



3900 Series Digital Radio Test Set

DMR Option Manual

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3900 Series

Digital Radio Test Set

DMR Option Manual

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Preface

Scope

This manual contains operational descriptions of the features contained in the 3900 Series DMR Test System Option. Refer to the 3900 Series Operation Manual for information regarding general Test Set operation.

Nomenclature Statement

The 3901, 3902 and 3920 Digital Radio Test Set is the official nomenclature for the test sets currently included in the 3900 Digital Radio Test Set Series. In this manual, 3900, unit or Test Set, refers to the 3901, 3902 and 3920 Digital Radio Test Sets unless otherwise indicated.

Intended Audience

This manual is intended for personnel familiar with the use of the 3900. Refer to the 3900 Series Operation Manual for information pertaining to Test Set operation.

Test Set Requirements

Refer to the 3900 Series Operation Manual for information on the following:

- Safety Precautions
- Power Requirements
- Platform Performance Data Specifications
- Repacking / Shipping Test Set

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Chapter 1

General Description

DMR Option Overview

The 3900 Digital Mobile Radio (DMR) Test System (390XOPT400) is an optional test system developed by Aeroflex to support the testing of digital two-way radio systems. DMR has been developed according to technical specifications outlined in ETSI TS 102 361-1, V1.4.1.

The 3900 DMR Test System Option provides the user with the following capabilities:

- Ability to lock/unlock paired generator and receiver frequencies;
- Ability to receive, demodulate and analyze DMR modulated signals;
- Ability to perform RF and modulation parametric tests on the Unit Under Test (UUT).
- Distribution, Constellation and Eye Diagram graph plots;
- Variety of UUT measurements including Bit Error Rate, Signal Power, Slot Power, Frequency Error, Symbol Clock Error, Symbol Deviation and Modulation Fidelity;
- Power Profile Over Time, Profile Full and Profile Ramps Display Tiles;
- Spectrum Analyzer, Channel Analyzer and Oscilloscope available within the DMR Test System.

Installing DMR Option

Refer to the section titled [Install New License \(Option\) File](#) in Chapter 4 of the 3900 Series Operation Manual for option installation procedure.

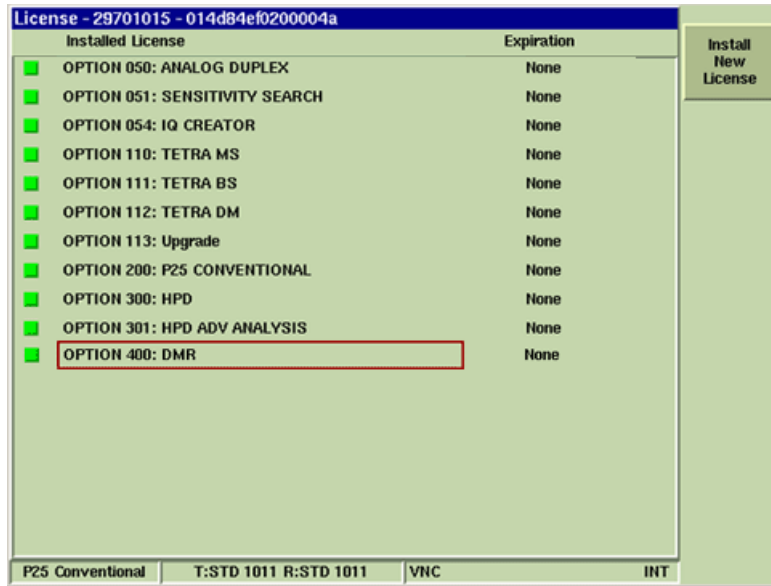
DMR Option Status

Verifying DMR Option Installation

To check the status of installed options when operating in Test Mode:

1. Push the [UTILS Key](#) twice to access the Utils floating menu.
2. Select Software Settings, License from the floating menu.

The License Tile displays a list of installed options, including the version and version date of each option (refer to Fig. 1-1). DMR is 390XOPT400. The option list varies according to the features installed on the Test Set. “Try before you buy” options have an expiration date.



Installed License	Expiration	Install New License
OPTION 050: ANALOG DUPLEX	None	
OPTION 051: SENSITIVITY SEARCH	None	
OPTION 054: IQ CREATOR	None	
OPTION 110: TETRA MS	None	
OPTION 111: TETRA BS	None	
OPTION 112: TETRA DM	None	
OPTION 113: Upgrade	None	
OPTION 200: P25 CONVENTIONAL	None	
OPTION 300: HPD	None	
OPTION 301: HPD ADV ANALYSIS	None	
OPTION 400: DMR	None	

P25 Conventional | T:STD 1011 R:STD 1011 | VNC | INT

Fig. 1-1 3900 License Tile

Chapter 2

DMR System Operation

Introduction

This chapter describes DMR Tile layout and provides an operational description of DMR System Tile components.

