

# FREEDOM

Communication Technologies

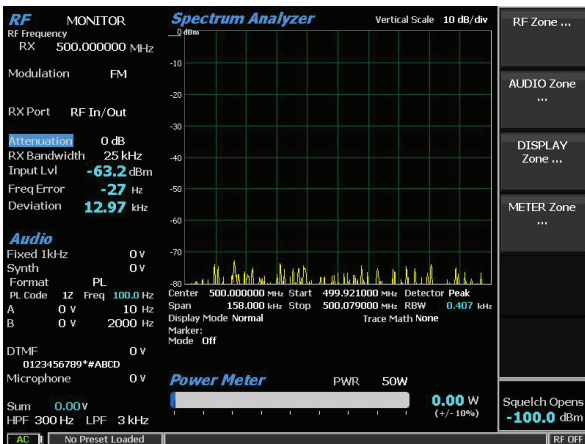
## Tetra Base Station Test and Monitoring



# Introduction to Tetra Base Station Test and Monitoring

- The two options TETRA Base Station Monitoring ( R8-TETRA\_BSM) and TETRA Base Station T1 Test (R8-TETRA\_BST1) share the same operating interface
- Whilst TETRA Base Station Monitoring Option may be purchased and operated as a stand alone application, TETRA Base Station T1 Test requires that TETRA Base Station Monitoring is enabled
- The user may select between these options on the fly if enabled
- The purchase of TETRA Base Station T1 Test application includes the TETRA Base Station Monitoring application
- There is an upgrade path from TETRA Base Station Monitoring to TETRA Base Station T1 Test
- Mobile Country Code(MCC), Mobile Network Code(MNC), Base Station Colour Code(BCC) and Local Area Code(Larea) are only decoded and displayed in the TETRA Base Station T1 Test application
- Both options conduct full transmitter parametric measurements, either by direct connect or OTA antenna connection
- The TETRA Base Station T1 Test option has additional transmitter and receiver T1 measurements for BER/MER

# Initial Power On

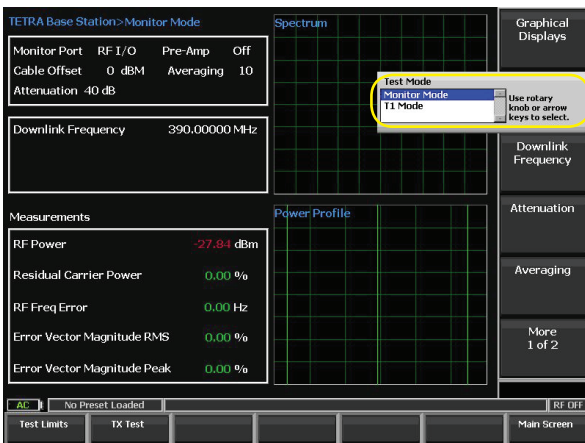


1. Initial Power On
2. Press Green Power Button
3. Wait for configuration to load around 30 Seconds
4. Press Blue "TEST" Button



Select "Test Mode"

On Page 2 Select "TETRA Base Station"



Select "Test Mode"  
Select "T1 Mode" or "Monitor Mode"

## RX Tones and Voice Loopback

This feature works in any Duplex call type.

Example:

Set up a Group Call:

Select "Call Type and "Group" from the dropdown menu

Select "Select Group"" the radio will have sent Group Allocations during Registration.

Select the Group to make the call to

Select "Call Mobile"

The Mobile will indicate Group Call ID 777 on its display.

Press PTT to observe TX measurements

Release PTT

"Select Voice Loopback"

Scroll to each tone in the menu to hear them on the mobiles speaker

Select "Voice"

