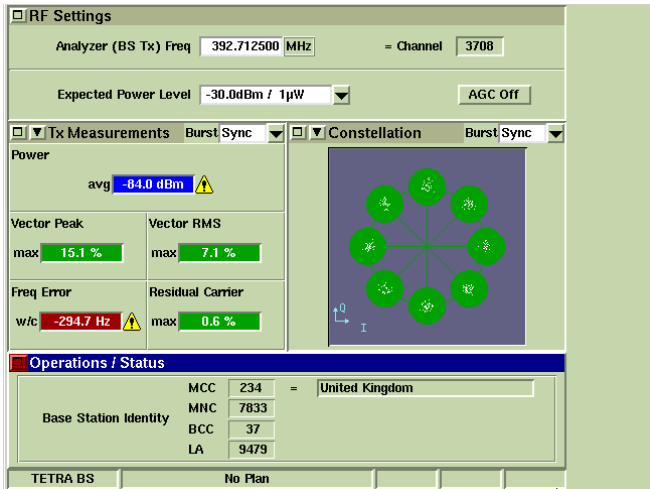


Figure 14 - TETRA BS system providing channel number and identity of local base station signal

If you have found multiple TETRA base station signals, they will not necessarily all be carrying Main Control Channel (MCCH) signals - on a multiple carrier base station site you are likely to also encounter signals carrying only traffic channels or unused channels. Only MCCH signals are used for registration. The 3901 Data Demod mode (TEST: Data Demod) can be used to analyze the base station signal to determine what it contains. Look at the channel decoded messages in Slot 1 only in Frames 1 to 17 only: an MCCH signal will have only AACH and SCH/F, SCH/HD or BNCH messages in slot 1 frames 1 to 17, not TCH/S or BSCH messages.

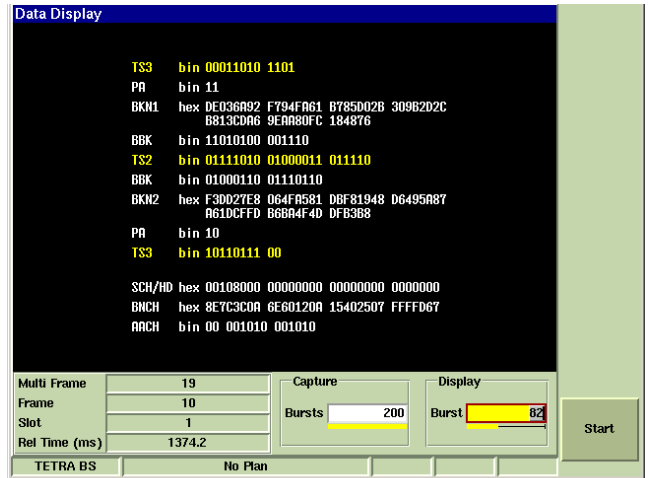


Figure 15 - TETRA BS system Data Display showing SCH/HD, BNCH and AACH in slot 1 frame 10 of a base station MCCH signal

Third, select the TETRA MS System and set up the 3901 (CONFIG: System ID & Access Params) with the same MCC and MNC as the local base station. It is advisable to set a different value of BCC (but not zero) to guard against co-channel reception of the real base station by the mobile. Use the equivalent channel number that was displayed in the TETRA BS System, or calculate the channel plan and channel number from the base station frequency (see A6.12 below) and set up the 3901 with the channel plan and control channel number to match the local base station MCCH signal.

Finally, connect the TETRA mobile to the 3901, ensuring that the RF In / Out is on the T/R port only and set the 3901 RF Gen Level to a high level (e.g. -40dBm) to guard against inadvertent reception of the local base station signal. Switch on the mobile and it should now register to the IFR 3901. The mobile may also be capable of scanning the frequency band to find the 3901's MCCH on a different channel if it can be screened or otherwise prevented from receiving the local base station signal.

Q6.12: How do I convert a frequency in Hz to a TETRA channel plan and channel number?

A6.12: The simplest way is to use the IFR 3901 to do the channel number conversion for you, as long as your frequency in Hz is reasonably accurate. In the TETRA MS System or the TETRA BS System, select No Plan (CONFIG: Channel Plan) and set the relevant base station transmit frequency in the RF Settings tile (RF Gen Freq in TETRA MS, RF Ana Freq in TETRA BS). The IFR 3901 shows the nearest equivalent channel number. You need to use your own judgement to determine the appropriate channel plan. Alternatively, just follow the straightforward calculation below.