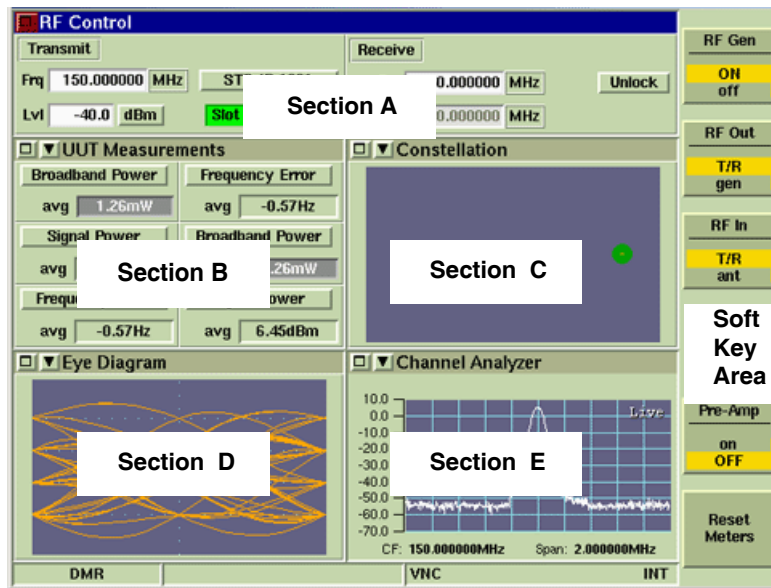


Fig. 2-1 DMR Display Layout

DMR System Tile Layout

The DMR Display Tiles can be configured according to test requirements. Each section of the display is configured using the drop-down menu on the title bar of each tile.

- Section A of the DMR User Screen always displays the RF Control Tile when the Tiles are minimized.
- DMR Test functions are selected from the drop-down menu located on the Tile menus on Sections B through E.
- DMR includes access to the Channel Analyzer, Spectrum Analyzer and Oscilloscope. Use of the Channel Analyzer, Spectrum Analyzer and Oscilloscope are described in the 3900 Series Operation Manual.

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RF Control Tile

The RF Control Tile configures the Test Set for testing the physical layer of DMR radio systems. RF Control Tile fields must be configured according to the operating parameters of the Unit Under Test (UUT) to obtain valid test data.

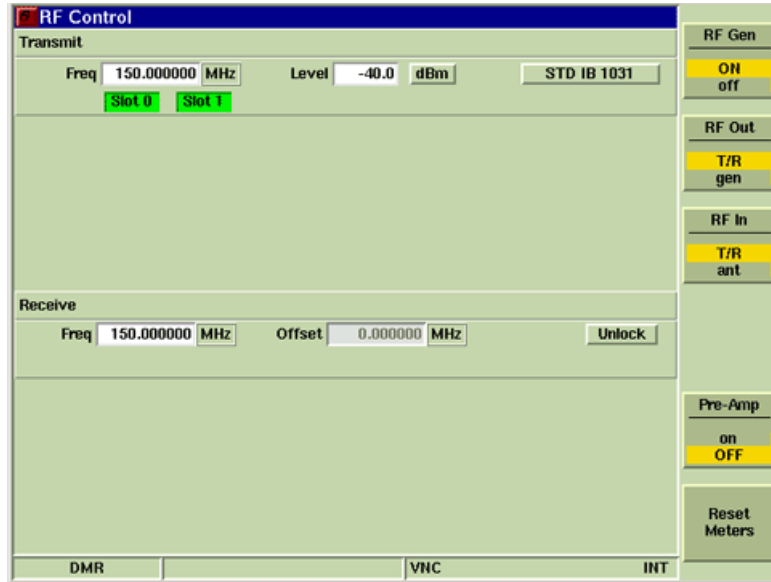


Fig. 2-2 DMR RF Control Tile

Transmit Field Definitions

Frq (Frequency)

The Transmit Frequency defines carrier frequency of the DMR signal being generated by the Test Set and is used to determine proper receiver operation. When used in conjunction with the Level, it is also used to determine UUT sensitivity by selecting the STD IB 1031 pattern.

Level

Level defines the output power of the 3900 DMR transmit signal from either the T/R or the GEN Connector. This is typically used to determine UUT receiver sensitivity using the STD IB 1031 pattern.

Units (Level)

The units drop-down menu selects the output power level unit of measure.

Pattern

The Pattern drop-down menu selects the type of pattern the Test Set sends to the UUT. The 1031 pattern is typically used in conjunction with the UUT to determine the BER of the radio at a particular level. Other patterns are used to verify proper operation of the radio receiver.

Slot 0 / Slot 1

The Slot 0 and Slot 1 buttons enable transmit functionality on each slot. The buttons must be enabled to obtain valid measurement data. Slot 0 and Slot 1 are currently linked and both are enabled when either is selected.

Receive Field Definitions

Frq (Frequency)

This field defines the receiver frequency. For accurate readings, this frequency should be set to the UUT transmit frequency.

Offset

When set to LOCK, changing the Receive or Transmit Frequency offsets the other frequency by the value specified in the Offset field. For example, setting the Receiver frequency to 150 MHz, with an offset of 2.5 MHz, results in the Transmit frequency updating to 152.5 MHz. Or, if the Transmit frequency is set to 150.0 MHz, with an Offset of 2.5 MHz, the Receive frequency updates to 147.5 MHz.

When set to UNLOCK, a value can be entered independently for either the Transmit Frequency or the Receiver Frequency.

Lock / Unlock

Locks / Unlocks frequency offset in relation to the Transmit and Receive frequencies.

Soft Key Definitions

RF Gen Soft Key

Selects and indicates the On/Off state of the RF Generator output from the Test Set. When the generator is disabled, an RF OFF indicator is shown on the Tile.

RF Out Soft Key

The RF Out Soft Key controls the RF Output signal routing. Select either the GEN (Generator) Connector or T/R Connector as RF Output port.

RF In Soft Key

The RF In Soft Key controls the RF Input signal routing. Select either the T/R Connector or ANT (Antenna) Connector as the RF Input port.