Press PTT and speak into the microphone to record a message

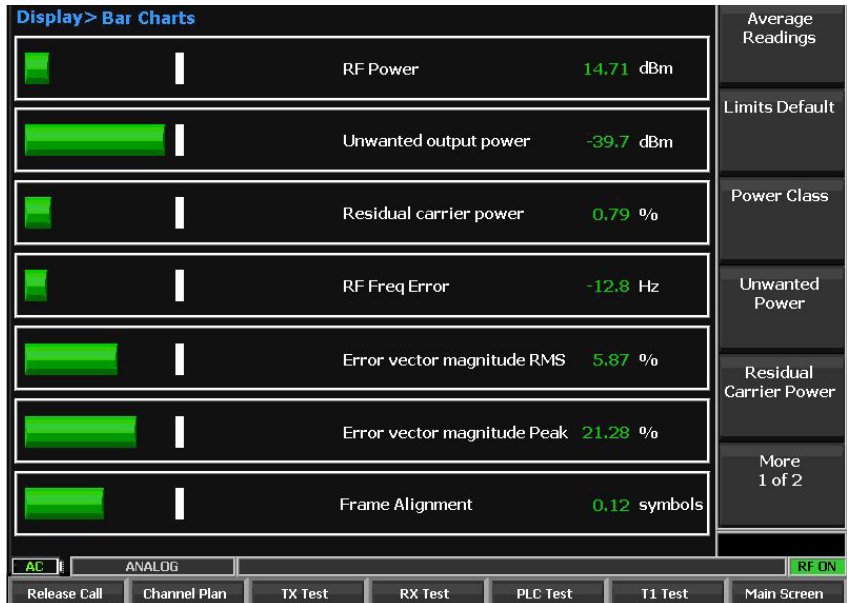
Release PTT. Recorded message will play back repeatedly until "OFF" is selected

Note. A manual test of the RX sensitivity can be made by:

Selecting "RF Level" then adjust negatively until the speech be comes broken up. <-116 to -120 is a typical level for breakup of voice.

# Full Screen Graphical Displays

## Bar Charts



Bar charts provide a graphical representation of measured parameters.

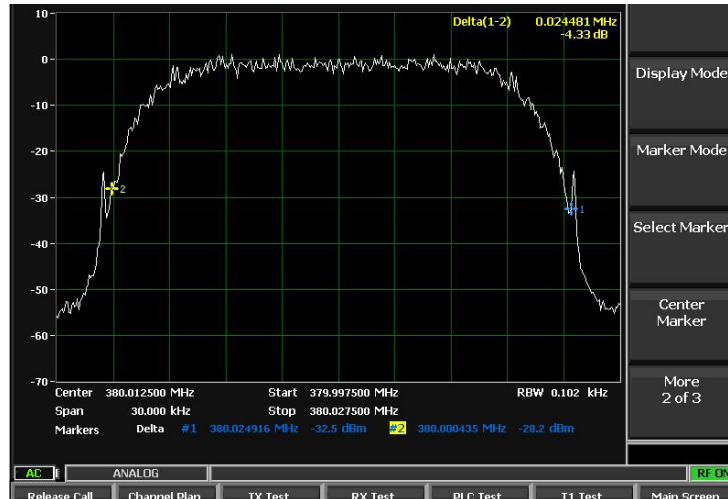
Colour coded pass/fail as in the main screen.

The White markers indicate the limit of each parameter.

Individual Limits may be adjusted by the operator

Power Class selection loads the limits for that class of radio.

# Spectrum Analyser



The Spectrum Analyser will be familiar as it is a copy on of the main Spectrum Analyser from the standard R8100. Only the functions applicable to TMO have been copied across, Page through all the menu pages to see the features included.

Start/Stop Frequency

Display Mode

-Max Hold is useful for capturing the TDMA Bursts.