When you are testing a base station, or a mobile in T1 test mode, you do not need to convert the frequency to a channel number because you can use the 3901 with channel plan No Plan and enter the transmitter frequency directly in Hz. However, when you are testing a mobile in normal trunked mode (TETRA MS System) you will need to set up the 3901 with a channel plan and channel

number. The TETRA signaling protocol uses the channel number, not the frequency, when the mobile is assigned to a traffic channel or control channel. Therefore the channel plan and channel number must be correct for these procedures to work, i.e. both the 3901 and the TETRA mobile must have the same understanding of what the channel number means when it is converted to frequencies for tuning transmitters and receivers.

The calculation and examples below are valid for the standard channel numbering scheme defined in ETSI TS 100 392-15 v1.2.1 and required by the TIP (TTR 001-01 v4.8.1 TIP Part 1: Core Services). The numbering is defined in terms of the base station transmitter frequency:

- Identify the relevant base station (downlink) frequency, accurate to 1 kHz or better
- The frequency should be the center frequency of the TETRA modulated signal
- The frequency should be an exact multiple of 25 kHz, 12.5 kHz or 6.25 kHz
- Round the frequency up or down so that it is an exact multiple of 6.25 kHz
- Subtract an integer multiple of 100 MHz, leaving a remainder less than 100 MHz
- The integer gives the value of the band parameter
- Divide the remainder by 25 kHz
- The result should be in the range 0 to 3999 see note
- The result should be xxxx.00, xxxx.25, xxxx.50 or xxxx.75
- Result xxxx.00: channel = xxxx, offset = 0 Hz
- Result xxxx.25: channel = xxxx, offset = +6.25 kHz
- Result xxxx.50: channel = xxxx, offset = +12.5 kHz
- Result xxxx.75: channel = xxxx+1, offset = -6.25 kHz

Example 1: BS frequency = 393.612500 MHz

Subtract 300 MHz: remainder = 93.612500 MHz, band = 3 (300 MHz)

Divide by 25 kHz: result = 3744.50, channel = 3744, offset = +12.5 kHz

Therefore channel plan = TETRA 380-400 +12.5 (includes +12.5 kHz offset), channel = 3744

Example 2: BS frequency = 421.568750 MHz

Subtract 400 MHz: remainder = 21.568750 MHz, band = 4 (400 MHz)

Divide by 25 kHz: result = 862.75, channel = 862+1 = 863, offset = -6.25 kHz

Therefore channel plan = TETRA 410-430 -6.25 (includes -6.25 kHz offset), channel = 0863

Example 3: BS frequency = 867.425000 MHz

Subtract 800 MHz: remainder = 67.425000 MHz, band = 8

(800 MHz)

Divide by 25 kHz: result = 2697.00, channel = 2697, offset = 0 Hz

Therefore channel plan = TETRA 805-870 ZERO (zero offset), channel = 2697

Note: The ETSI numbering scheme permits a small overlap of the 100 MHz bands (2.4 MHz overlap) since the channel numbering extends to 4095. For example, a base station covering 395.000 MHz to 400.000 MHz would probably use channel numbers 3800 to 4000 on band 3, rather than numbering the last channel as channel number 0000 on band 4.

Q6.13: Can I test a TETRA mobile that does not conform to the ETSI channel numbering?

A6.13: Yes. User Defined channel plans allow you to define your own channel numbering schemes to match e.g. manufacturers' proprietary numbering schemes, or to support other TETRA channel plans that may be defined in the future. Typically a TETRA mobile may have a proprietary channel numbering scheme when it has a factory default configuration before it has been configured for a particular network, e.g. the lowest frequency supported by the mobile may be numbered as channel 0001. The IFR 3901 can support any frequency from 1 MHz to 1 GHz. Refer to the 3901 Operating Manual, chapter 21 'Channel Plans', for details of setting up New User Defined channel plans.

Q6.14: Can I ignore channel plans and channel numbers and set the 3901 frequency in Hz?