Pre-Amp Soft Key

The 3900 is equipped with an internal 15 dB broadband amplifier that affects the T/R Connector and ANT (Antenna) Connector. When Pre-Amp is turned ON, the 3900 has a typical noise figure of -9 dB leading to a noise floor level of approximately -140 dBm in the Spectrum Analyzer (RBW = 300 Hz) and approximately -126 dBm for the Inband Power Meter (IF = 6.25 kHz). Using the Pre-Amp feature increases the sensitivity of the 3900.

NOTE

When Pre-Amp is used, special attention is required; it is a broadband amplifier and could lead to saturation or compression problems in the receiver chain if the signal of interest is very low, but a strong out of band signal is present.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

UUT Measurements Limits Configuration Tile

The UUT Measurement Configuration Tile allows the user to define limits for UUT Measurements meter readings.

UUT Measurements Limits			
Broadband Power	Units: W	Upper Limit: 100 uW	Disabled
	Averages: 1	Lower Limit: 100 uW	Disabled
Frequency Error		Upper Limit: 0.00 Hz	Disabled
	Averages: 2	Lower Limit: 0.00 Hz	Disabled
Mod Fidelity		Upper Limit: 0.00 %	Disabled
	Averages: 2	Lower Limit: 0.00 %	Disabled
Signal Power	Units: dBm	Upper Limit: 0.00 dBm	Disabled
	Averages: 2	Lower Limit: 0.00 dBm	Disabled
Slot0 Power	Units: dBm	Upper Limit: 0.00 dBm	Disabled
	Averages: 2	Lower Limit: 0.00 dBm	Disabled
Slot1 Power	Units: dBm	Upper Limit: 0.00 dBm	Disabled
	Averages: 2	Lower Limit: 0.00 dBm	Disabled
DMR		INT	

Fig. 2-3 UUT Measurements Limits Configuration Tile

Field/Soft Key Definitions

Disabled/Enabled

The Enable/Disable Toggle button turns defined limits on and off. Default values are applied if values are not defined by user.

Upper Limit

The UPPER LIMIT function sets a maximum acceptable reading for a specific measurement. When a measured level exceeds the enabled UPPER LIMIT, the Meter Bar and reading background on the Measurement Tiles turns RED.

When readings within enabled Upper and Lower limits the Meter Bar and reading background on the Measurement Tiles turns GREEN.

Lower Limit

When a measured level drops below the enabled LOWER LIMIT, the Meter Bar and reading background of the Measurement Tiles turns BLUE.

When readings within enabled Upper and Lower limits the Meter Bar and reading background on the Measurement Tiles turns GREEN.

Units

Selects the unit of measurement for applicable measurement.

Averages

Specifies the number of bursts over which data is averaged for each measurement. Values can be set independently for each meter. If the Averages field is set to 50, the Test Set averages data over 50 samples.

Set All Averages To Soft Key

Specifies the number of bursts over which data is averaged for all measurements. Values can also be set independently for each meter.

Subject to Export Control, see Cover Page for details.

Offsets Configuration Tile

The Offsets Configuration Tile allows users to define Generator (Tx) and Receiver (Rx) Level offsets.

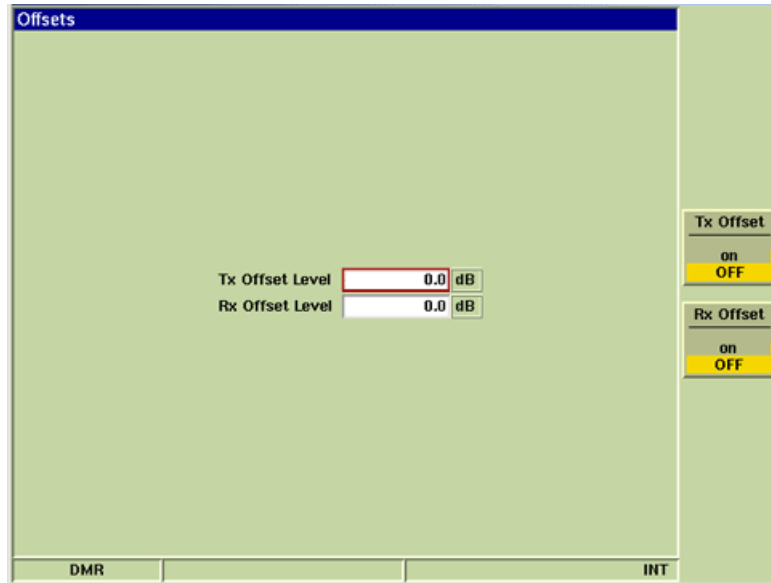


Fig. 2-4 Offsets Configuration Tile

Field/Soft Key Definition

Tx Offset Level

Defines RF Generator Level Offset value.

Rx Offset Level

Defines Receiver Level Offset value.

TX Offset / Rx Offset Soft Keys

Enables / Disables defined Tx and Rx offset values.

UUT Measurements Tile

The UUT Measurement Configuration Tile allows the user to define limits for UUT Measurements meter readings.

