User Manual

Tektronix

RSA3408B Option 29
WLAN 802.11a/b/g/n Analysis Software

071-2405-00

This document supports firmware version 4.0 and above.

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Preface

This manual provides operating instructions for the RSA3408B Real-Time Spectrum Analyzer Option 29 WLAN 802.11a/b/g/n Analysis Software.

This manual supports the following instrument:

- RSA3408B Option 29

About This Manual

This manual is composed of the following sections:

- *Getting Started* provides overviews of the product and its functions.
- *Operating Basics* provides information needed for routine operation.
- *Reference* describes the measurement procedure, setup menu, and view format specific to Option 29 in detail.
- *Appendices* provides additional information, including the scale setting range and save file format.

The analyzer uses Microsoft Windows XP as the operating system. This manual does not describe common usage of Windows XP. Refer to your Windows manuals as necessary.

Related Manuals

The following related documents are also available:

- *RSA3408B User Manual*
  (Standard accessory; Tektronix part number 071-2364-XX)
  Describes how to install the analyzer and how to work with the menus, and details the standard functions. Also shows the specifications.
- *RSA3000B Series Programmer Manual*
  (Standard accessory; PDF, Tektronix part number 071-2382-XX)
  Contains an alphabetical listing of the programming commands and other information related to controlling the analyzer over the GPIB interface.

PDF Manual

The *RSA3000B Series Programmer Manual* (PDF only) is included in the Documents CD (Tektronix part number 063-4089-XX).

Getting Started

Getting Started

The RSA3408B Option 29 is the WLAN 802.11a/b/g/n analysis software that performs signal measurements for high-speed wireless LAN transmitters in 5 GHz and 2.4 GHz bands complying with the IEEE802.11 a, b, g, and n standards. Table 1-1 summarizes the IEEE802.11 standards.

Table 1-1: IEEE802.11 standards

WLAN standard	Frequency band	Modulation method		Tx rate (max)
IEEE802.11a	5 GHz	OFDM	BPSK, QPSK, 16QAM	54Mbps
IEEE802.11b	2.4 GHz	DSSS	DBPSK, DQPSK, CCK	11Mbps
IEEE802.11g	2.4 GHz	OFDM-CCK	DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM	54Mbps
		PBCC	DBPSK, DQPSK, CCK, PBCC	33Mbps
		OFDM	BPSK, QPSK, 16QAM	54Mbps
IEEE802.11n	2.4 GHz / 5 GHz	OFDM	BPSK, QPSK, 16QAM, 64QAM	>100Mbps

1. **This software is compliant with Draft 11n as of December 2006.**

Figure 1-1 shows a typical display example of WLAN analysis.

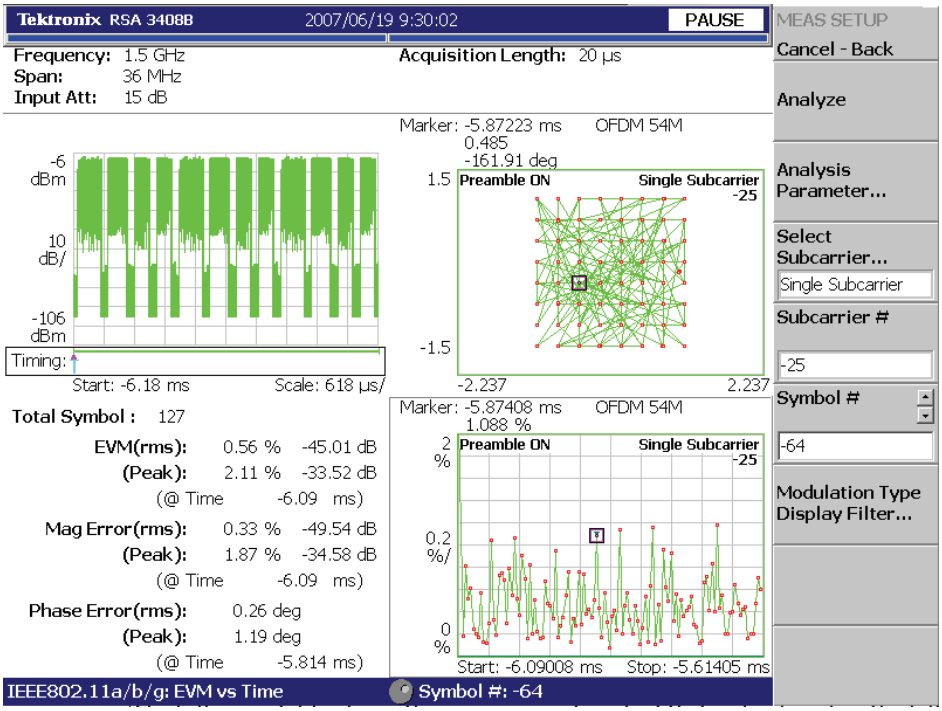


Figure 1-1: WLAN analysis display

Measurement Items

Table 1-2 shows all the measurement and display items available in Option 29 WLAN analysis software and the supported standards. The measurement items are classified into Modulation measurement and Power measurement.

Table 1-2: Option 29 WLAN measurement items

Measure menu item	Measurement contents [1]	802.11a	802.11b	802.11g	802.11n (nx1)	802.11n (MIMO)
Modulation measurement						
Transfer Function (Amplitude and Phase)	-				✓	✓
Delay Profile	-				✓	✓
Transfer Efficiency versus Time	-					✓
EVM versus Time	EVM	✓	✓	✓	✓	✓
	Mag Err	✓	✓	✓	✓	✓
	Phase Err	✓	✓	✓	✓	✓
Power versus Time	-	✓	✓	✓	✓	✓
Constellation	-	✓	✓	✓	✓	✓
Transfer Efficiency versus SC	-					✓
EVM versus SC	EVM	✓	✓	✓	✓	✓
	Mag Err	✓	✓	✓	✓	✓
	Phase Err	✓	✓	✓	✓	✓
Power versus SC	-	✓	✓	✓	✓	✓
SC Constellation	-	✓	✓	✓	✓	✓
Frequency Error	-	✓	✓	✓	✓	✓
OFDM Flatness	-	✓		✓	✓	
OFDM Linearity	-	✓		✓	✓	
Symbol Table	-	✓	✓	✓	✓	✓
Power measurement						
Spectrum Mask	-	✓		✓	✓	
Transmit Power	-		✓	✓		

Abbreviation. Err: Error; Mag: Magnitude; SC: Subcarrier. Refer to *Glossary* for acronyms.

1. **Selectable in the View Scale menu.**

NOTE. *For the 802.11n standard, this software is compliant with Draft 11n as of December 2006.*

Signal Format in IEEE802.11n Analysis

IEEE802.11n analysis consists of 802.11n (nx1) and MIMO (2x2) analyses, supporting three signal formats as shown in Figure 1-2.