A6.14: Yes, but not for normal trunked mode mobile testing. The IFR 3901 provides a 'No Plan' channel plan for setting the 3901 frequency in Hz instead of using a channel number.

Important note: When you are testing a base station, or a mobile in T1 test mode, you can ignore channel numbers and enter the transmitter frequency directly in Hz. However, when you are testing a mobile in normal trunked mode (TETRA MS System) you will need to set up the 3901 with a channel plan and channel number. The TETRA signaling protocol uses the channel number, not the frequency, when the mobile is assigned to a traffic channel or control channel. Therefore you must use the correct channel plan and channel number for normal mobile testing.

## Section 7 Q&A: Signaling and protocol operations

Q7.1: Is it possible to read the individual bits of the PDU fields that the 3901 receives?

A7.1: Yes. The 3901 Data Demod mode allows individual burst data to be seen, before and after channel decoding, in hex and binary as appropriate. Up to 1000 bursts can be captured, equivalent to 14s of continuous capture on all four slots from a base station, or 60s of continuous capture of traffic on one slot from a mobile. Set up the 3901 RF Analyzer as normal in TEST: Manual Tiled mode to receive the BS or MS transmissions, and switch to TEST: Data Demod to start / stop capture and to view the data. Having started the capture, you can return to TEST: Manual Tiled

mode to perform mobile operations and the mobile transmissions will be captured in the background.

Q7.2: Is it possible to edit the PDU fields that the 3901 sends ?

A7.2: Partially. Specific parameters can be set in the CONFIG: System ID & Access Params menu and these will affect the contents of the information elements (fields) in the PDUs that are sent by the 3901. In particular, the CONFIG: Call Types and CONFIG: Messages menus allow configuration of various CMCE parameters. However, the 3901 is not designed as an editable protocol test script tester, i.e. it does not execute TTCN test scripts. The PDU fields that are not editable by the user are set by the 3901 protocol software.

Q7.3: Is it possible to view and edit the SYSINFO and SYNC messages sent by the 3901?

A7.3: You can see the values of the editable parameters in the CONFIG: System ID & Access Params menu. For information on the SYSINFO and SYNC parameters that can be changed, refer to the 3901 Operating Manual chapter 23 'System ID & Access Parameters'.

## Section 8 Q&A: Testing mobiles with encryption and authentication

Q8.1: Can I test TETRA mobiles that use encryption and / or authentication?

A8.1: Yes. The IFR 3901 does not test the encryption or authentication aspects but the mobile functional aspects and RF performance can be tested without using encryption or authentication. Refer to A8.4 and A8.8 below for further information.

Q8.2: Does the IFR 3901 test Air Interface Encryption (AIE) or End to End encryption (E2E)?

A8.2: No. The IFR 3901 does not support either form of encryption.

Q8.3: Will the IFR 3901 support encryption in a future upgrade?

A8.3: Aeroflex currently has no plans to support encryption in the IFR 3901.

Q8.4: How can I test a TETRA mobile that uses encryption?

A8.4: TETRA mobiles are only able to use encryption if both the mobile and the network (or test set) support encryption, and if the network (or test set) permits its use. TETRA mobiles that are not able to use encryption normally attempt operation in clear. The system information generated by the IFR 3901 indicates to the mobile that the IFR 3901 does not support encryption and allows the mobile to operate in clear. Mobiles may be configured to display warning icons or generate warning beeps to the user when operating in clear but this should not prevent them from being tested in the normal manner.

However, there are some mobiles (such as those meeting the CESG Baseline security requirements for operation on the UK Airwave network) that are configured to operate only with encryp-

tion in normal use. These mobiles will not register to a TETRA base station or a TETRA test set operating in clear mode, and therefore cannot be tested in their normal operating mode. For testing purposes, these mobiles should provide a means of accessing a secure test mode, typically the TETRA Test (TT) mode supported by the IFR 3901, which allows the mobile to operate in clear mode on a radio test set subject to various safeguards. You should contact the mobile manufacturer for further information.

Encryption (or the lack of it) has no effect on the measurement of the RF performance, which is the primary purpose of the IFR 3901. The functional tests, and the obtaining of information from the mobile, can all be performed in clear thus the only un-tested functionality is the additional signaling related to cipher keys and encryption. In any case, the security keys necessary for using encryption may be removed from a mobile for security reasons before it is sent to a third party for test and repair.