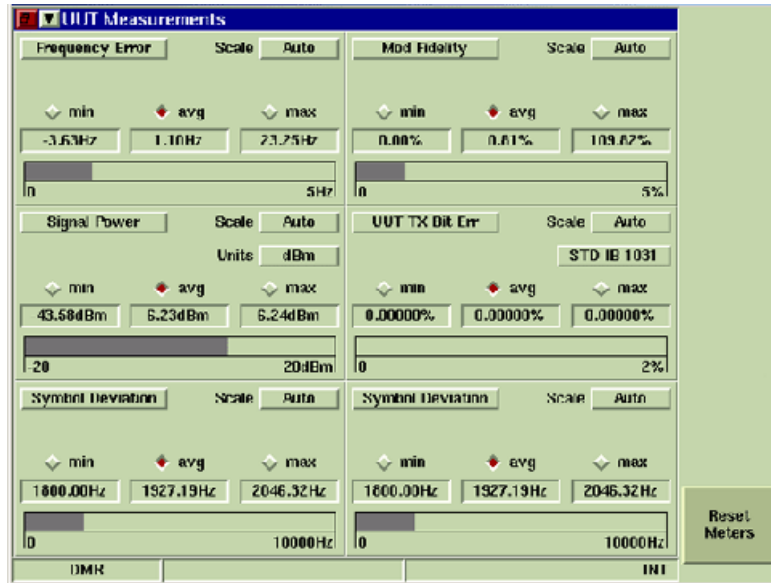


Fig. 2-5 UUT Measurements Tile

Field/Soft Key Definitions

min/avg/max Reading Indicators

These radio buttons select the reading displayed on the bar graphs and the reading displayed when the UUT Measurements Display Tile is minimized.

Selecting min displays the lowest recorded reading.

Selecting avg displays the average of all recorded readings over the period of defined bursts (default setting).

Selecting max displays the highest recorded reading.

Bar Graph

The METER BAR is a single, linear indicator that provides a visual measurement reading based on a user defined scale. Upper and lower limit indicators are set on the UUT Measurement Configuration Tile.

Refer to the section titled [UUT Measurements Limits Configuration Tile](#) for information on Upper and Lower Limits.

Scale

Defines the display of the METER BAR. User selection is made from a drop-down box offering the choice of Auto (default value) or a fixed value.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Measurement Meters

The drop-down menu on each section of the UUT Measurements Tile selects the type of meter to be displayed in that section.

Broadband Power

The Broadband Power Meter measures input power levels at the T/R Connector over a range of 100 mW to 125 W. The Broadband Power Meter is frequency independent which allows the user to measure and align transmitter power settings without adjusting the 3900's receiver frequency to match the transmitter frequency.

Frequency Error

The Frequency Error Meter measures the frequency error of the incoming RF carrier signal. Frequency Error is calculated as the difference between the frequency of the received signal and the receive frequency defined on the RF Control Tile.

Mod Fidelity

The Mod Fidelity Meter measures rms deviation error at the symbol deviation points of the signal. Modulation Fidelity is measured over one 30 ms slot and is expressed as the percentage of the deviation.

Outbound traffic (signal generated by BR) contains 144 symbols; inbound traffic (signal generated by mobile) contains 132 symbols. Mod Fidelity should not exceed 5%.

Signal Power

The Signal Power Meter is a tuned power meter that indicates the amount of RF Energy that is contained within the 3900's selected receiver bandwidth (i.e., 12.5 kHz). The Signal Power Meter is tuned to a specific frequency, giving the ability to selectively measure the power of one channel when other channels are present.

Signal Power can be measured at the T/R or ANT Connector. The T/R Connector provides measurements from -60 to +51 dBm. The ANT Connector provides the ability to measure levels from -100 to +10 dBm.

Drop-down menu selects unit of measurement as dBm or Watts. When Watts is selected and the reading falls below 100 mW, the meter background turns GRAY, indicating the reading may be inaccurate. If this occurs, switch the unit of measurement to dBm to obtain an accurate reading.

Slot0 / Slot1 Power

The Slot Power Meters indicate measurements for Slot 0 and Slot 1 of the DMR signal.

Symbol Clock Error

The Symbol Clock Error Meter measures the symbol clock of the incoming DMR signal over one 30 ms slot. Outbound traffic (signal generated by BR) contains 144 symbols; inbound traffic (signal generated by mobile) contains 132 symbols.

Symbol Clock Error measurements should not exceed ± 48 mHz.

Symbol Deviation

The Symbol Deviation Meter measures the deviation of the DMR signal at symbol time, normalized to the 1944 Hz symbol point. Symbol Deviation is measured over one 30 ms slot.

Outbound traffic (signal generated by BR) contains 144 symbols; inbound traffic (signal generated by mobile) contains 132 symbols. Symbol deviation measurements should be >1750 and <2138 .

UUT Tx Bit Error

The UUT Tx BER Meter compares incoming DMR symbol data to a standard pattern to determine errors in signal processing.

Constellation Tile

The Constellation tile is used to determine proper operation of the transmitter. The four points represent the four deviation states (DIBIT Symbols) of the DMR FSK modulation shown below. The green plot fields indicate the expected location of plot clusters.

Information Bits	Symbol	4FSK Deviation
01	+3	+1.944 kHz
00	+1	+0.648 kHz
10	-1	-0.648 kHz
11	-3	-1.944 kHz