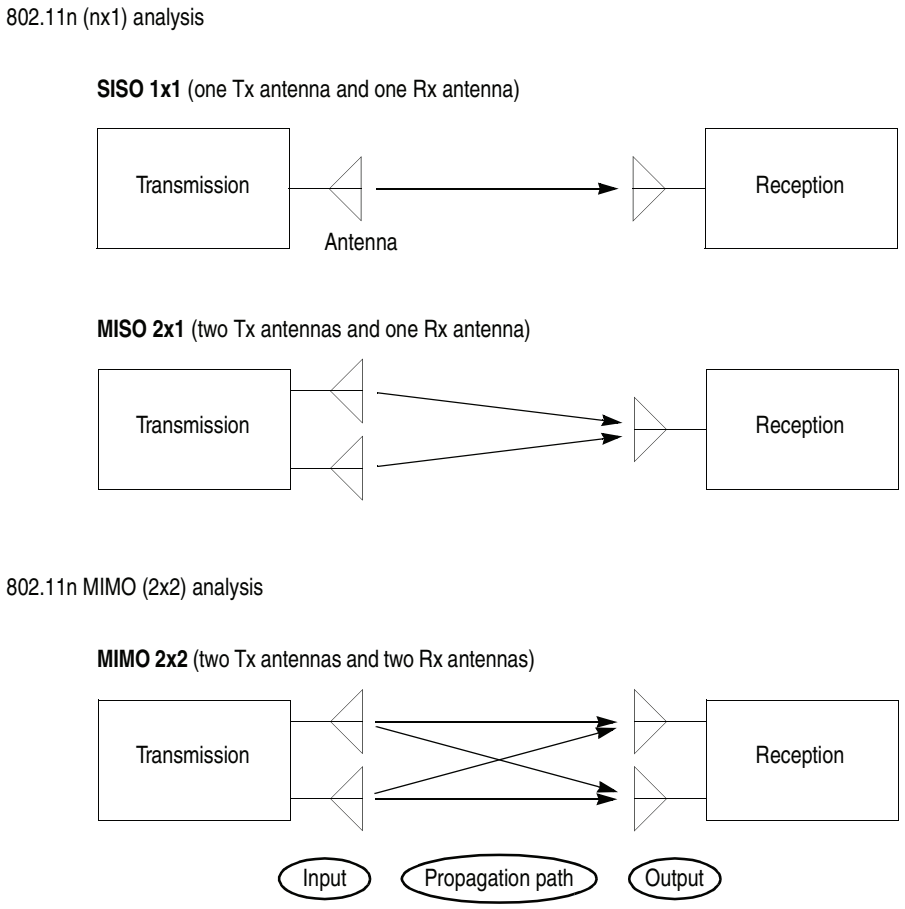


Figure 1-2: Signal format in IEEE802.11n analysis

MIMO (Multi-Input Multi-Output) uses more than one antennas for both transmitting and receiving to transfer data at the same time. Radio signals input from the transmitter go through multiple propagation paths and output to the receiver. Multiple antennas send and receive different data streams simultaneously over multiple paths as independent channels, resulting in a higher transmission rate along with the number of antennas. Special, degenerated cases of MIMO are *MISO* (Multi-Input Single-Output) when the receive antenna is single, and *SISO* (Single-Input Single-Output) when both transmit and receive antennas are traditionally single. The Option 29 WLAN analysis software supports three signal formats: SISO 1x1, MISO 2x1, and MIMO 2x2.

Analyzable Signals

In IEEE802.11n analysis, the analyzable signals vary between the 1x1, 2x1, and 2x2 measurement modes.

NOTE. *This software supports only the Direct mapping as the spatial mapping method for MIMO signals. The analyzer cannot properly demodulate signals of the Spatial expansion and Beam forming.*

1x1. The 11n SISO signals including 802.11b/g (DSSS, CCK, PBCC) can be analyzed. In this mode, the sync timing is calculated accurately using STF (Short Training Field) to analyze the OFDM preamble part. It is effective for the measurements with the analyzer connected directly to the transmitter. But in such a multi-path environment as the transfer function flatness degrades, the analyzer may not synchronize properly.

2x1. The 11n SISO signals excluding 802.11b/g, STBC (Nss=1, Nsts=2) signals, and MIMO signals of Direct Mapping (Nss=2, Nsts=2) can be analyzed.

For MIMO signals, the data part can be analyzed with the analyzer inputting only one-channel transmit signal directly. When inputting a two-channel mixed signal, the data part cannot be demodulated properly, but the transfer function and delay profile can be calculated.

In the 2x1 mode, the sync timing is not calculated accurately to analyze the OFDM preamble part for processing multi-channel mixed signals. So the measurement result, such as EVM of STF (Short Training Field) and LTF (Long Training Field) may degrade.

2x2. The 11n SISO signals excluding 802.11b/g, STBC (Nss=1, Nsts=2) signals, and MIMO signals of Direct Mapping (Nss=2, Nsts=2) can be analyzed.

Table 1-3 summarizes the analyzable signals for each measurement mode.

Table 1-3: Analyzable signals with the 802.11n measurement modes

Signal	1x1	2x1	2x2
11b/g (DSSS, CCK, PBCC)	✓		
11n (OFDM) SISO	✓	✓	✓
STBC (2x1)		✓	✓
Direct Mapping (2x2)		✓[1]	✓

[1] **Only for one-channel direct connection, or the transfer function and delay profile displays.**

Accessing the Measurements

The Option 29 WLAN measurement functions are contained in the Demod mode as shown in Figure 1-3. The analysis is categorized into three groups: IEEE 802.11a/b/g, 802.11n (nx1, Multi-Input Single-Output), and 802.11n MIMO (Multi-Input Multi-Output, 2x2).

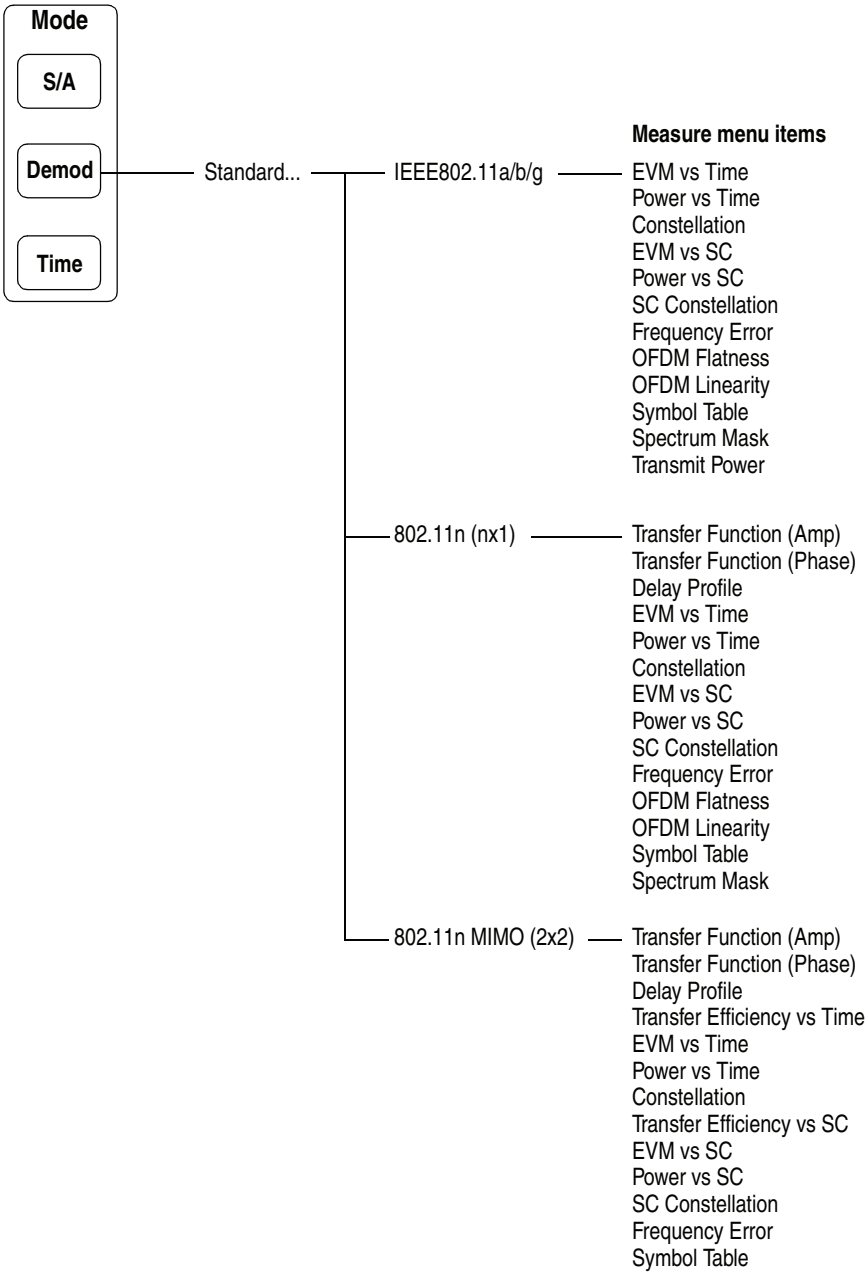


Figure 1-3: Measure menu in the WLAN analysis

Operating Basics

Operating Basics

This section describes the basic operation specific to the WLAN analysis with the following topics:

- Screen Elements
- Setting Frequency and Span
- Setting Acquisition and Analysis Parameters
- View Operation
- Saving Measurement Results and Loading Waveform Data

NOTE. *For complete details on operating the analyzer, refer to the* RSA3408B User Manual.

Screen Elements

Figure 2-1 shows the screen elements of the WLAN analysis. The analysis runs in the Demod (modulation analysis) mode and displays the following three views on the screen. The spectrum mask measurement is an exception; it uses a single view like the S/A (Spectrum Analyzer) mode.

- **Overview.** Displays all data in one acquisition block. Use this overview to set the acquisition and analysis parameters such as acquisition length and analysis length (refer to *Setting Acquisition and Analysis Parameters* on page 2-6).
- **Main view.** Displays the measurement results and waveform for the range specified in the overview.
- **Subview.** Displays the spectrum (by default) for the range specified in the overview. You can select the view content with the View Define menu.

For details on setting the views, refer to *View Operation* on page 2-7.