Q8.5: The IFR 3901 has a setting for "Air Interface Encryption" - what is this for?

A8.5: The menu "CONFIG: Base Services" allows the user to set the values of the "Base Station Services" parameters. These are 12 binary flags which indicate to a TETRA mobile which services are provided by the base station. One of these is for Air Interface Encryption and it can be set to "Available" even though the IFR 3901 does not support Air Interface Encryption. Some users wish to have full control of all of these flags even though the IFR 3901 does not support all of the services. For normal mobile testing the Base Services flags should remain set to their factory default values, which indicate the services that the IFR 3901 does provide. N.B. these flags are simply information broadcast to the mobile under test; changing their values does not alter the functionality of the test set. The IFR 3901 displays a warning message if you set these flags to indicate the availability of services that are not supported by the test set.

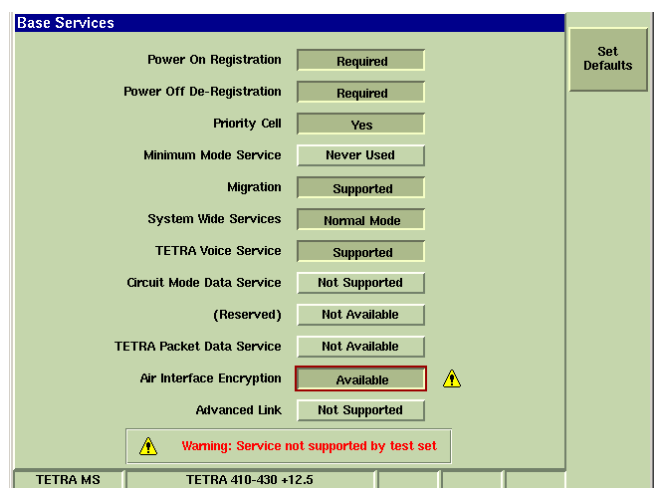


Figure 16 - CONFIG: Base Services tile with warning for Air Interface Encryption flag indicating 'Available'

Q8.6: Can I check that the mobile attempts to perform an encrypted registration by setting the Base Services "Air

Interface Encryption" flag to "Available"?

A8.6: No. The 3901 does not support encryption. It is not possible for the MS to register or set up a call to the 3901 in encrypted mode. The control channel information generated by the 3901 makes it clear to the MS that it does not support encryption (system code is "no security functions"). If the BS Services AI encryption field is set to "Available", the MS will look for, but not find, the cipher key information which it requires in order to use encryption. Depending on the MS, it may perform a registration in clear or it may reject the test set as being unsuitable and indicate that there is No Service.

For normal MS testing this flag should always be set to "Not Available".

Q8.7: Does the IFR 3901 test Authentication or Mutual Authentication?

A8.7: No. The IFR 3901 does not test either type of authentication.

Q8.8: How can I test a TETRA mobile that uses authentication?

A8.8: Normal authentication is initiated by the TETRA network. The network sends a challenge to the mobile and checks the response returned by the mobile. The mobile should respond if challenged but it should not be upset if it is not sent a challenge (as is the case with the IFR 3901). The IFR 3901 system information indicates that authentication is not supported hence a TETRA mobile should not expect to be authenticated by the 3901.

Authentication (or the lack of it) has no effect on the measurement of the RF performance, which is the primary purpose of the IFR 3901. The functional tests, and the obtaining of information from the mobile, can all be performed without authentication thus the only untested functionality is the additional signaling related to authentication challenge and response. In any case, the authentication keys may be removed from a mobile for security reasons before it is sent to a third party for test and repair.

Q8.9: Will the IFR 3901 support authentication in a future upgrade?

A8.9: Aeroflex currently has no plans to support authentication in the IFR 3901.

Q8.10: How can I test a TETRA mobile that uses mutual authentication?

A8.10: Mutual authentication involves the mobile authenticating the network as well as the network authenticating the mobile. This functionality is always initiated by the TETRA network. There is currently no TIP specification for a TETRA mobile to initiate authentication of the network when the network has not authenticated the mobile. The IFR 3901 system information indicates that authentication is not supported, hence a TETRA mobile should not expect to be authenticated by the IFR 3901, and should not expect to authenticate the IFR 3901.