DIBIT Symbol Mapping to 4FSK Deviation

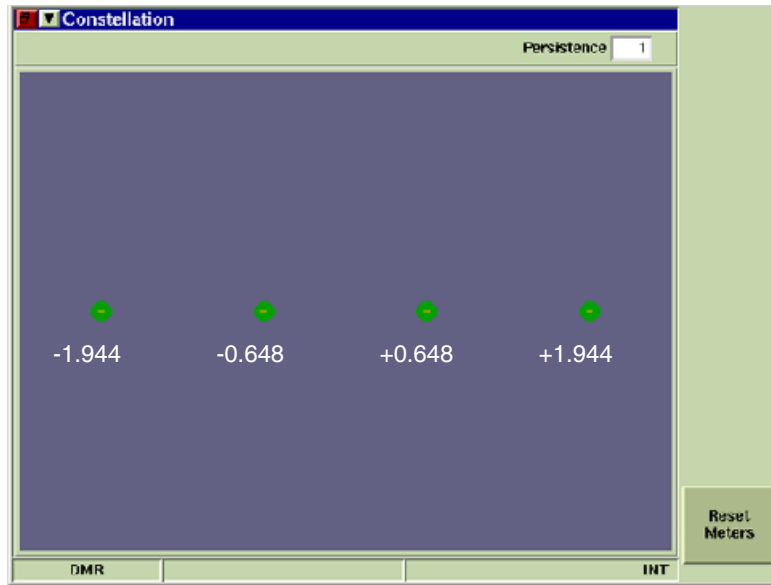


Fig. 2-6 Constellation Tile

Field/Soft Key Definitions

Persistence

Specifies how many trace plots are shown simultaneously on the display field. Selectable range is 1 to 10. Selecting 1 means that only one burst or time slot is displayed on the display field. Selecting 10 means the last 10 bursts or time slots are displayed simultaneously on the display field.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Eye Diagram Tile

The Eye Diagram is used to plot the demodulated signal from one slot of the DMR signal. The plot shows the demodulated signal periods from that slot which allows the user to observe the deviation accuracy of the demodulated signal at the symbol points. The point at which symbol deviation is measured is referenced to the symbol clock to determine the deviation of the waveform at the symbol time.

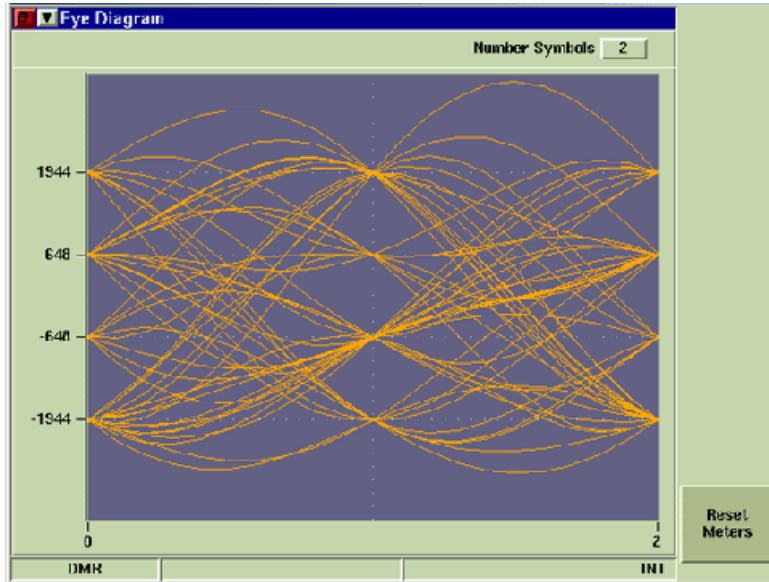


Fig. 2-7 Eye Diagram Tile - Maximized View - 2 Symbols

Field/Soft Key Definitions

Number Symbols

Defines the horizontal scale of the display field. Lowering the number or symbols shows more detail of the signal pattern.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Distribution Tile

The Distribution Tile shows the relative number of symbols in relation to each other. The plot shows the four deviation points and the level of symbols accumulated over 38 slots. For example, a higher level on the +1 or 648 Hz deviation point would indicate that more “00” information bits were received compared to the other deviation points.

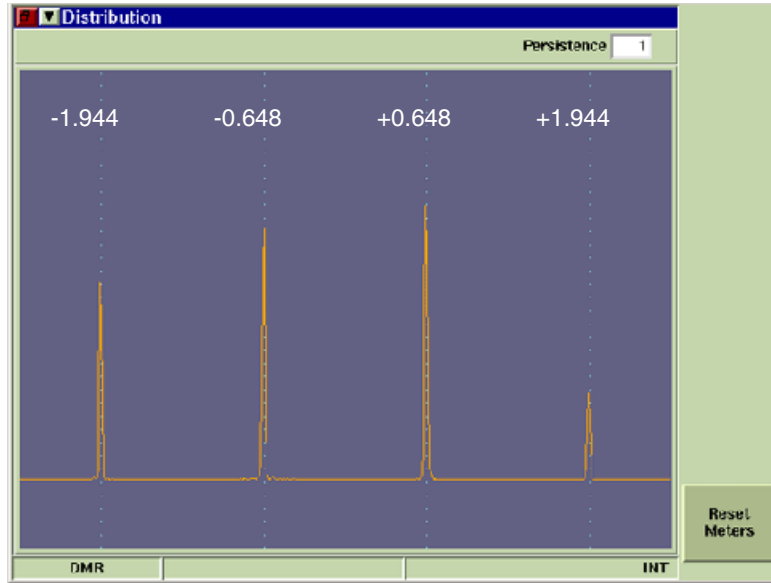


Fig. 2-8 Distribution Tile - Maximized View

Field/Soft Key Definitions

Persistence

Specifies how many trace plots are shown simultaneously on the display field. Selectable range is 1 to 10. Selecting 1 means that only one burst or time slot is displayed on the display field. Selecting 10 means the last 10 bursts or time slots are displayed simultaneously on the display field.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Power Over Time Tile

The Power Over Time Tile displays the power measurement of the received signal over a specified period of time. This measurement provides an indication of the transmitter's stability.