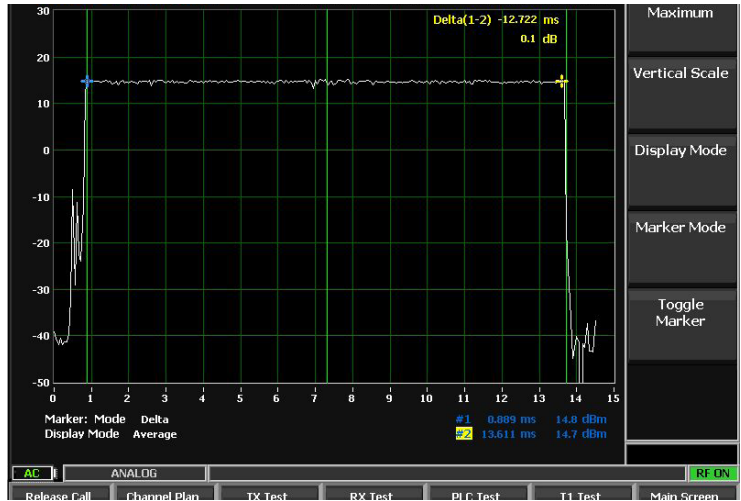
Markers

Marker Modes

-Delta Mode is useful to measure channel bandwidth

Adjustable Span

# Power Profile

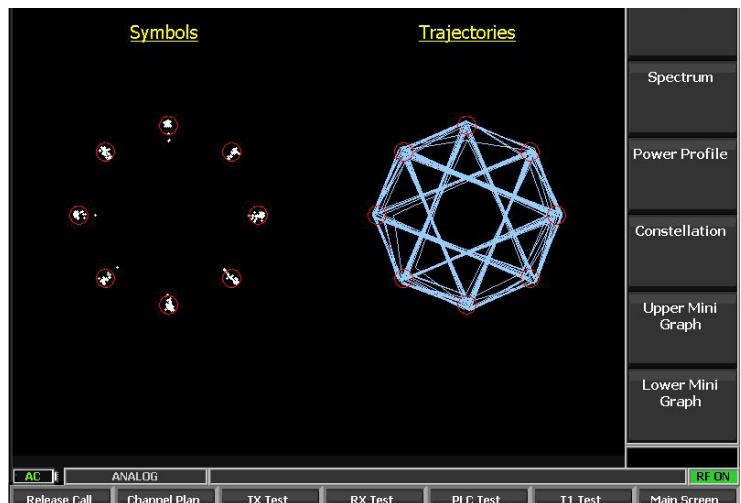


TDMA slot view  
2 Markers for timing analysis  
Markers toggle for Mkr1 or Mkr2 adjustment.

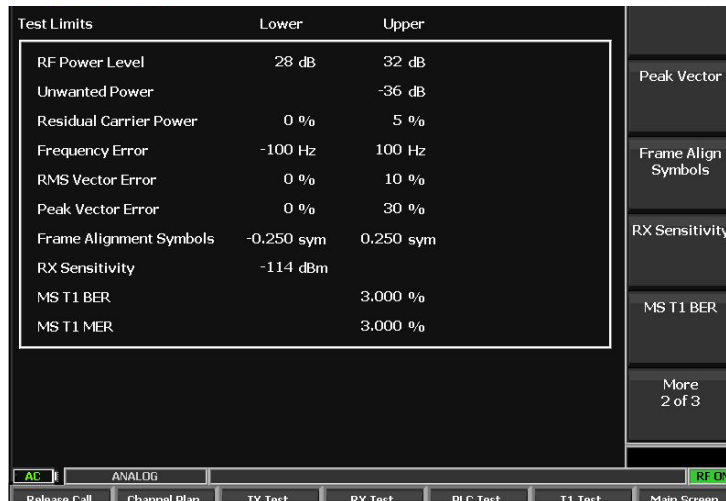
# Constellation Display

Industry standard QPSK Constellations  
Graphical representation of:

- Phase errors
- Amplitude Errors
- I/Q Imbalance



# Test Limits



Test Limits	Lower	Upper
RF Power Level	28 dB	32 dB
Unwanted Power		-36 dB
Residual Carrier Power	0 %	5 %
Frequency Error	-100 Hz	100 Hz
RMS Vector Error	0 %	10 %
Peak Vector Error	0 %	30 %
Frame Alignment Symbols	-0.250 sym	0.250 sym
RX Sensitivity	-114 dBm	
MS T1 BER		3.000 %
MS T1 MER		3.000 %

Peak Vector  
Frame Align Symbols  
RX Sensitivity  
MS T1 BER  
More 2 of 3

AC ANALOG RF ON  
Release Call Channel Plan TX Test RX Test PLP Test T1 Test Main Screen

This menu allows the operator to set his own limits for each TMO parameter being measured. These limits are mirrored in the Bar Charts display. The setting of each parameter is used to calculate pass/fail results automatically.

The default key returns all limits the ETSI standard

## Call Types

Each type of call can be made individually to and from the mobile.

Ind Duplex Simultaneous TX and RX

Ind Simplex PTT to TX.

Group PTT to TX

Phone Simultaneous TX and RX

SDS & DGNA Send and Receive short message, Assign and Unassign Dynamic Groups OTA..  
Emergency

Ambient Listening. Covert operation... Radio speaker is inhibited, Microphone is live.

