

## **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
- $\cdot$  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
- $\cdot$  Both options conduct full transmitter parametric measurements, either by direct connect or OTA antenna connection
- $\cdot$  The TETRA Base Station T1 Test option has additional transmitter and receiver T1 measurements for BER/MER



## Initial Power On

<b>RF</b> MONITOR	Spectrum Analyzer Vertical Scale 10 dB/div	RF Zone
RF Frequency	_Q dBm	
RX 500.000000 MHz		
	-10	
Modulation FM		AUDIO Zone
	-20	10010 2016
RX Port RF In/Out		
in an an out	-30	
Attenuation 0 dB		D7001 111
RX Bandwidth 25 kHz	-40	DISPLAY Zone
Input Lvl -63.2 dBm		Zone
	-50	
Freq Error -27 Hz	-50	
Deviation 12.97 kHz		METER Zone
	-60	
Audio		
Fixed 1kHz 0 V	-70	
Synth O V	the Alexandrian and a second second second second	
Format PL	. 80 LANDER AND	
PL Code 12 Freq 100.0 Hz	Center 500.000000 MHz Start 499.921000 MHz Detector Peak Span 158.000 kHz Stop 500.079000 MHz RBW 0.407 kHz	
A O V 10 Hz	Display Mode Normal Trace Math None	
B 0 V 2000 Hz	Marker:	
DD (5 0)	Mode Off	
DTMF 0 V 0123456789*#ABCD		
Microphone 0 V	0	
	Power Meter PWR 50W	
Sum 0.00 V	0.00 W	Squelch Opens
HPF 300 Hz LPF 3 kHz	(+/-10%)	-100.0 dBm
AC IL No Preset Loaded		RF OF

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

Use cus	e the se tom te	sting.	s menu to mana		gurations and of	ptional	Presets Test Mode AutoTune AutoScript
AC	No Pr	eset Loaded	-				RF OFF
TETRA D	MO	TETRA TMO	TETRA Base Station	DPMR	P25 II	PTC-ITCR	More 2 of 2

#### Select "Test Mode"

On Page 2 Select ("TETRA Base Station")

TETRA Base Station>Monitor Mode	Spectrum	Graphical Displays	
Monitor Port RFI/O Pre-Amp Off		Bispidys	
Cable Offset 0 dBM Averaging 10 Attenuation 40 dB	Test N Monit	or Mode	
Downlink Frequency 390.00000 MHz		kibb or arrow keys to select.	
		Downlink Frequency	Select Select
			Select
Measurements	Power Profile	Attenuation	
RF Power -27.84 dBm			
Residual Carrier Power 0.00 %		Averaging	
RF Freq Error 0.00 Hz			
Error Vector Magnitude RMS 0.00 %		More 1 of 2	
Error Vector Magnitude Peak 0.00 %			
AC It No Preset Loaded		RF OFF	
Test Limits TX Test		Main Screen	ĺ

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

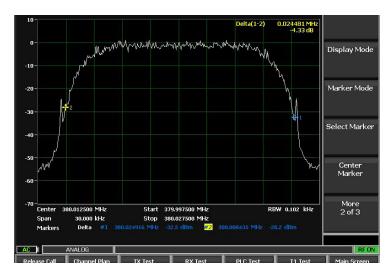
Display> Bar Charts			Average Readings
Ξ Ι	RF Power	14.71 dBm	
	Unwanted output power	-39.7 dBm	Limits Default
	Residual carrier power	0.79 %	Power Class
	RF Freq Error	-12.8 Hz	Unwanted Power
	Error vector magnitude RMS	5.87 %	Residual Carrier Power
	Error vector magnitude Peak	21.28 %	More
	Frame Alignment	0.12 symbols	1 of 2
			REON
Release Call Channel Plan	TX Test RX Test PLC Test	T1 Test	Main Screen

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**

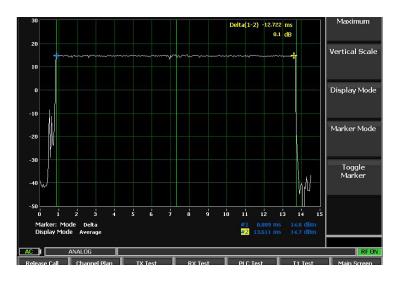


The Spectrum Analyser will be familiar as it is a copy on of the main Spectrum Analyser from the standard R8100. Only the functions applicable to TMO have been copied across, Page through all the menu pages to see the features included.

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**



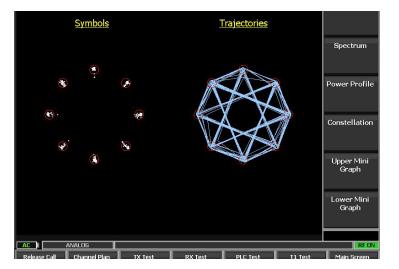
TDMA slot view 2 Markers for timing analysis Markers toggle for Mkr1 or Mkr2 adjustment.