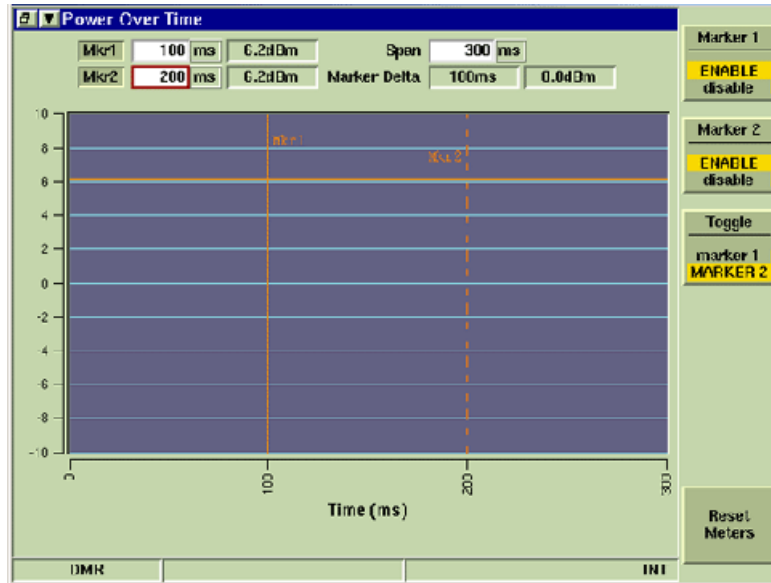


Fig. 2-9 Power Over Time Tile

Field/Soft Key Definitions

Mkr1 / Mkr2

The Mkr1 and Mkr2 toggle buttons enable Marker 1 and Marker 2. Markers must be enabled to edit the Marker position fields. Status and functionality of these toggle buttons is linked to the Marker 1 and Marker 2 Soft Keys.

Marker Position

The data field beside the Mkr1 and Mkr2 toggle buttons allows the user to enter a value to specify Marker position on the graph field. A marker must be enabled before this field can be edited.

Power Measurement

The data fields beside each marker position field indicate the power reading at the signal point.

Marker Delta

When both markers are defined and enabled the Delta field indicates the difference between the position and power measurement at each point on the signal.

Span

Span sets the length of time (horizontal scale) over which the power measurement is displayed. Maximum Span setting is 24,000 ms.

Marker 1/Marker 2 Soft Key

The Marker 1 and Marker 2 Soft Keys enables or disables markers displayed on the graph field. Markers can also be enabled using the Mkr1 and Mkr2 toggle buttons. The Marker 1 and Marker 2 Soft Key status is linked to the Mkr1 and Mkr2 toggle buttons.

Toggle Marker Soft Key

The Toggle Marker Soft Key focuses on an enabled marker. The Toggle Marker Soft Key also controls the marker readings displayed at the top of a minimized tile. Each press of this Soft Key changes the source of the measurements through Mkr1, Mkr2 and Delta readouts.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Power Profile Full

The Power Profile Full Tile displays the complete profile of the signal's power reading over a period of time.

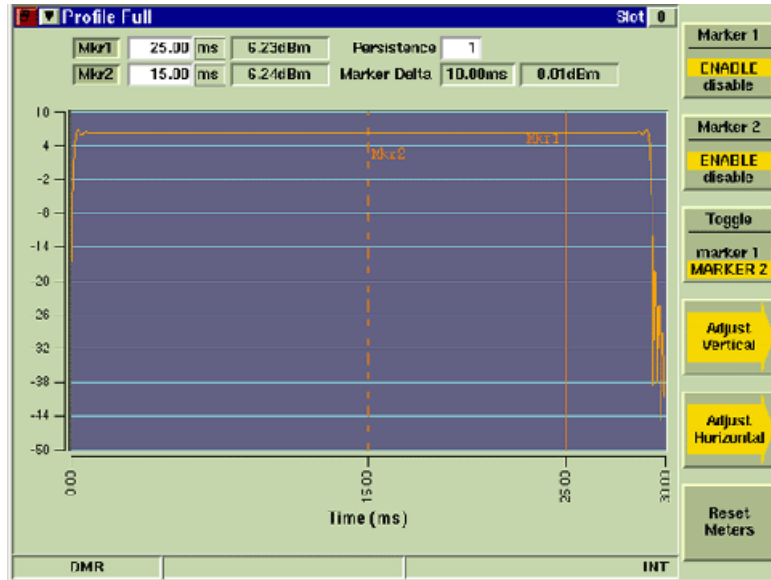


Fig. 2-10 Power Profile Full - Maximized View

Field/Soft Key Definitions

Mkr1 / Mkr2

The Mkr1 and Mkr2 toggle buttons enable Marker 1 and Marker 2. Markers must be enabled to edit the Marker position fields. Status and functionality of these toggle buttons is linked to the Marker 1 and Marker 2 Soft Keys.

Horizontal Position

The data field beside the Mkr1 and Mkr2 toggle buttons allows the user to enter a value to specify Marker position on the graph field. A marker must be enabled before this field can be edited.

Power Reading

The field to the right of the Horizontal Position field indicates the Power reading at the marker's position.

Marker Delta

When both markers are defined and enabled the Delta field indicates the difference between the position and power measurement at each point on the signal.

Persistence

Specifies how many trace plots are shown simultaneously on the display field. Selectable range is 1 to 10. Selecting 1 means that only one burst or time slot is displayed on the display field. Selecting 10 means the last 10 bursts or time slots are displayed simultaneously on the display field.

Slot

The Slot drop-down menu selects the Slot (0 or 1) for which data is being displayed on the plot and measurement fields.

Subject to Export Control, see Cover Page for details.

Marker 1/Marker 2 Soft Key

The Marker 1 and Marker 2 Soft Keys enables or disables markers displayed on the graph field. Markers can also be enabled using the Mkr1 and Mkr2 toggle buttons. The Marker 1 and Marker 2 Soft Key status is linked to the Mkr1 and Mkr2 toggle buttons.