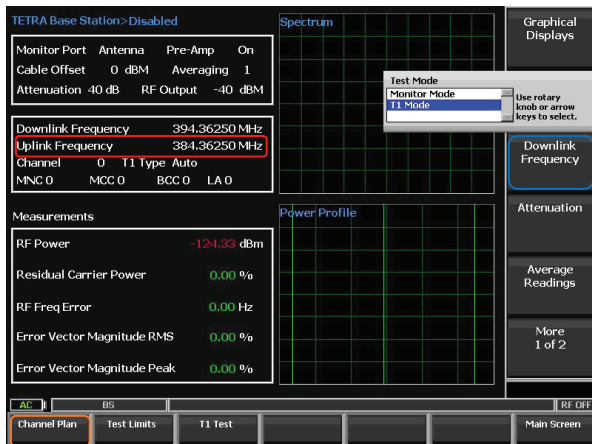
All of these can be activated or turned off by the Radio's Programming software.  
Call initiation and connections can be made by the MS Radio or the BS R8100.



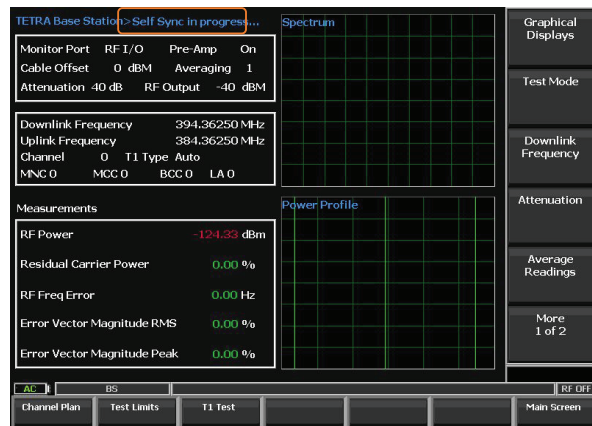
# BST T1 Mode operation

1. Connect the Base Station RF to the units RF I/O port
2. On Page 2 of 2 select "Monitor Port" and set to RF I/O
3. Depending on the BS Output Power the Attenuation may require adjustment
4. Enter the BS **Downlink Frequency**
5. Or select from the **channel plan**

Note: The Uplink channel parameters are set in the channel plan. Entry of a Frequency directly will use this plan to define the **Uplink Parameters** automatically



The unit will display : **Self Synch in Progress** and synchronise to the BS Signal

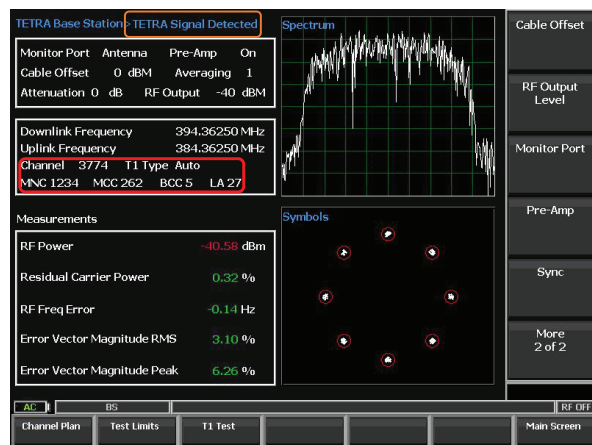


When synchronisation is achieved the **TETRA Signal Detected** will be displayed

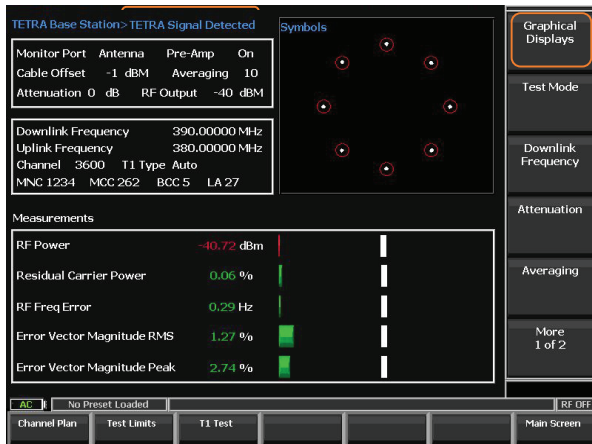
If the BS is transmitting a T1 signal this will be displayed as **TETRA T1 Detected**