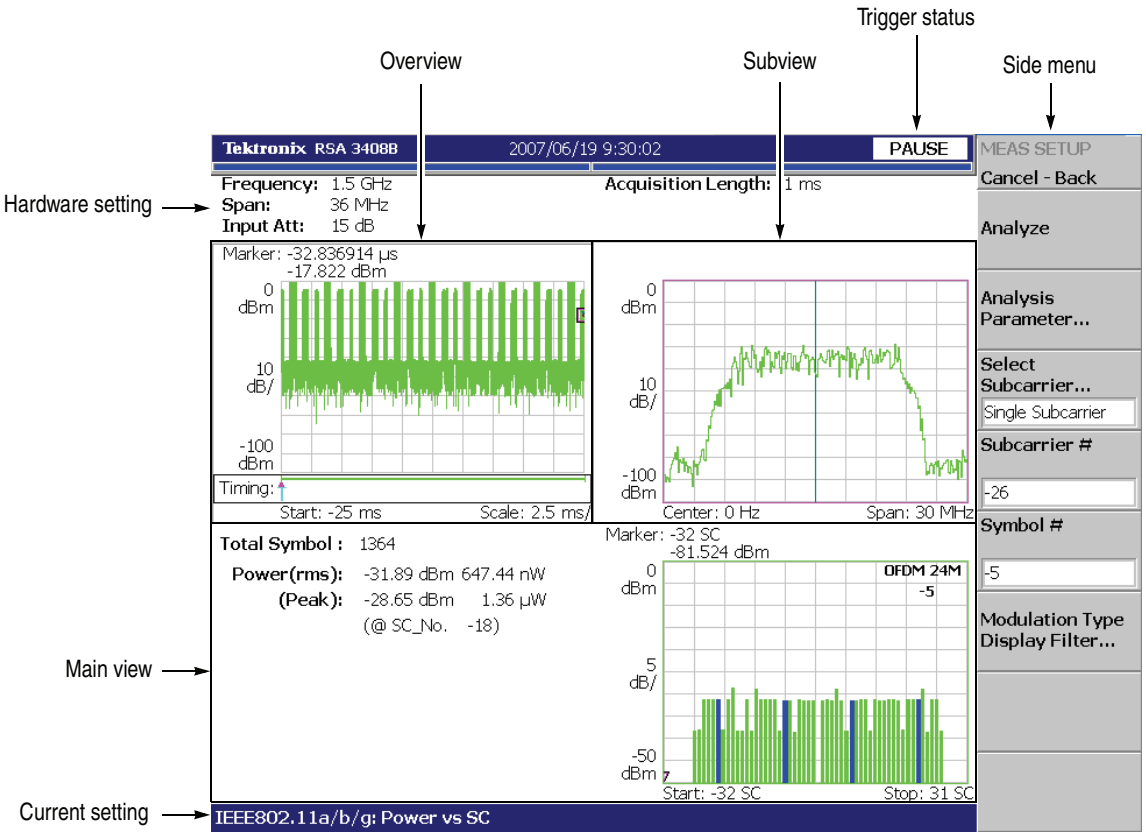


Figure 2-1: Screen elements

Setting Frequency and Span

Use the **Frequency/Channel** and the **Span** keys on the front panel to set frequency and span. For WLAN analysis, you can use the channel tables shown in Table 2-1.

Table 2-1: Channel table for the WLAN analysis

Channel table	Channel	Center frequency (GHz)
IEEE 802.11a	34	5.170
	36	5.180
	38	5.190
	40	5.200
	42	5.210
	44	5.220
	46	5.230
	48	5.240
	52	5.260
	56	5.280
	60	5.300
	64	5.320
	100	5.500
	104	5.520
	108	5.540
	112	5.560
	116	5.580
	120	5.600
	124	5.620
	128	5.640
	132	5.660
	136	5.680
	140	5.700
	149	5.745
	153	5.765
	157	5.785
	161	5.805

Table 2-1: Channel table for the WLAN analysis (cont.)

Channel table	Channel	Center frequency (GHz)
IEEE 802.11b/g	1	2.412
	2	2.417
	3	2.422
	4	2.427
	5	2.432
	6	2.437
	7	2.442
	8	2.447
	9	2.452
	10	2.457
	11	2.462
	12	2.467
	13	2.472
	14	2.484
IEEE 802.11n (2.4 GHz)	1	2.422
	2	2.427
	3	2.432
	4	2.437
	5	2.442
	6	2.447
	7	2.452
IEEE 802.11n (5 GHz)	1	5.190
	2	5.230
	3	5.270
	4	5.310
	5	5.510
	6	5.550
	7	5.590
	8	5.630
	9	5.670
	10	5.755
	11	5.795

The span setting depends on the measurement item as shown in Table 2-2.

Table 2-2: Span setting

Analysis type	Measurement item	Span
Modulation analysis	Transfer Function	20 or 36 MHz (The default is 36 MHz)
	Delay Profile	
	Transfer Efficiency versus Time	
	EVM versus Time	
	Power versus Time	
	Constellation	
	Transfer Efficiency versus SC	
	EVM versus SC	
	Power versus SC	
	SC Constellation	
	Frequency Error	
	OFDM Flatness	
	OFDM Linearity	
	Symbol Table	
Power analysis	Spectrum Mask	100 MHz to 3 GHz
	Transmit Power	20 or 36 MHz (The default is 36 MHz)

Setting Acquisition and Analysis Parameters

Press the **Acquisition/Analysis** key to set the acquisition and analysis parameters described below on the overview (see Figure 2-2).

Acquisition Length. Sets the time to acquire one block.

Acquisition History. Specifies the number of the block to analyze and display.

Spectrum Length. Shows time for FFT to display spectrum in the subview.

Spectrum Offset. Sets the beginning of Spectrum Length.

Analysis Length. Sets the analysis range in time units (max. 100 ms).

Analysis Offset. Sets the beginning of Analysis Length.

Output Trigger Indicator. Turns on or off the output trigger indicator.

For details on setting the timing and trigger, refer to the *RSA3408B User Manual*.

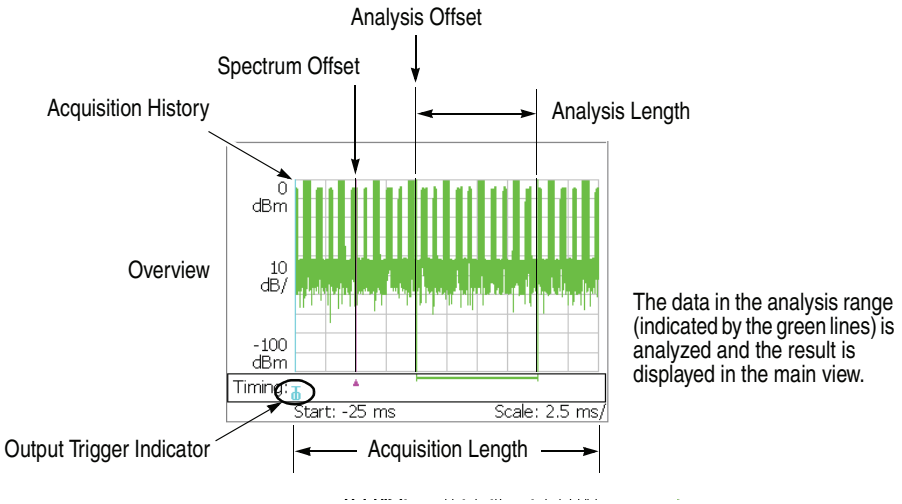


Figure 2-2: Acquisition and analysis parameters

NOTE. *Only Acquisition Length is available in the Transmit Power measurement. The Timing menu is not available in the Spectrum Mask measurement.*

View Operation

This section provides view operating basics, addressing the following topics:

- Changing the View Content
- Selecting the Phase Unit
- Scaling the Graph

Changing the View Content

You can change the view content with the View: **Define** key on the front panel. The View Define menu has the following controls.

Show Views. Selects the single or multi view.

- **Single.** Displays one view on screen.
  Select the view with the View: **Select** key.
- **Multi.** Displays the overview, the main view, and the subview on screen.

Overview Content... Selects the overview content.

Subview Content... Selects the subview content.

The view contents depend on the measurement items. Refer to each

Selecting the Phase Unit

The phase unit in the EVM measurement defaults to degrees. You can select degrees or radians using the following steps:

1. Press the **System** key.
2. Press the **Instrument Setup...** side key.
3. Press the **Angular Units** side key to select Degrees or Radians.

Scaling the Graph

You can expand a waveform horizontally and vertically pressing View: **Scale/Lines →View Scale...** (you cannot compress the original waveform). The scale setting affects only the display; it does not change the acquisition parameters such as span, center frequency, and reference level. Although the Scale menu varies with the measurement items, it has commonly the following controls as shown in Figure 2-3.

Horizontal Scale. Sets the range of the horizontal axis.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

Vertical Scale. Sets the range of the vertical axis.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.

Vertical Offset. Sets the center value of the vertical axis.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.