Toggle Marker Soft Key

The Toggle Marker Soft Key focuses on an enabled marker. The Toggle Marker Soft Key also controls the marker readings displayed at the top of a minimized tile. Each press of this Soft Key changes the source of the measurements through Mkr1, Mkr2 and Delta readouts.

Adjust Vertical Soft Key

The Adjust Vertical soft key opens a soft key sub-menu. The sub-menu soft keys adjust the position of the Vertical Scale and appearance of the signal on the graph. Scale is adjusted in increments of 10 dBm.

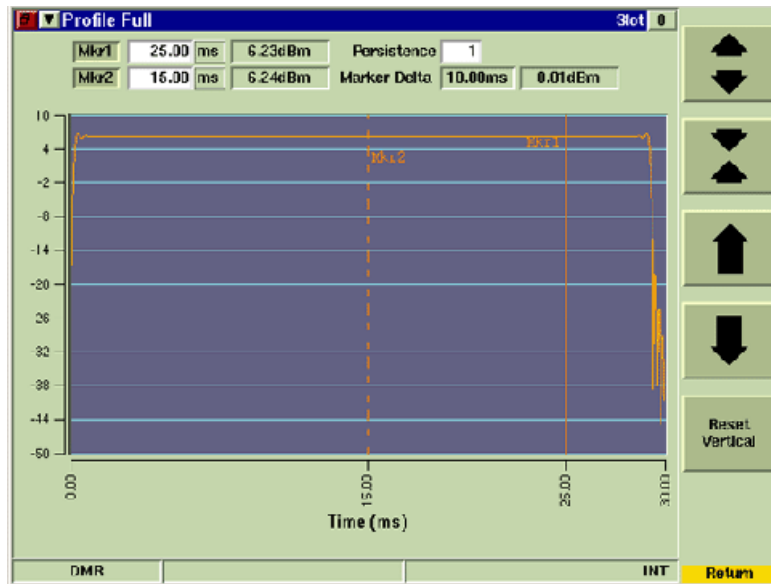


Fig. 2-11 Power Profile Full - Adjust Vertical Soft Key Sub-menu

Reset Vertical Soft Key

Resets all vertical values to default values and centers trace pattern vertically on the graph field. This soft key is accessed by pressing the Adjust Vertical Soft Key.

Adjust Horizontal Soft Key

Adjust Horizontal soft key opens a soft key sub-menu that allows users to adjust the position and range of the graph's horizontal scale. This feature can be used to focus on specific time spans of the slot, such as the first 2 ms (msec) or the last 5 ms (msec).

The largest range setting for Outbound and Inbound Reserved signal is 0 to 30 ms. The largest range setting for Inbound Random signals is 0 to 10 ms. The smallest range setting is 2 ms.

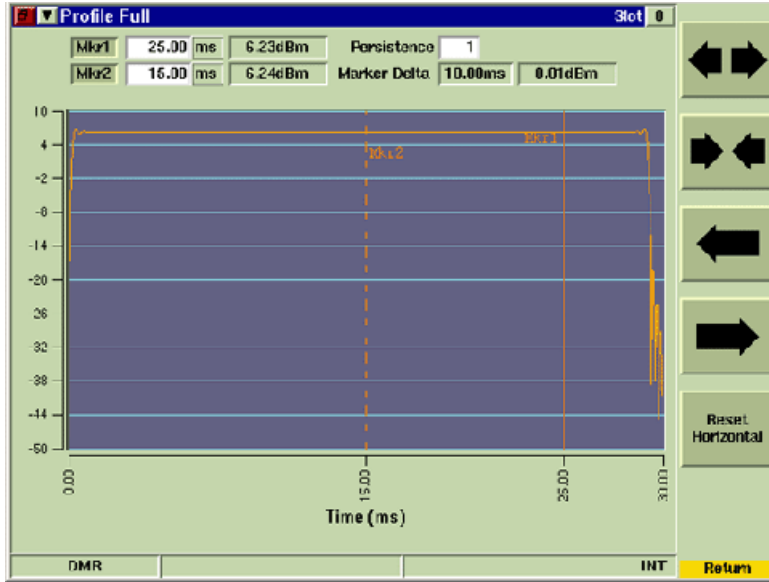


Fig. 2-12 Power Profile Full Adjust Horizontal Soft Key Sub-menu

Reset Horizontal Soft Key

Resets the horizontal scale to default settings. This soft key is accessed by pressing the Adjust Horizontal Soft Key.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

Power Profile Ramps

The Profile Ramps Tile displays the ramp profile of the signal's power reading over one slot. The left side of the field provides a detailed view of the first 2 ms (msec) of the slot. The right side of the field provides a detailed view of the last 2 ms (msec) of the slot.