**Channel, T1 Type, MNC, MCC, BCC and LA** Are decoded and displayed

All Transmitter measurements are now live in both digital and graphical displays



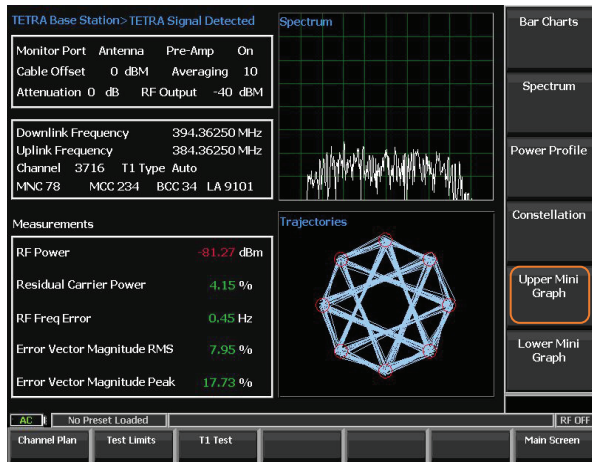
# Graphical Displays



The **Graphical Displays** key provides access to full screen displays for:

- Bar Charts
- Spectrum
- Power Profile
- Constellations

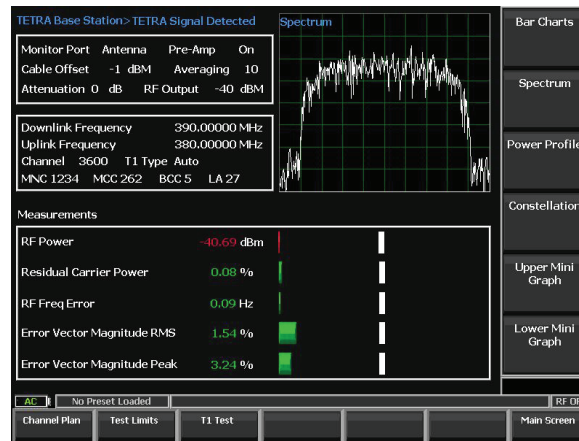
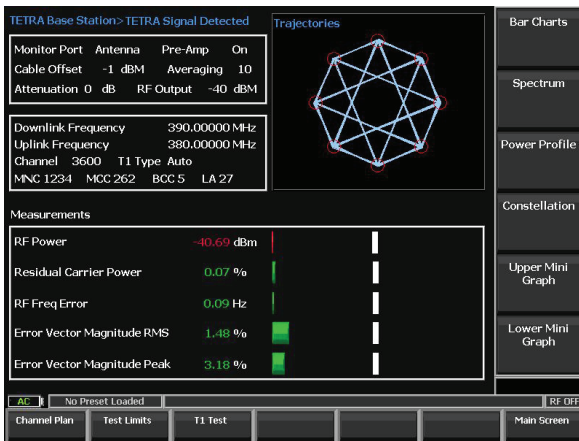
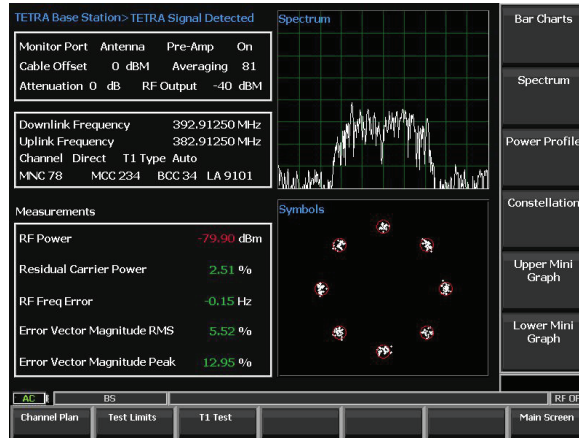
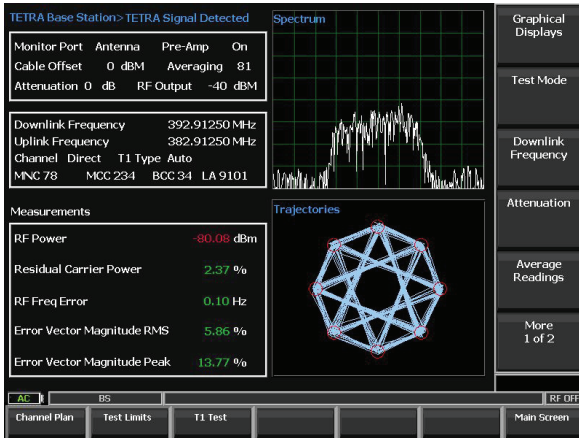
# Upper and Lower Mini Graphs