#### **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		Peak Vector
Unwanted Power		-36 dB		Реак vector
Residual Carrier Power	0%	5 %		
Frequency Error	-100 Hz	100 Hz		Frame Align
RMS Vector Error	0 %	10 %		Symbols
Peak Vector Error	0%	30 %		
Frame Alignment Symbols	-0.250 sym	0.250 sym		RX Sensitivity
RX Sensitivity	-114 dBm			
MS T1 BER		3.000 %		MS T1 BER
MS T1 MER		3.000 %		
				More 2 of 3
				REON
Release Call Channel Plan	TX Test	RX Test PLC 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**

FETRA Base Station>Disabled	Spectrum	Graphical Displays
Monitor Port Antenna Pre-Amp On		
Cable Offset 0 dBM Averaging 1 Attenuation 40 dB RF Output -40 dBM	Test Mode Monitor Mode T1 Mode	Use rotary knob or arrow
Downlink Frequency 394.36250 MHz		keys to select.
Uplink Frequency 384.36250 MHz		Downlink
Channel 0 T1 Type Auto MNC 0 MCC 0 BCC 0 LA 0		Frequency
Measurements	Power Profile	Attenuation
RF Power -124.33 dBm		
Residual Carrier Power 0.00 %		Average Readings
RF Freq Error 0.00 Hz	الصراحين المراجع والع	
Error Vector Magnitude RMS 0.00 %		More 1 of 2
Error Vector Magnitude Peak 0.00 %		
AC t BS		RFO
Channel Plan Test Limits T1 Test		Main Screen

- 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

TETRA base station > sell sync in progress	spectrum	Displays
Monitor Port RFI/O Pre-Amp On		Dispidito
Cable Offset 0 dBM Averaging 1 Attenuation 40 dB RF Output -40 dBM		Test Mode
Downlink Frequency         394.36250 MHz           Uplink Frequency         384.36250 MHz           Channel         0         T1 Type Auto           MNC 0         MCC 0         BCC 0         LA 0		Downlink Frequency
Measurements	Power Profile	Attenuation
RF Power -124.33 dBm		
Residual Carrier Power 0.00 %		Average Readings
RF Freq Error 0.00 Hz	. کار تصدر است است سر اس ک	
Error Vector Magnitude RMS 0.00 %		More 1 of 2
Error Vector Magnitude Peak 0.00 %		
AC IL BS		RF OFF
Channel Plan Test Limits T1 Test		Main Screen

Monitor Port Antenna Pre-Amp On Cable Offset 0 dBM Averaging 1 Attenuation 0 dB RF Output -40 dBM	And the second	RF Output Level
Downlink Frequency         394.36250 MHz           Uplink Frequency         384.36250 MHz           Channel         3774         T1 Type           MNC 1234         MCC 262         BCC 5         LA 27		Monitor Port
Measurements	Symbols	Pre-Amp
RF Power -40.58 dBm	<ul> <li>•</li> <li>•</li> <li>•</li> </ul>	
Residual Carrier Power 0.32 %		Sync
RF Freq Error -0.14 Hz	۲	
Error Vector Magnitude RMS 3.10 %	• •	More 2 of 2
	۲	
Error Vector Magnitude Peak 6.26 %		

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
- $\cdot$  Constellations

# **Upper and Lower Mini Graphs**

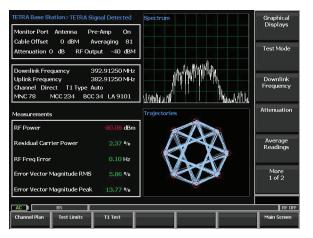
TETRA Base Station > TETRA Signal Detected	Spectrum	Bar Charts
Monitor Port Antenna Pre-Amp On		
Cable Offset 0 dBM Averaging 10 Attenuation 0 dB RF Output -40 dBM		Spectrum
Downlink Frequency 394.36250 MHz		Power Profile
Uplink Frequency         384.36250 MHz           Channel         3716         T1 Type           MNC 78         MCC 234         BCC 34         LA 9101		Power Profile
Measurements	Trajectories	Constellation
RF Power -81.27 dBm		
Residual Carrier Power 4.15 %		Upper Mini Graph
RF Freq Error 0.45 Hz	AAI	$\begin{tabular}{ c c } \hline \end{tabular}$
Error Vector Magnitude RMS 7.95 %		Lower Mini Graph
Error Vector Magnitude Peak 17.73 %		
AC I No Preset Loaded		RF OFF
Channel Plan Test Limits T1 Test		Main Screen