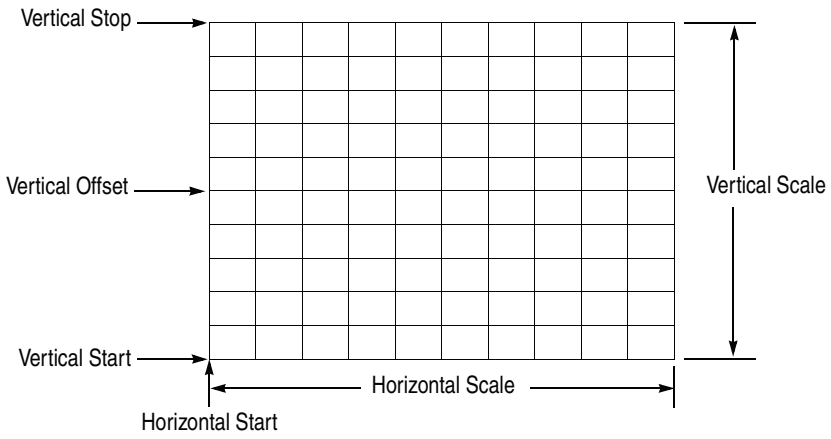


Figure 2-3: Definition of the View Scale menu items

Press the View: **Select** key to select a view before scaling the graph pressing View: **Scale/Lines →View Scale...**. Chapter 3, *Reference*, describes the Scale menu for each measurement item. Refer to the following sections:

- IEEE802.11a/b/g Analysis: View Format on page 3-11
- IEEE802.11n (nx1) Analysis: View Format on page 3-55
- IEEE802.11n MIMO (2x2) Analysis: View Format on page 3-102

Saving Measurement Results and Loading Waveform Data

Use the **Save** and **Load** keys on the front panel to save measurement results and load waveform data to/from a file.

NOTE. *This section provides information about file save specific to Option 29 WLAN analysis. For details on standard file operations, refer to the* RSA3408B User Manual.

Save Menu

The Save menu for the modulation measurements has the following controls.

Save State. Saves the instrument settings.

Save Data... / Data (.CSV)... / Data (.MAT)... Saves the input waveform (IQ data in the time domain) to a file in the IQT, CSV (Comma Separated Values), or MATLAB format, respectively. You can export the CSV file into Microsoft Excel or other database systems and the MAT file into the MATLAB technical computing environment.

- **All Blocks.** *IQT format only.* Saves all the acquired blocks.
- **Current Block.** Saves the block currently displayed in the overview.
- **Current Area.** Saves the data in the analysis range.

Save Mainview Results. *802.11n (nx1) and MIMO (2x2) analyses only.* Saves the measurement results to a file in the CSV (Comma Separated Values) format. You can export the file into Microsoft Excel or other database systems. Refer to *Appendix B* for the save format.

Submenu items for the transfer function and delay profile measurements:

- **Trace 1.** Saves Trace 1 to a specified file.
- **Trace 2.** Saves Trace 2 to a specified file.
- **Trace 1 and 2.** Saves Trace 1 and 2 to two files with the file names of "1" and "2" added respectively to a specified name.
- **All Data.** *MIMO (2x2) analysis only.* Saves Trace 1 and 2 to a specified file in all combinations of the Tx and Rx antennas.
- **Packets Offset.** Specifies the first packet to save. (See Figure 2-4.)
  Range: –[(the number of packets in the analysis range) – 1] to 0.
  Zero (0) represents the latest packet.
- **Number of Packets.** Sets the number of packets to save. (See Figure 2-4.)
  Range: 1 to [–(Packet Offset) + 1].

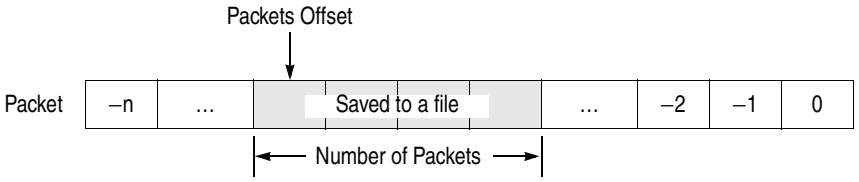


Figure 2-4: Setting packets to be saved

Submenu items for other than transfer function and delay profile measurements (MIMO (2x2) analysis only):

- **Trace Data.** Saves the displayed trace data to a specified file.
- **All Data.** Saves the trace data to a specified file in all combinations of the Tx and Rx antennas.

Load Menu

The Load menu for the modulation measurements has the following controls.

Load State. Loads the instrument settings.

Load Data. *802.11n (nx1) analysis only.*
Loads the input waveform (IQ data in the time domain) from a file (.iqt).

Load Rx1 / Load Rx2. *802.11n MIMO (2x2) analysis only.*
Loads the receiving antenna 1 and 2 input waveform (IQ data in the time domain) from a file (.iqt), respectively.

Displaying File Name

When you load an .iqt file, the file name appears on the **Load Data / Rx1 / Rx2** side key. Because of the limitation of display area, if the number of characters exceed the limit, only the part within the allowable range will be displayed with line feed inserted at space if any (see Figure 2-5).

File name: “Example.iqt”
Displayed normally.

File name: “ExampleOfLongName withSpaces Inserted.iqt”
Only the part within the allowable range is displayed with line feed inserted at space. The third and the subsequent lines are omitted.

Figure 2-5: Displaying the file name on the Load Data / Rx1 / Rx2 side key

Reference

IEEE802.11a/b/g Analysis

This section describes the basic operation of the IEEE802.11a/b/g analysis. You can access the measurement items by pressing **Demod** →**Standard...** → **IEEE802.11a/b/g** as shown in Figure 3-1.

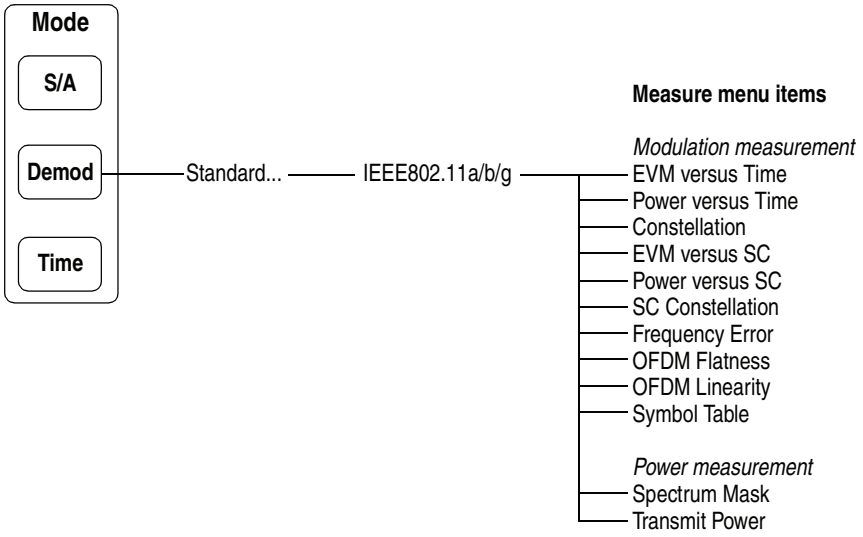


Figure 3-1: IEEE802.11a/b/g measurement menu

Basic Measurement Procedure

The basic measurement procedures are described for the modulation analysis and the power analysis.

Modulation Measurement

Follow these steps to perform the modulation measurement.

1. Press **Demod** → **Standard...** → **IEEE 802.11a/b/g**.
2. Set frequency and span appropriately using the **Frequency/Channel** and the **Span** keys. Refer to *Setting Frequency and Span* on page 2-3.
3. Set the amplitude appropriately using the **Amplitude** key.

NOTE. *If the input signal level is too high, "Overrange - increase RefLev or Atten" will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

4. Press the **Acquisition/Analysis** key and set the acquisition and analysis parameters. Refer to *Setting Acquisition and Analysis Parameters* on page 2-6.
5. After acquiring measurement data, stop the data acquisition using the **Run/Stop** key.
6. Press the **Measure** key and select the measurement item.
   For example, press the **Power vs Time** side key to observe power variance.
7. Press **Meas Setup** → **Analysis Parameter...** to preset the parameters.
   a. Press the **Modulation Detection...** side key and select the modulation type (data rate). The default setting is AUTO.
   b. Select the **Synchronization** and **Equalization** options as necessary.

   For details on setting the Measurement Setup menu, refer to page 3-5.
8. Press **Meas Setup** → **Analyze** to start the analysis for the acquired data with the specified parameters.

   If you cancel the analysis, press the **Cancel-Back** (top) side key.
9. Use the View menu to modify the displayed graph.
   For details on setting the views, refer to *View Format* on page 3-11.

Power Measurement

The power analysis consists of Spectrum Mask and Transmit Power. Follow these steps to perform the power analysis.

1. Press **Demod** → **Standard...** → **IEEE 802.11a/b/g**.
2. Set frequency and span appropriately using the **Frequency/Channel** and the **Span** keys. Refer to *Setting Frequency and Span* on page 2-3.
3. Set the amplitude appropriately using the **Amplitude** key.