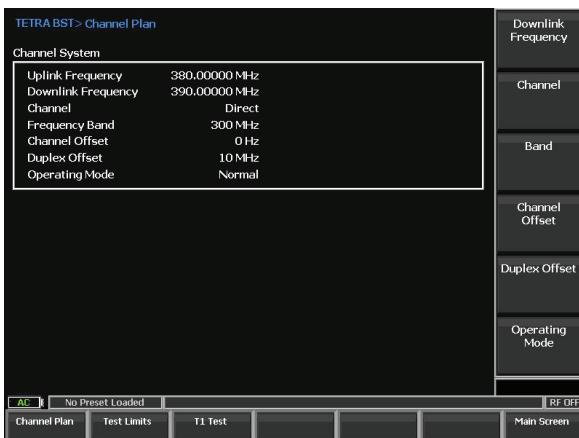
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# Upper and Lower Mini Graphs



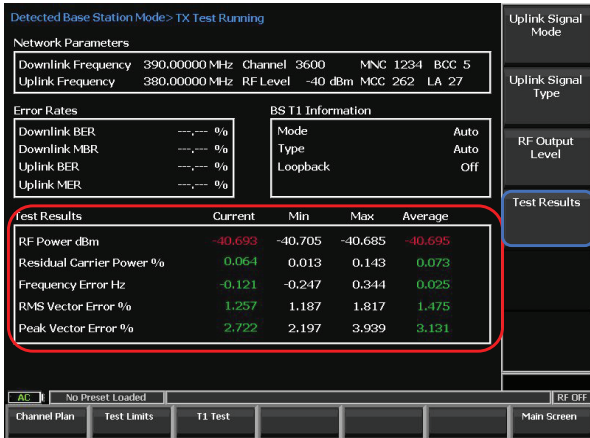
# Channel Plan Settings



# Test Limit Settings



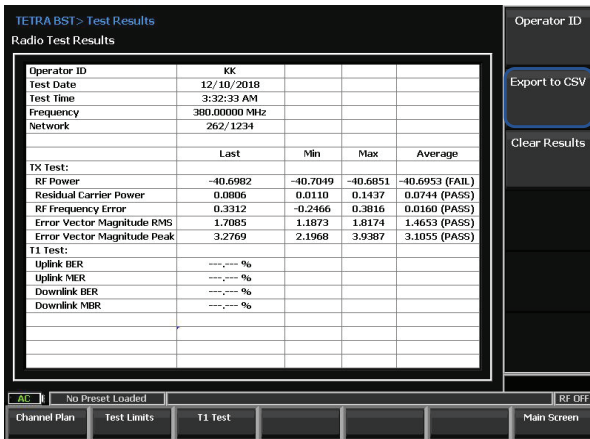
# Automatic Transmitter Test



If a valid TETRA signal is present live **Test Results** will be calculated and displayed

To save these results select: **Test Results**

# Test Results and Save to File



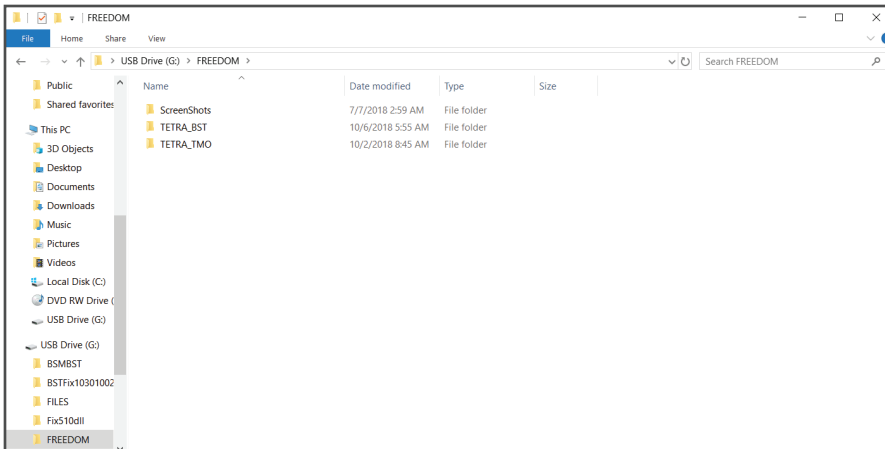
When a USB flash drive is inserted into the unit the button **Export to CSV** becomes active