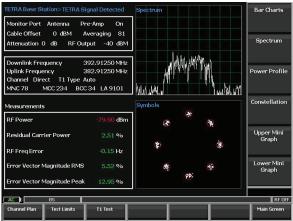
The Graphical Displays key provides access to full screen displays for:

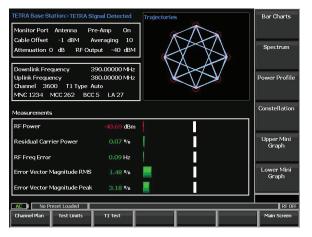
- Bar Charts
- · Spectrum
- · Power Profile
- $\cdot$  Constellations

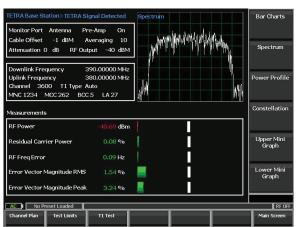


# Upper and Lower Mini Graphs

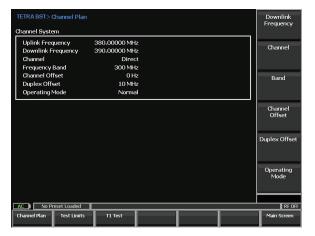








# **Channel Plan Settings**



# **Test Limit Settings**

TRA TMO> Test Limits			Limits Defau
est Limits	Lower	Upper	
RF Power Level	43 dB	45 dB	
Residual Carrier Power	0 %	5 %	RF Power Lower Limi
Frequency Error	-100 Hz	100 Hz	
RMS Vector Error	0 %	10 %	RF Power
Peak Vector Error		30 %	Upper Limi
Uplink BER		3.000 %	
Uplink MER		3.000 %	Residual Carrier Pow
Downlink BER		3.000 %	Carrier Pow
Downlink MBR		3.000 %	
			Frequency Error
			More
			1 of 3
C E No Preset Loaded			RF
AL R NO Preset Loaded			 RF



#### **Automatic Transmitter Test**

	90.00000 MHz Chai 80.00000 MHz RFL			1234 BCC 262 LA 2	7 Uplink Sig
Error Rates		BS T1 Info	mation		Туре
Downlink BER	, %	Mode		,	Auto
Downlink MBR	%	Туре		1	Auto RF Outpi Level
Uplink BER	, %	Loopback			Off
Uplink MER	, %				
fest Results	Current	Min	Мах	Average	Test Resu
RF Power dBm		-40.705	-40.685		
Residual Carrier Power	<b>%</b> 0.064	0.013	0.143		
Frequency Error Hz	-0.121	-0.247	0.344		
RMS Vector Error %		1.187	1.817		
Peak Vector Error %		2.197	3.939	3.131	

Test Results and Save to File

Operator ID	KK				
Test Date	12/10/2018				Export to C
Test Time	3:32:33 AM				
Frequency	380.00000 MHz				
Network	262/1234				
	Last	Min	Max	Average	Clear Resu
TX Test:					
RF Power	-40.6982	-40.7049	-40.6851	-40.6953 (FAIL)	
Residual Carrier Power	0.0806	0.0110	0.1437	0.0744 (PASS)	
RF Frequency Error	0.3312	-0.2466	0.3816	0.0160 (PASS)	
Error Vector Magnitude RMS	1.7085	1.1873	1.8174	1.4653 (PASS)	
Error Vector Magnitude Peak	3.2769	2.1968	3.9387	3.1055 (PASS)	
T1 Test:					
Uplink BER	%				
Uplink MER	%				
Downlink BER	96				
Downlink MBR	, %				

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

To save these results select: Test Results

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

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File Home Share	View							~
$\leftarrow \rightarrow \neg \uparrow \blacksquare \rightarrow u$	SB Drive (G:) > FREEDOM >				~ Ŭ	Search FREEDOM		٩
Public ^	Name	Date modified	Туре	Size				
Shared favorites	ScreenShots	7/7/2018 2:59 AM	File folder					
interview and the second secon	TETRA_BST	10/6/2018 5:55 AM	File folder					
📙 3D Objects	TETRA_TMO	10/2/2018 8:45 AM	File folder					
늘 Desktop								
Documents								
🔈 Downloads								
🚺 Music								
hictures								
Videos								
💺 Local Disk (C:)								
DVD RW Drive (								
🥪 USB Drive (G:)								
USB Drive (G:)								
BSMBST								
BSTFix10301002								
FILES								
Fix510dll								
FREEDOM								