NOTE. *If the input signal level is too high, "Overrange - increase RefLev or Atten" will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

4. *Transmit Power only.* Press the **Acquisition/Analysis** key and set the acquisition and analysis parameters. Refer to *Setting Acquisition and Analysis Parameters* on page 2-6.
5. Press the **Measure** key and select the measurement item. For example, press the **Spectrum Mask** side key to observe the spectrum mask.
6. Press the **Meas Setup** key and set the measurement parameters. For details on setting the Measurement Setup menu, refer to page 3-4.
7. Use the View menu to modify the displayed graph. For details on setting the views, refer to *View Format* on page 3-11.

Meas Setup Menu

Press the **Meas Setup** key to set the measurement parameters. The Meas Setup menu varies among the measurement items. Refer to the section shown in Table 3-1.

Table 3-1: Measurement setup reference for the 802.11a/b/g analysis

Measurement item	Reference section
Modulation measurements	
EVM versus Time	Measurement Setup for Modulation Measurements on page 3-5
Power versus Time	
Constellation	
EVM versus SC	
Power versus SC	
SC Constellation	
Frequency Error	
OFDM Flatness	
OFDM Linearity	
Symbol Table	
Power measurements	
Spectrum Mask	Measurement Setup for Spectrum Mask on page 3-9
Transmit Power	Measurement Setup for Transmit Power on page 3-10

Measurement Setup for Modulation Measurements

The Meas Setup menu for the modulation measurements has the following controls:

Analyze Performs the analysis for the input data in the range specified on the overview.

Analysis Parameter... You need to set the analysis parameters before pressing the **Analyze** side key.

Modulation Detection... Selects the demodulation type. If you select Auto, the demodulation type will be determined dynamically by decoding the preamble.

Table 3-2: Modulation detection

Parameter	Data rate	Modulation 1st/2nd	Encoding rate
AUTO (default)	Auto	Auto	
OFDM,64QAM(54Mbps)	54 Mbps	64QAM/OFDM	3/4
OFDM,64QAM(48Mbps)	48 Mbps	64QAM/OFDM	2/3
OFDM,16QAM(36Mbps)	36 Mbps	16QAM/OFDM	3/4
OFDM,16QAM(24Mbps)	24 Mbps	16QAM/OFDM	1/2
OFDM,QPSK(18Mbps)	18 Mbps	QPSK/OFDM	3/4
OFDM,QPSK(12Mbps)	12 Mbps	QPSK/OFDM	1/2
OFDM,BPSK(9Mbps)	9 Mbps	BPSK/OFDM	3/4
OFDM,BPSK(6Mbps)	6 Mbps	BPSK/OFDM	1/2
CCK(11Mbps)	11 Mbps	CCK	
CCK(5.5Mbps)	5.5 Mbps	CCK	
DSSS,DQPSK(2Mbps)	2 Mbps	BPSK/PBCC	
DSSS,DBPSK(1Mbps)	1 Mbps	QPSK/PBCC	
PBCC,8PSK(33Mbps)	33 Mbps	DBPSK/DSSS	
PBCC,8PSK(22Mbps)	22 Mbps	DQPSK/DSSS	
PBCC,QPSK(11Mbps)	11 Mbps	DBPSK/DSSS	
PBCC,BPSK(5.5Mbps)	5.5 Mbps	DQPSK/DSSS	

Synchronization. Selects the synchronization method.

- **LTS.** *Default*. Synchronizes with Long Training Symbol.
- **GI.** Synchronizes with Guard Interval.

Equalization. Determines whether to apply the data correction using the long training symbol during the analysis.

- **On.** *Default.* Enables the data correction.
- **Off.** Disables the data correction.

Select Subcarrier... Selects subcarrier for a displayed line graph.

- **Data + Pilot.** *Default.* Displays the measurement results for data and pilot.
- **Data.** Displays the measurement results for data only.
- **Pilot.** Displays the measurement results for pilot only.
- **Single Subcarrier.** Displays the measurement results for the subcarrier specified using the **Subcarrier #** side key below.

Subcarrier # Specifies the subcarrier number for the measurement. Range: –32 to +31. The function varies by measurement as shown in Table 3-3.

Symbol # Specifies the analysis symbol number for the measurement. The function varies by measurement as shown in Table 3-3. Range: –[(the number of symbols in the analysis range) – 1] to 0. Zero (0) represents the latest analysis symbol.

NOTE. *For definition of the analysis symbol, refer to page 3-7.*

The **Select Subcarrier...**, **Subcarrier #**, *and* **Symbol #** *menu items are effective only in the measurements shown in Table 3-3.*

Table 3-3: Submenu availability

Measure menu item	Select Subcarrier...	Subcarrier #	Symbol #
EVM versus Time	D	S	M
Power versus Time	D	S	M
Constellation	D	S	M
EVM versus SC	-	M	D
Power versus SC	-	M	D
SC Constellation	-	M	D
Frequency Error	D	S	M
OFDM Flatness	-	M	-
OFDM Linearity	-	-	-
Symbol Table	-	M	D

D: Changing the setting updates the measurement data.
M: Changing the setting updates the marker position.
S: Changing the setting updates the measurement data only when Select Subcarrier is set to Single Subcarrier.

Abbreviation. SC: Subcarrier

Definition of the Analysis Symbol. In the modulation analysis, it is important to calculate average values of RMS voltage or center frequency error for enough time to get good analysis results. The length of a signal to calculate the RMS voltage or center frequency error is called “analysis symbol” in the WLAN analysis software. For example, frequency error by the analysis symbol is displayed on the center frequency error view. Although “symbol” is defined for OFDM in the 802.11a/g standard, “analysis symbol” is used in the WLAN analysis software taking the other modulation types into account.

The following views display the averaged values by analysis symbol for power, EVM, magnitude error, and phase error, respectively.

- Power versus Time
- EVM versus Time
- MagErr versus Time
- PhaseErr versus Time

The following views display analysis results of power, EVM, magnitude error, and phase error, respectively for each data point, chip, or subcarrier contained in one analysis symbol.

- Power versus SC
- EVM versus SC
- MagErr versus SC
- PhaseErr versus SC

The length of an analysis symbol depends on the modulation type as follows:

Table 3-4: Length of an analysis symbol, IEEE802.11a/g

Part of a signal	Type of the signal	Length of an analysis symbol
Data part	OFDM	80 sample points
	DSSS	88 chips
	CCK	80 chips
	PBCC	80 data points
Preamble/Header part	Short OFDM training symbol	16 sample points
	Long OFDM training symbol	160 sample points
	PLCP preamble	1584 chips
	Short PLCP preamble	792 chips
	PLCP header	528 chips
	Short PLCP header	264 chips

Modulation Type Display Filter...

Selects the modulation type(s) to display the measurement results on the screen. The results and graph are shown only for the types set to On.

Select cell to edit. Selects an item to change the on/off setting in the table on screen. The table consists of six blocks as shown in Figure 3-2. The selected item appears on the second side key where you can turn it on or off.

All Preambles On/Off. Turns on or off all the preambles.

All Data On/Off. Turns on or off all the data.

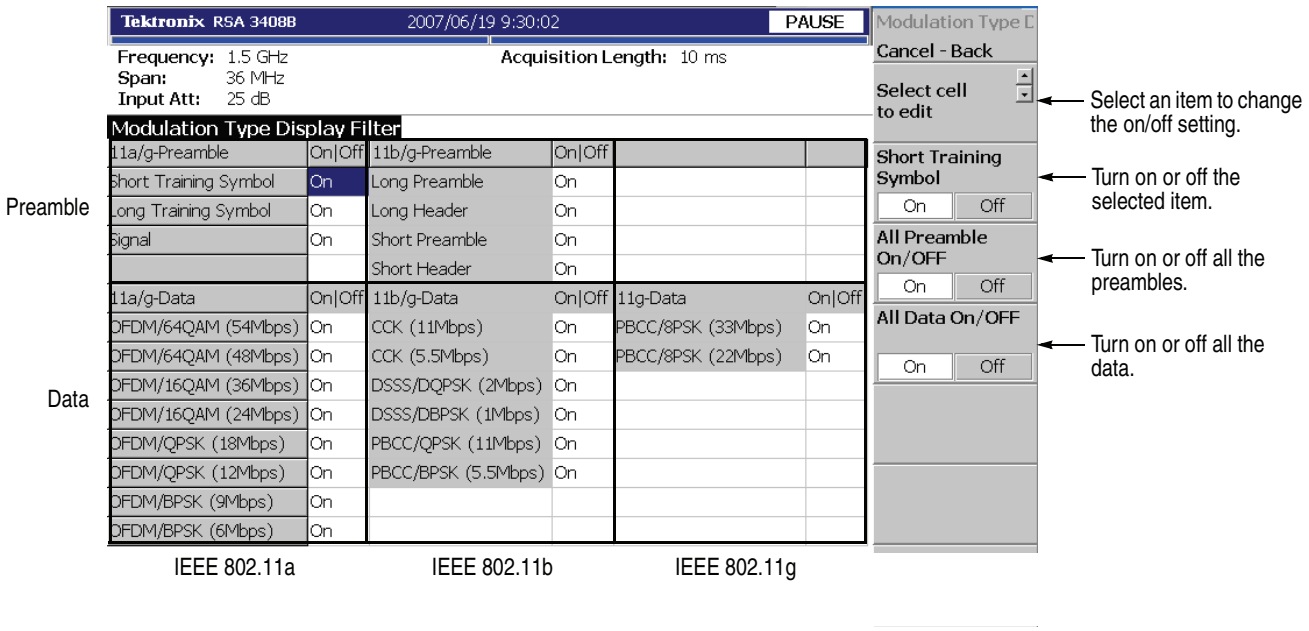


Figure 3-2: Modulation Type Display Filter setting

Measurement Setup for Spectrum Mask

The Meas Setup menu for the Spectrum Mask has the following controls:

Spectrum Mask Selects the spectrum mask specified in the IEEE802.11a/b standard. (See Figure 3-3.)