Q8.11: Will the IFR 3901 support mutual authentication in a future

upgrade?

A8.11: No, this would be a breach of TETRA security. The purpose of mutual authentication is for TETRA mobiles to be sure that they are communicating with a real TETRA base station and not a spoof base station intercepting their calls. It is therefore important that the algorithms and keys for mutual authentication are only released to genuine TETRA networks and are not implemented in a radio test set.

Q8.12: Could the IFR 3901 test the authentication process without involving secure algorithms and keys in a future upgrade?

A8.12: This is a possibility, although currently Aeroflex has no plans to implement this functionality. This process is supported in GSM testing through the use of a standard simple authentication algorithm for test purposes (XOR challenge with internal key) and through the use of standard Test SIMs incorporating the test algorithm and a known test key. Hence GSM test sets send an authentication challenge to a mobile and know what response to expect, without involving any breach of the secure algorithms and keys used on real networks.

Currently, TETRA mobiles do not use SIMs, there is no definition for a TETRA Test SIM, and no standard simple algorithm or known key for test purposes. Therefore such a test would be of limited value since the IFR 3901 would not know what response to expect.

## Section 9 Q&A: Miscellaneous functions

Q9.1: Can the IFR 3901 test TETRA mobiles off-air?

A9.1: Yes, but this should only be used as a last resort for functional testing if you are unable to achieve a direct RF connection between the mobile and the test set. Transmitter power and receiver sensitivity levels will be uncalibrated and there are associated problems of the mobile receiving real base station signals and generating unauthorized transmissions. Refer to 'RF connection between the mobile and the IFR 3901' in the IFR application note 'Testing TETRA mobiles with the IFR 3901' for details.

Q9.2: Can the IFR 3901 receive TETRA base station signals off-air?

A9.2: Yes, when in reasonably close proximity, typically no more than 3 km line of sight and with a signal level not less than -90 dBm. Connect a suitable antenna (preferably outdoor-mounted) to the ANT port and use the softkey in the RF Settings tile to set RF In to ANT. The expected level (range 0dBm to -80dBm) and the AGC (On / Off) should be set as required to obtain a satisfactory input signal. Tx Measurements with a dark gray background indicate that the input signal is not optimally ranged for accurate measurements however the base station signal can usually be demodulated and channel decoded at a lower signal level than that required for accurate measurements. The 'Modulation Accuracy: Constellation' display is a useful indicator of the quality of reception. The Data Demod mode

indicates bursts that failed channel decoding.

Q9.3: Can the IFR 3901 perform off-air BER testing (coverage monitoring or drive testing)?

A9.3: The IFR 3901 can perform some limited off-air monitoring, but it does not have the same sensitivity and selectivity as a TETRA mobile or a specialist coverage monitoring receiver. It can receive off-air base station signals in close proximity to a base station, e.g. 3 km line of sight, and can decode the base station signals down to a level of approx. -90 dBm. It may be possible to improve this with an external RF amplifier and filters. The IFR 3901 is designed for measuring strong signals either directly connected or in close proximity off-air hence it does not have the ability to receive weak signals in fringe coverage areas subject to multipath fading and interference.

The IFR 3901 Data Demod mode can be used to capture up to 1000 bursts (14s) of continuous signaling on all four slots from a base station. The 3901 attempts to demodulate and channel decode each burst, but does not attempt to perform any error correction in the channel decoding. Where noise has caused incorrect demodulation in one or more bits in a slot, the channel decoding for that slot is likely to fail, which is indicated in red with a warning on the display. For a static signal (not subject to fading) the error rate is likely to become significant at around -93 dBm to -95 dBm, but should be mostly error-free at -90 dBm. Thus the 3901 off-air monitoring is not representative of the performance likely to be achieved by a normal TETRA mobile or a specialist monitoring receiver. However, you could use the 3901 to receive off-air base station signals in a reference location with an acceptable signal level, and periodically monitor the signal quality at this location to check for any degradation.

There are other specialist test and measurement companies who do have coverage analysis products, a selection of which are listed below:

Actix [www.actix.com](http://www.actix.com)

ATDI [www.atdi.co.uk](http://www.atdi.co.uk)

Nemo Technologies [www.nemotechnologies.com](http://www.nemotechnologies.com)

(The above is not necessarily a complete list.)