# **TETRA T1 Testing**

	000 MHz Chai 000 MHz RFL			1234 BCC 262 LA 2	25	Uplink Sign Type
rror Rates		BS T1 Infor	mation			туре
Downlink BER	%	Mode		,	luto	DE O UNI
Downlink MBR	%	Туре		1	\uto	RF Output
Uplink BER	%	Loopback			Off	
Uplink MER	-, %					
est Results	Current	Min	Max	Average		Test Resul
RF Power dBm		-40.705	-40.685			
Residual Carrier Power %		0.013	0.143			
Frequency Error Hz		-0.247	0.344			
RMS Vector Error %		1.187	1.817			
Peak Vector Error %		2.197	3,939			
					Ļ	

# **TETRA T1 Testing**

Downlink Frequency 394 Uplink Frequency 384	.36250 MHz C .36250 MHz R		MN 40 dBm MCC	0 000 x	Uplink Signa Mode
rror Rates		BS T1 1	nformation		
Downlink BER Downlink MBR Uplink BER Uplink MER	, % , % , %	Mode Type Loopb	ack	Aut Aut Of	o Uplink Signa Type
Test Results	Curren	t Min	Мах	Average	RF Output Level
RF Power dBm		7 -218.0	03 218.027		
Residual Carrier Power %			0 0		Test Result
Frequency Error Hz			0 0		
RMS Vector Error %			0 0		
Peak Vector Error %		0	0 0	0	

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	BS OEM	TETRA BST> Channel Plan	Duplex Offset
Channel System	_	Channel System	
Uplink Frequency 384.36250 MHz Downlink Frequency 394.36250 MHz Channel 0 Frequency Band	Downlink Frequency	Uplink Frequency 384.36250 NHz Downlink Frequency 394.36250 MHz Channel 0 Frequency Band	Operating Mode
Channel Offset 0 Hz Duplex Offset 10 MHz Operating Mode Normal	Channel	Channel Offset 0 Hz Duplex Offset 10 MHz Operating Mode Normal	MCC
MCC         0           NNC         0           BCC         1	Band	MCC 0 NNC 0 BCC 1	MNC
	Channel Offset		BCC
	More 1 of 2		More 2 of 2
	RF OFF		RF OFF
Channel Plan Test Limits T1 Test	Main Screen	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 dBm Averaging 1	Spectrum	Graphical Displays
Attenuation 0 dB RF Output -40 dBM		Test Mode
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		Downlink Frequency
Measurements	Power Profile	Attenuation
Residual Carrier Power 0.12 %		Average Readings
RF Freq Error     0.09 Hz       Error Vector Magnitude RMS     1.57 %		More 1 of 2
Error Vector Magnitude Peak 3,42 %		
AC It BS Channel Plan Test Limits T1 Test		Main Screen

# **Test Results Screen**

	90.00000 MHz Cha 80.00000 MHz RF L			1234 BCC 262 LA 0	Uplink Sign
Fror Rates		BS T1 Infor	mation		
Downlink BER Downlink MBR Uplink BER Uplink MER	0.000 % 0.000 % , %	Mode Type Loopback		Transmit M TCH/	Unlink Sign
est Results	Current	Min	Мах	Average	RF Output Level
RF Power dBm	-41.372	-41.381	-41.372	-41.375	
Residual Carrier Power	% 0.298	0.025	0.324		Test Result
Frequency Error Hz		-0.026	0.506		
RMS Vector Error %		1.43	2.431		
Peak Vector Error %		2.834	4.935		



## T1 Measurements Display Screen Motorola MTS1 or Dimetra Selected

	0.00000 MHz Cha 0.00000 MHz RF L		MNC IBm MCC		RF Output
rror Rates		BS T1 Infor	mation		
Downlink BER Downlink MBR Uplink BER	43.750 % 1.380 %	Mode Type Loopback	I	Manual Receive TCH/7.2 Off	Test Results
Uplink MER	, %				
est Results	Current	Min	Мах	Average	
RF Power dBm		-41.257	-41.235	-41.247	
Residual Carrier Power 9	⁄o 0.088	0.007	0.382		
Frequency Error Hz		-0.202	0.697		
RMS Vector Error %		1.207	2.821		
Peak Vector Error %	5.261	2.262	5.568	3.719	

# **TETRA T1 Testing**

ETRA BST> Test Results Radio Test Results					Operator ID
Operator ID					
Test Date	21/11/2018	-			Export to CSV
Test Time	8:10:28 AM				
Frequency	380.00000 MHz	-			
Network	262/1234	-			
		-			E
	Last	Min	Max	Average	Export Log Files
TX Test:					rites
RE 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)	Clear Result
Error Vector Magnitude RMS	2.5131	1.3006	2.9374	1.8002 (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 %				
AC IL BS					REG
4	1			1	-
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



9