- DSSS (default)
- OFDM

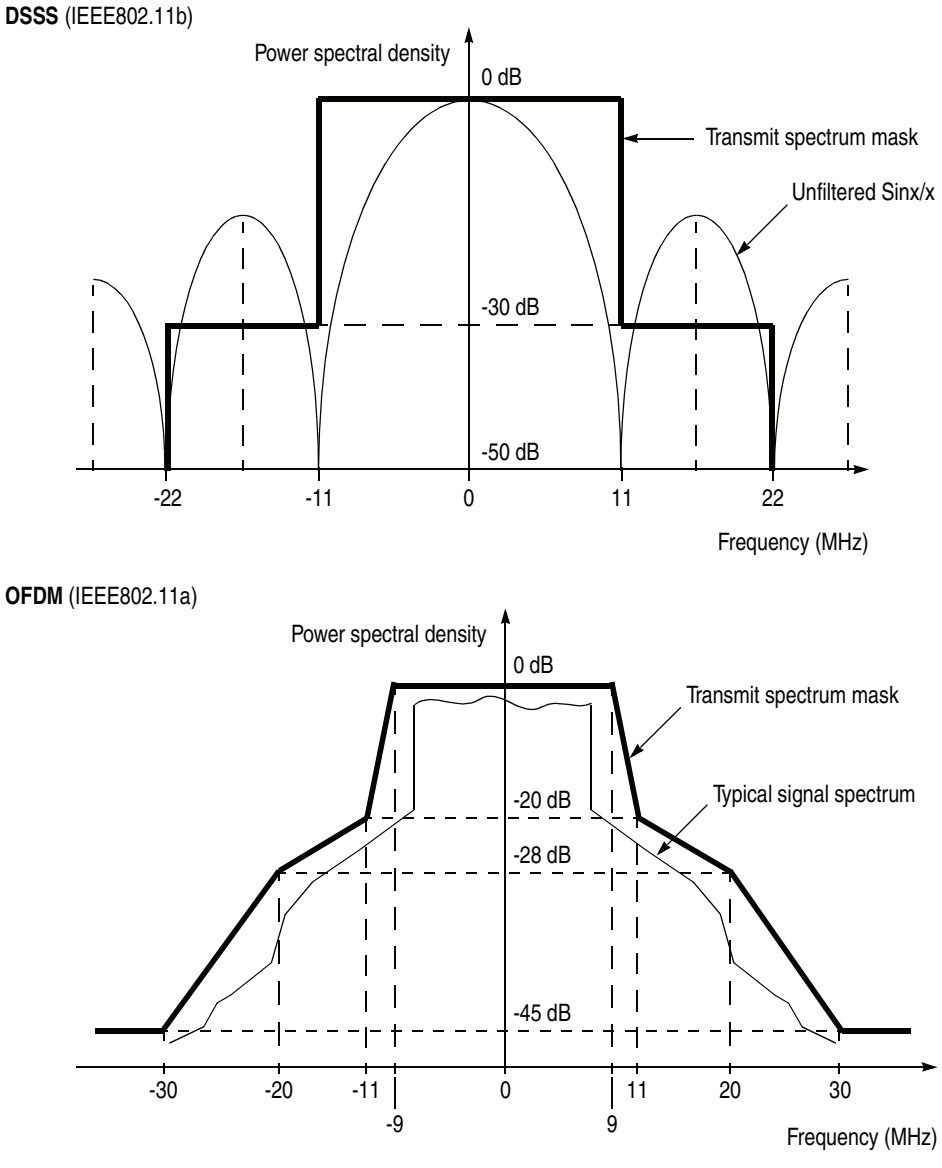


Figure 3-3: IEEE802.11a/b spectrum mask

Measurement Setup for Transmit Power

The Meas Setup menu for the Transmit Power has the following controls:

Transmit Power Selects the measurement: Transmit Power On or Down.
The measurement results for the selected item are displayed on the screen.

- **On.** Selects the Transmit Power On measurement.
- **Down.** Selects the Transmit Power Down measurement.

Burst Select Specifies the index of a burst to display the measurement results.

Range: from (the number of all bursts in one acquisition block) −1 to 0.
0 (zero) indicates the latest burst.

The specified burst is indicated with the green bar in the Timing field on the overview as shown in Figure 3-4.

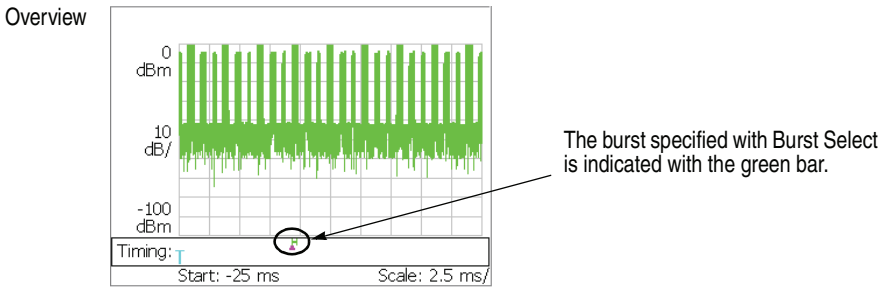


Figure 3-4: Burst indicator on the overview

View Format

This section provides information about the view formats of the IEEE802.11a/b/g analysis. It consists of two parts:

- View Format for Modulation Measurements
- View Format for Power Measurements

Selecting View Content

You can change the view content with the View: **Define** key on the front panel. The view contents depend on the measurement items as shown in Table 3-5.
In the EVM measurement, you can change the measurement content pressing View: **Scale/Lines →View Scale...**.

Table 3-5: View content selection, IEEE802.11a/b/g

Measurement item	View: Define → Overview content	View: Define → Subview content	View: Scale/Lines → View Scale... → Measurement content
Modulation analysis			
EVM versus Time	Waveform (default) Spectrogram	Spectrum (default) Constellation EVM versus Time Power versus Time SC Constellation EVM versus SC Power versus SC Frequency Error OFDM Flatness OFDM Linearity Symbol Table	EVM Mag Err Phase Err
Power versus Time			-
Constellation			Vector / Constellation
EVM versus SC			EVM Mag Err Phase Err
Power versus SC			-
SC Constellation			Vector / Constellation
Frequency Error			-
OFDM Flatness			-
OFDM Linearity			Vector / Dot
Symbol Table			-
Power analysis			
Spectrum Mask	-	-	-
Transmit Power	Waveform (default) Spectrogram	Spectrum (default) Power On / Down	-

NOTE. *The View Define menu for Spectrum Mask is the same as in the S/A (Spectrum Analysis) mode. Refer to the* RSA3408B User Manual.

View Format for Modulation Measurements

EVM versus Time

The main view shows the EVM of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-5. The vertical axis represents EVM in percent and the horizontal axis represents time in seconds.