A folder named "Freedom" will be Created on the drive with a sub folder named "TETRA BST" and a sub-folder named "Results"

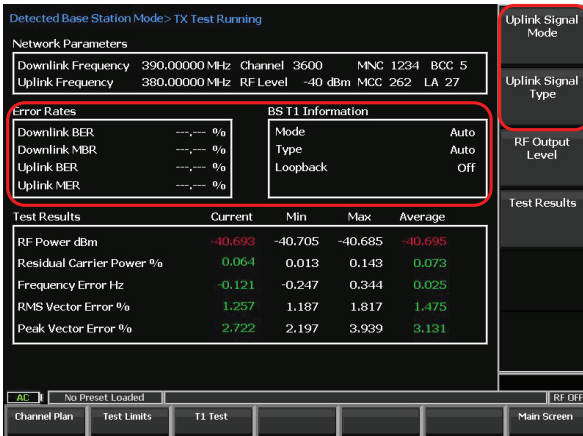
The same folder will have a sub-folder named "Screen Shots"

Full screen jpg format screen shots

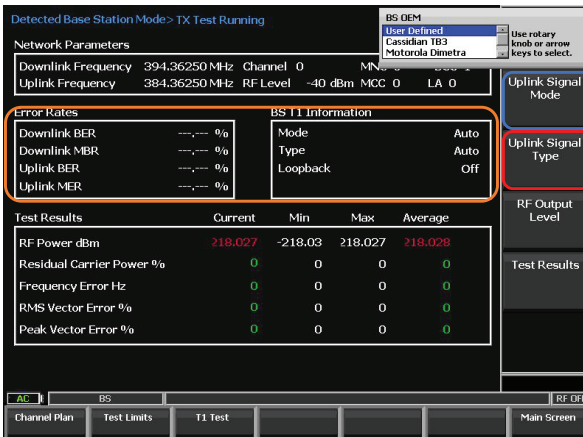
May be saved at any time by selecting Shift +0 at any time



# TETRA T1 Testing



# TETRA T1 Testing



There are two Modes of Operation:  
User Defined and Base Station Specific

In User Defined the operator may select:

## 1. Uplink Signal Type

- Auto responds to a valid T1 Downlink and sets the appropriate Uplink response

- Selectable:
  - TCH 7.2
  - SCH/F
  - STCH+STCH
  - SCH/HU+SCH+HU
  - TCH/S
  - TCH/2.4 N=1
  - TCH/4.8 N=1

## 2. Uplink Signal Mode

- Auto
- TX ON
- Transmit
- Receive
- Loopback
- Manual Transmit

Note: The user of this mode must have intimate knowledge of the BS and its T1 test procedures

MNC, MCC and BCC are set in the Channel Plan to support the above selections for valid scrambling encode/decode.

# Channel Plan Screen

TETRA BST> Channel Plan

Channel System

Uplink Frequency	384.36250 MHz
Downlink Frequency	394.36250 MHz
Channel	0
Frequency Band	
Channel Offset	0 Hz
Duplex Offset	10 MHz
Operating Mode	Normal
MCC	0
MNC	0
BCC	1

BS OEM

Downlink Frequency

Channel

Band

Channel Offset

More  
1 of 2

AC BS RF OFF

Channel Plan Test Limits T1 Test Main Screen

TETRA BST> Channel Plan

Channel System

Uplink Frequency	384.36250 MHz
Downlink Frequency	394.36250 MHz
Channel	0
Frequency Band	
Channel Offset	0 Hz
Duplex Offset	10 MHz
Operating Mode	Normal
MCC	0
MNC	0
BCC	1

Duplex Offset

Operating Mode

MCC

MNC

BCC

More  
2 of 2

AC BS RF OFF

Channel Plan Test Limits T1 Test Main Screen

# Valid T1 Signal Flow>Searching>Found>Proving>Connected Select T1 Test Key to make and see measurements

TETRA Base Station> T1 Found>Connected

Monitor Port Antenna Pre-Amp On  
Cable Offset 0 dB Averaging 1  
Attenuation 0 dB RF Output -40 dBM