Q9.4: Can I store and recall different TETRA system setups on the IFR 3901?

A9.4: Yes. Select UTILS: Store / Recall, and press the [New Store] softkey. Enter a file name for the store, which can be up to 32 characters long including spaces, using multiple presses of the numeric keypad and press ENTER to complete the file name entry. If you select the 'Comments' field, you can enter a comment with the store, pressing ENTER when the comment is complete. Press the [Store] softkey to store the settings on the internal hard disk of the test set. The store will include a date and time stamp, so you do not need to make the date and time part of a comment.

Select UTILS: Store / Recall to see the list of stored files. Highlight the required filename using the cursor keys, rotary knob or mouse. Press the [Details] softkey to see more details including

the time stamp. Press the [Recall] softkey to recall settings from the selected file. The relevant System will be reloaded and the stored settings will be applied.

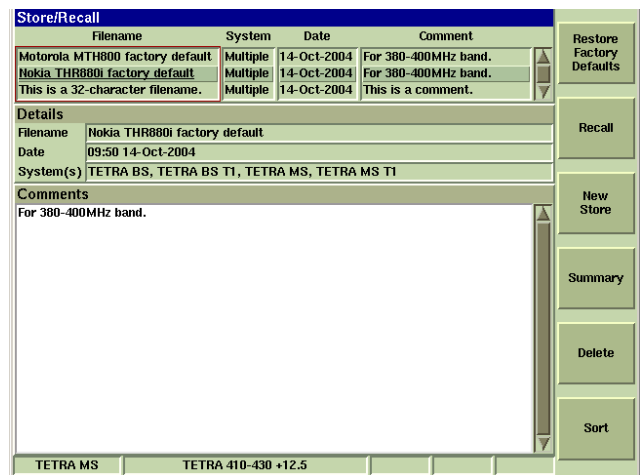


Figure 17 - UTILS: Store / Recall tile

Important note: The Store / Recall facility stores all settings for all Systems, not just for the currently selected System. When you Recall a stored file, all settings in all Systems will be changed to their state at the time that the stored file was created and you will lose the current settings. If you wish to preserve the current settings in one or more systems, you should store the current settings by creating a new store before recalling the stored file.

The stored system setup files do not include user-defined TETRA channel plans or Auto Test scripts. The test set hard disk can hold multiple channel plans and scripts, any of which can be selected at any time, without losing the details of the other plans and scripts.

Q9.5: Can I transfer settings between test sets ?

A9.5: Yes. Having created a store of settings on the hard disk of one test set, you can export it to a floppy disk and import it to the hard disk of another IFR 3901 test set. Select UTILS: File Management and select 'Stores' in the top box. Select the required store from the displayed list, place a formatted floppy disk (not supplied by Aeroflex) in the IFR 3901 floppy disk drive and press the [Export] softkey to copy the store to the floppy disk. On the second IFR 3901, also select UTIL: File Management and select 'Stores'. Place the floppy disk in the second IFR 3901's floppy disk drive and press the [Import] softkey to copy the store to the hard disk of the second test set. You can now recall these stored settings using the UTILS: Store / Recall menu in the normal manner.

If you wish to transfer Auto Test scripts or TETRA channel plans to another test set, follow the same procedure, this time selecting 'Auto Test', 'Scripts' or 'TETRA', 'Channel Plans' instead of 'Stores'.

Q9.6: Can I capture a 3901 screen image and use it in PC applications?

A9.6: Yes, you can capture screen shots similar to those that you see in the IFR 3901 operating manual (color in the pdf ver-

sion). Screen dumps are created by pressing the [HOLD] hardkey, which gives you the option of copying the image to a printer, storing the image to the internal hard disk or simply holding the display. To store the image, press the [Save Screen As] softkey, enter a filename and specify the format for the image - JPEG (.jpg), bitmap (.bmp) or PNG (.png). To transfer a stored image to a PC, select UTILS: I/O Settings: File Management and select 'Screens'. Place a formatted floppy disk (not supplied by Aeroflex) in the IFR 3901 floppy disk drive and press the [Export] softkey to save the image file to the floppy disk which you can read in to a PC.



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