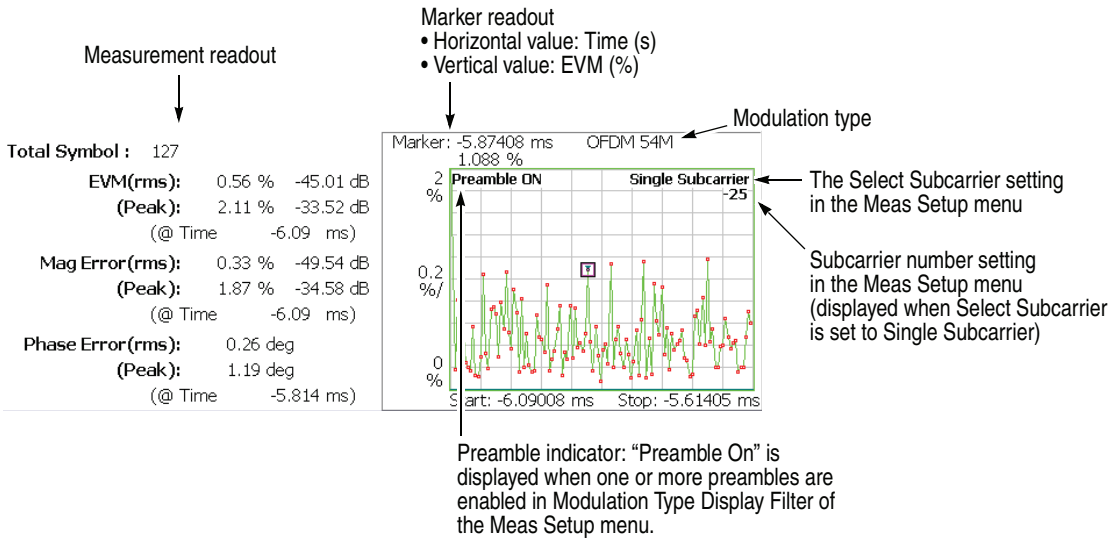


Figure 3-5: EVM versus Time (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
EVM (rms)	%, dB	RMS value of EVM
(Peak)	%, dB	Peak value of EVM
(@Time)	s	The peak time relative to the last data point
Mag Error (rms)	%, dB	RMS value of Mag Error
(Peak)	%, dB	Peak value of Mag Error
(@Time)	s	The peak time relative to the last data point
Phase Error (rms)	degrees or radians	RMS value of Phase Error
(Peak)	degrees or radians	Peak value of Phase Error
(@Time)	s	The peak time relative to the last data point

Scale Menu. The Scale menu for EVM versus Time has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Refer to Table 3-6 for the setting range.

Vertical Start. When the measurement content is EVM, sets the minimum value (bottom edge) of the vertical axis. Refer to Table 3-6 for the setting range.

Vertical Offset. When the measurement content is Mag Error or Phase Error, sets the center value ((maximum + minimum) / 2) of the vertical axis.
Refer to Table 3-6 for the setting range.

Table 3-6: Vertical setting range

Measurement	Vertical Scale	Vertical Start	Vertical Offset
EVM	100µ to 100%	–100 to 100%	-
Magnitude error	200µ to 200%	-	–200 to 200%
Phase error	450µ to 450°	-	–450 to 450°

Full Scale. Sets the scale of vertical axis to the default full-scale value.

Measurement Content... Selects how to display the vertical axis:

- **EVM.** Represents the vertical axis with EVM (Error Vector Magnitude).
- **Mag Error.** Represents the vertical axis with magnitude error.
- **Phase Error.** Represents the vertical axis with phase error.

MagErr versus Time

The main view shows the magnitude error of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-6. The vertical axis represents magnitude error in percent and the horizontal axis represents time in seconds.

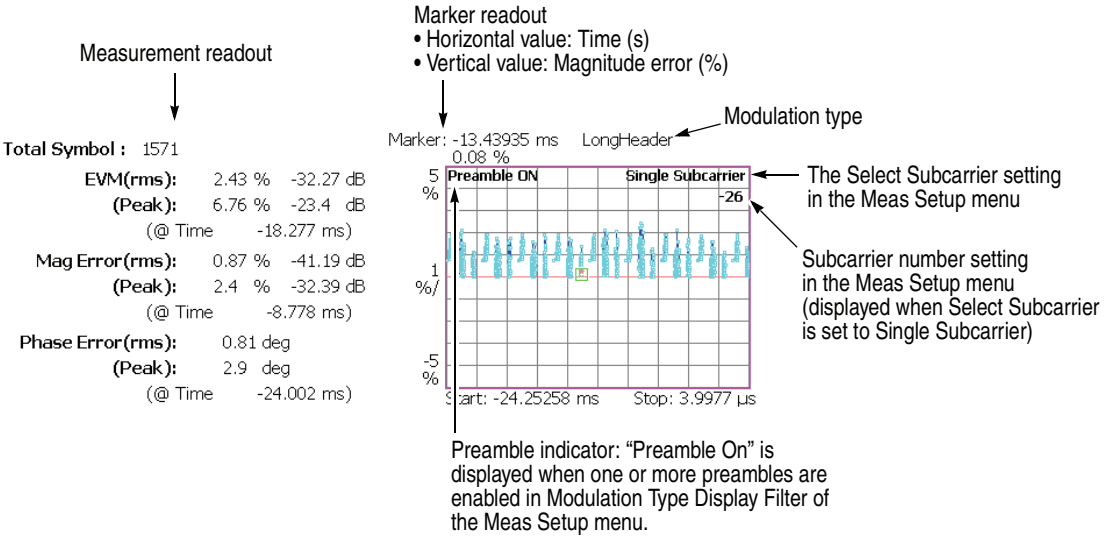


Figure 3-6: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. Refer to the Scale menu of EVM versus Time on page 3-13.

PhaseErr versus Time

The main view shows the Phase Error of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-7. The vertical axis represents phase error in degrees or radians and the horizontal axis represents time in s.

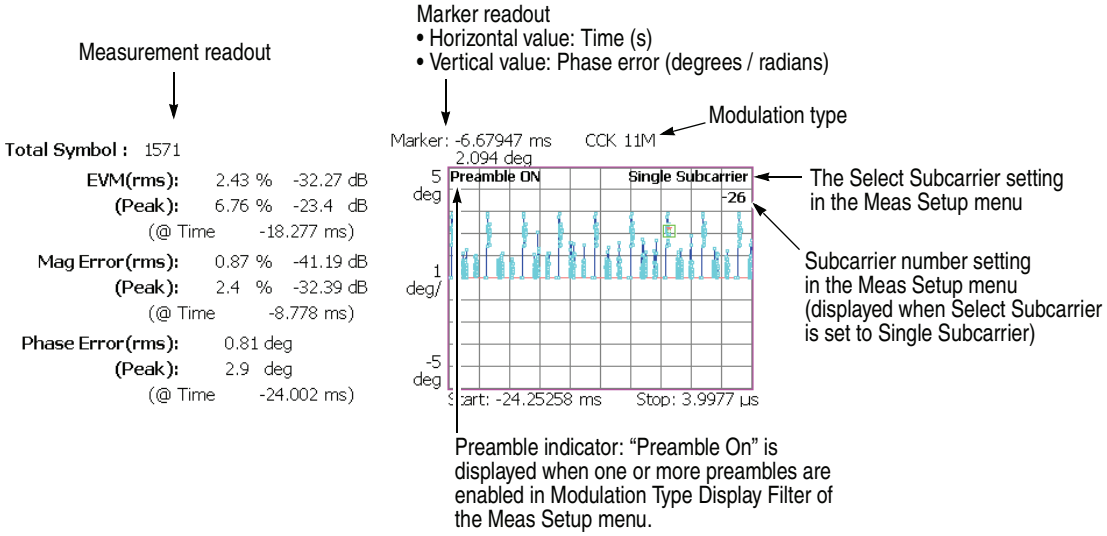


Figure 3-7: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. Refer to the Scale menu of EVM versus Time on page 3-13.

Power versus Time

The main view shows the power of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-8. The vertical axis represents power in dBm and the horizontal axis represents time in seconds.

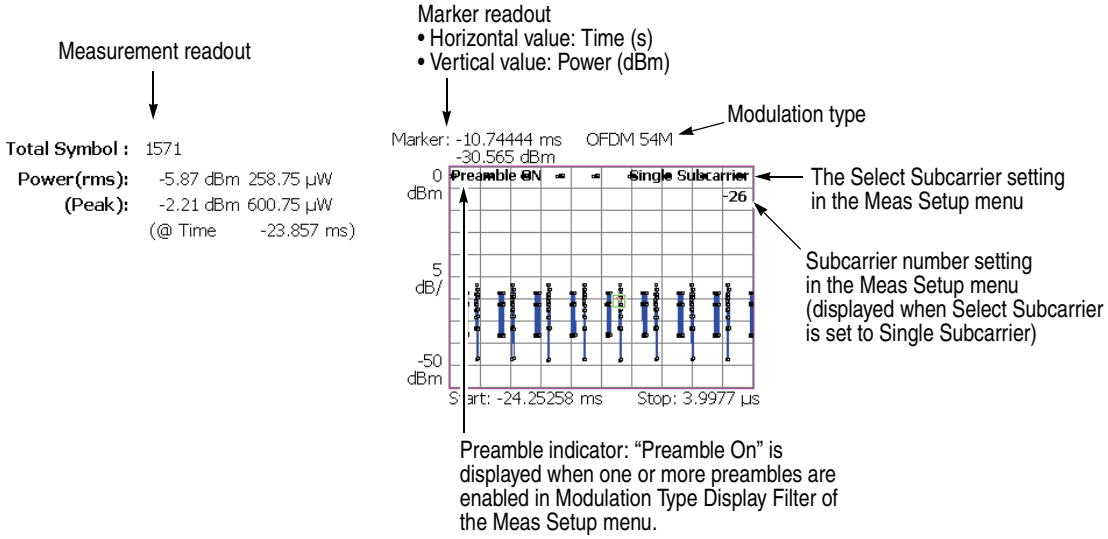


Figure 3-8: Power versus Time (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
Power (rms)	dBm, W	RMS power of one or all subcarriers
(Peak)	dBm, W	Peak power of one or all subcarriers
(@Time)	s	The peak time relative to the last data point

Scale Menu. The Scale menu for Power versus Time has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Range: 50 µ to 50 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: −50 to 50 dB.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Constellation

The main view displays the constellation of one or all subcarriers in a rectangular coordinates graph, as shown in Figure 3-9. The horizontal axis represents I and the vertical axis represents Q.