Downlink Frequency 390.00000 MHz  
Uplink Frequency 380.00000 MHz  
Channel 3600 T1 Type TCH/7.2  
MNC 1234 MCC 262 BCC 5 LA 0

Measurements

RF Power	-41.38 dBm
Residual Carrier Power	0.12 %
RF Freq Error	0.09 Hz
Error Vector Magnitude RMS	1.57 %
Error Vector Magnitude Peak	3.42 %

Spectrum

Power Profile

Graphical Displays

Test Mode

Downlink Frequency

Attenuation

Average Readings

More  
1 of 2

AC BS RF ON

Channel Plan Test Limits T1 Test Main Screen

# Test Results Screen

Detected Base Station Mode> T1 Test Running

Network Parameters

Downlink Frequency	390.00000 MHz	Channel	3600	MNC	1234	BCC	5
Uplink Frequency	380.00000 MHz	RF Level	-40 dBm	MCC	262	LA	0

Error Rates

Downlink BER	0.000 %
Downlink MBR	0.000 %
Uplink BER	---
Uplink MER	---

BS T1 Information

Mode	Transmit Mode
Type	TCH/7.2
Loopback	Off

Test Results

	Current	Min	Max	Average
RF Power dBm	-41.372	-41.381	-41.372	-41.375
Residual Carrier Power %	0.298	0.025	0.324	0.131
Frequency Error Hz	0.328	-0.026	0.506	0.23
RMS Vector Error %	1.476	1.43	2.431	1.72
Peak Vector Error %	4.935	2.834	4.935	3.604

BS OEM

Uplink Signal Mode

Uplink Signal Type

RF Output Level

Test Results

AC BS RF ON

Channel Plan Test Limits T1 Test Main Screen

# T1 Measurements Display Screen Motorola MTS1 or Dimetra Selected

Detected Base Station Mode> T1 Test Running

BS OEM

Network Parameters

Downlink Frequency 390.00000 MHz Channel 3600 MNC 0 BCC 1  
 Uplink Frequency 380.00000 MHz RF Level -40 dBm MCC 0 LA 0

RF Output Level

Error Rates

Downlink BER 43.750 %  
 Downlink MBR 1.380 %  
 Uplink BER --- %  
 Uplink MBR --- %

BS T1 Information

Mode Manual Receive  
 Type TCH/7.2  
 Loopback Off

Test Results

	Current	Min	Max	Average
RF Power dbm	-41.246	-41.257	-41.235	-41.247
Residual Carrier Power %	0.088	0.007	0.382	0.122
Frequency Error Hz	0.697	-0.202	0.697	0.223
RMS Vector Error %	2.624	1.207	2.821	1.83
Peak Vector Error %	5.261	2.262	5.568	3.719

Test Results

Channel Plan Test Limits T1 Test Main Screen

RF Adjust for Uplink RX Test of BER/MER

Motorola MTS & Dimetra Pre-set Test Conditions

Downlink TX Measurements

Uplink Measurements are displayed on the OEM BS Control software screen

# TETRA T1 Testing

TETRA BST> Test Results

Operator ID

Radio Test Results

Operator ID	21/11/2018			
Test Date	8:10:28 AM			
Test Time	380.00000 MHz			
Frequency	262/1234			
Network				
	Last	Min	Max	Average
TX Test:				
RF Power	-41.3666	-41.3835	-41.3620	-41.3726 (FAIL)
Residual Carrier Power	0.0733	0.0162	0.3438	0.1171 (PASS)
RF Frequency Error	0.4773	-0.3672	0.6700	0.2553 (PASS)
Error Vector Magnitude RMS	2.5131	1.3806	2.9374	1.8802 (PASS)
Error Vector Magnitude Peak	5.0230	2.8211	6.1915	3.6779 (PASS)
T1 Test:				
Uplink BER	---	---	---	---
Uplink MER	---	---	---	---
Downlink BER	0.000 %			
Downlink MBR	0.000 %			

Operator ID

Export to CSV

Export Log Files

Clear Results

Channel Plan Test Limits T1 Test Main Screen