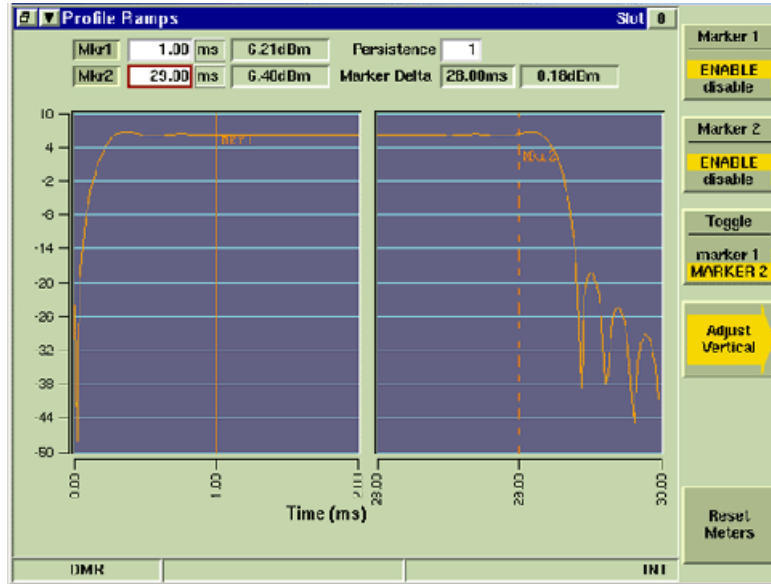


Fig. 2-13 Power Profile Ramps

Field/Soft Key Definitions

Mkr1 / Mkr2

The Mkr1 and Mkr2 toggle buttons enable Marker 1 and Marker 2. Markers must be enabled to edit the Marker position fields. Status and functionality of these toggle buttons is linked to the Marker 1 and Marker 2 Soft Keys.

Horizontal Position

The data field beside the Mkr1 and Mkr2 toggle buttons allows the user to enter a value to specify Marker position on the graph field. A marker must be enabled before this field can be edited.

Power Reading

The field to the right of the Horizontal Position field indicates the Power reading at the marker's position.

Marker Delta

When both markers are defined and enabled the Delta field indicates the difference between the position and power measurement at each point on the signal.

Persistence

Specifies how many trace plots are shown simultaneously on the display field. Selectable range is 1 to 10. Selecting 1 means that only one burst or time slot is displayed on the display field. Selecting 10 means the last 10 bursts or time slots are displayed simultaneously on the display field.

Slot

The Slot drop-down menu selects the Slot (0 or 1) for which data is being displayed on the plot and measurement fields.

Subject to Export Control, see Cover Page for details.

Marker 1/Marker 2 Soft Key

The Marker 1 and Marker 2 Soft Keys enables or disables markers displayed on the graph field. Markers can also be enabled using the Mkr1 and Mkr2 toggle buttons. The Marker 1 and Marker 2 Soft Key status is linked to the Mkr1 and Mkr2 toggle buttons.

Toggle Marker Soft Key

The Toggle Marker Soft Key focuses on an enabled marker. The Toggle Marker Soft Key also controls the marker readings displayed at the top of a minimized tile. Each press of this Soft Key changes the source of the measurements through Mkr1, Mkr2 and Delta readouts.

Adjust Vertical Soft Key

The Adjust Vertical soft key opens a soft key sub-menu. The sub-menu soft keys adjust the position of the Vertical Scale and appearance of the signal on the graph. Scale is adjusted in increments of 10 dBm.

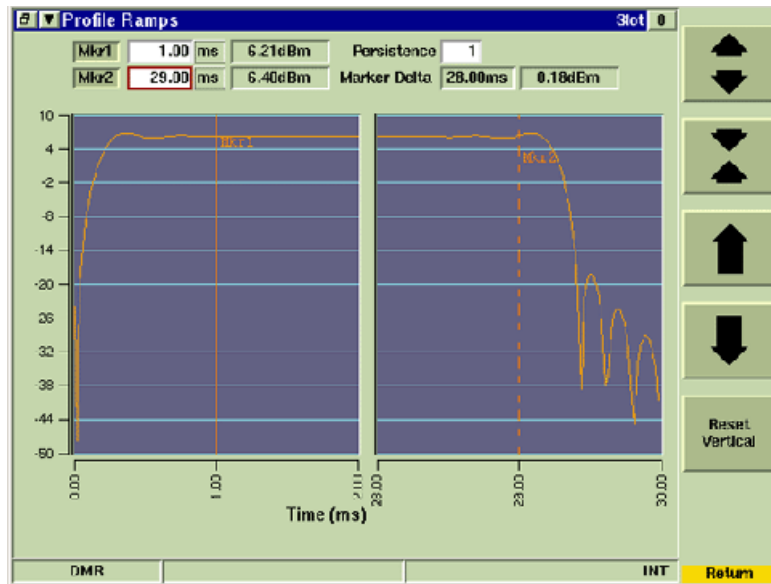


Fig. 2-14 Power Profile Ramps - Adjust Vertical Soft Keys Sub-menu

Reset Vertical Soft Key

Resets all vertical values to default values and centers trace pattern vertically on the graph field. This soft key is accessed by pressing the Adjust Vertical Soft Key.

Reset Meters Soft Key

The Reset Meters Soft Key clears and resets the meter readings.

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Appendix A

DMR Terms and Abbreviations

avg	Average reading
Bit Err	Bit Error Rate
CONFIG	Configuration
dB	decibel
dBm	decibel relative to 1 mW
dBV	decibel relative to 1 Volt
dBW	decibel relative to 1 Watt
DMR	Digital Mobile Radio
frq / freq	Frequency
GEN	Generate/Generator
GHz	Giga Hertz
Hz	Hertz
kHz	kilo Hertz
Lvl	Level
max	Maximum reading
MHz	Mega Hertz
min	Minimum reading
Mkr	Marker
Mod	Modulation
ms / msec	Millisecond
mW	milli-Watt
RF	Radio Frequency
Rx	Receive
TOS	Top of Scale
Tx	Transmit
UTILS	Utilities
UUT	Unit Under Test
VNC	Virtual Network Client / Virtual Network Computing
W	Watt

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	Toll Free: 800 835 2352	

The logo for AEROFLEX features a stylized 'A' with a blue triangle at its base, followed by the word 'AEROFLEX' in a bold, black, sans-serif font. The logo is set against a white background with a blue swoosh underneath.

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven, customer-focused.