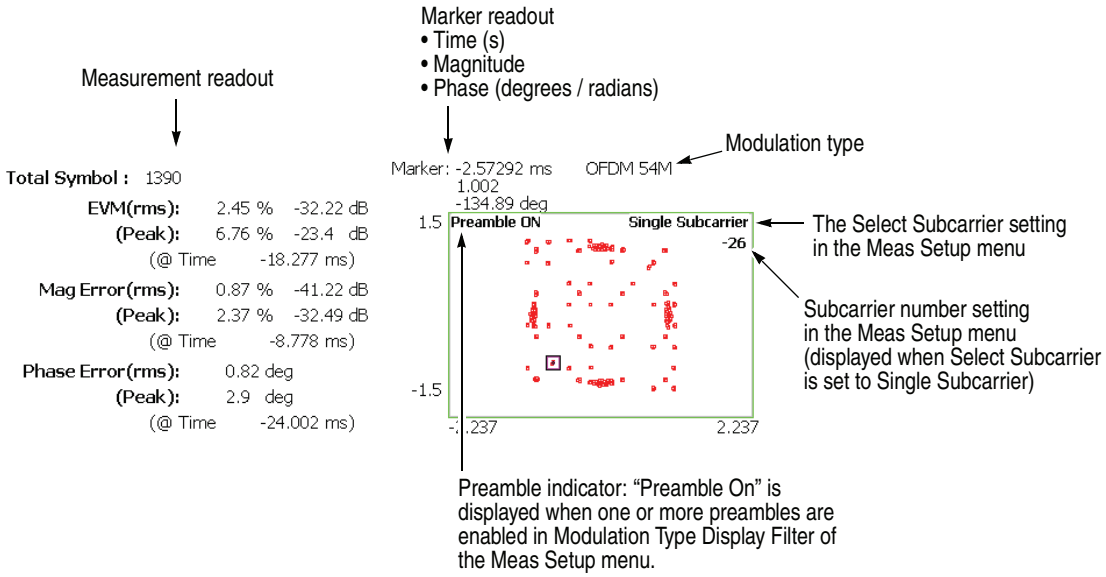


Figure 3-9: Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. The Scale menu for the constellation has the following controls:

Measurement Content... Selects vector or constellation display.

- **Vector.** Selects vector display. A signal represented by phase and amplitude is displayed in polar coordinate or IQ diagram. The red point indicates the symbol position of the measured signal, and the yellow trace indicates the locus of the signal between symbols.
- **Constellation.** Selects constellation display. It is the same as the vector display, except that only symbols of the measured signal are indicated in red, and the locus between symbols is not shown. The cross marks indicate the symbol positions of an ideal signal.

EVM versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the EVM of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-10. The vertical axis represents EVM in percent and the horizontal axis represents subcarrier number ranging from –32 to +31.

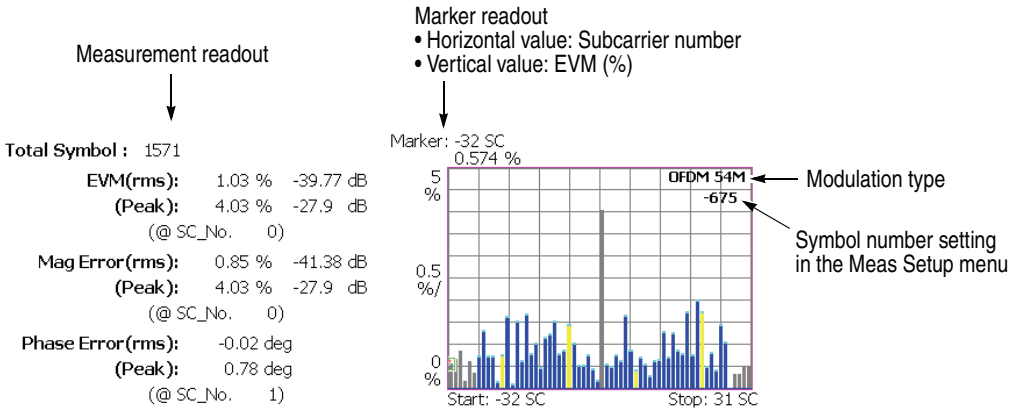


Figure 3-10: EVM versus SC (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
EVM (rms)	%, dB	RMS value of EVM
(Peak)	%, dB	Peak value of EVM
(@SC_No.)	-	The subcarrier number at the peak
Mag Error (rms)	%, dB	RMS value of Mag Error
(Peak)	%, dB	Peak value of Mag Error
(@SC_No.)	-	The subcarrier number at the peak
Phase Error (rms)	degrees or radians	RMS value of Phase Error
(Peak)	degrees or radians	Peak value of Phase Error
(@SC_No.)	-	The subcarrier number at the peak

Scale Menu. The Scale menu in EVM versus SC for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number). Range: 8 to 64.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis. Range: −32 to 24.

Vertical Scale. Sets the range of the vertical axis.
Refer to Table 3-7 for the setting range.

Vertical Start. When the measurement content is EVM, sets the minimum value (bottom edge) of the vertical axis. Refer to Table 3-7 for the setting range.

Vertical Offset. When the measurement content is Mag Error or Phase Error, sets the center value ((maximum + minimum) / 2) of the vertical axis. Refer to Table 3-7 for the setting range.

Table 3-7: Vertical setting range

Measurement	Vertical Scale	Vertical Start	Vertical Offset
EVM	100 µ to 100%	–100 to 100%	-
Magnitude error	200 µ to 200%	-	–200 to 200%
Phase error	450 µ to 450°	-	–450 to 450°

Full Scale. Sets the scale of vertical axis to the default full-scale value.

Measurement Content... Selects how to display the vertical axis:

- **EVM.** Represents the vertical axis with EVM (Error Vector Magnitude).
- **Mag Error.** Represents the vertical axis with magnitude error.
- **Phase Error.** Represents the vertical axis with phase error.

Non-OFDM. The main view displays the EVM of carriers by analysis symbol in a bar graph, as shown in Figure 3-11. The vertical axis represents EVM in percent and the horizontal axis represents time in s.

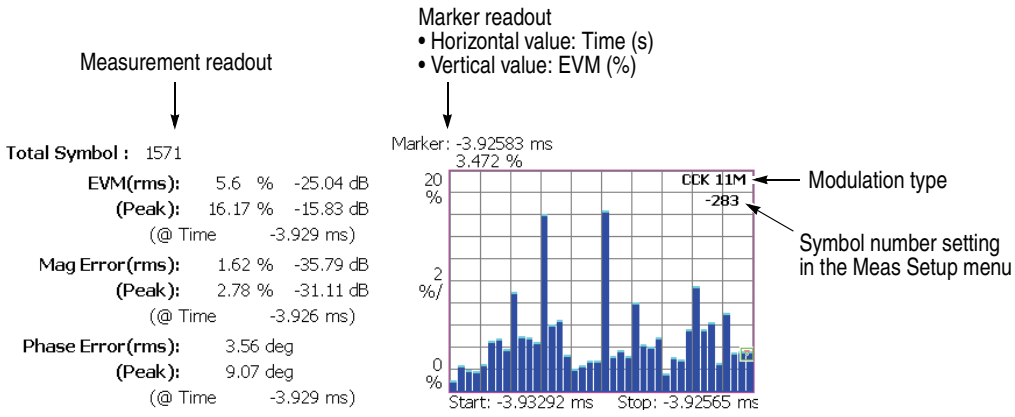


Figure 3-11: EVM versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. The Scale menu in EVM versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-13.

MagErr versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the magnitude error of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-12.
The vertical axis represents magnitude error in percent and the horizontal axis represents the subcarrier wave number ranging from −32 to +31.

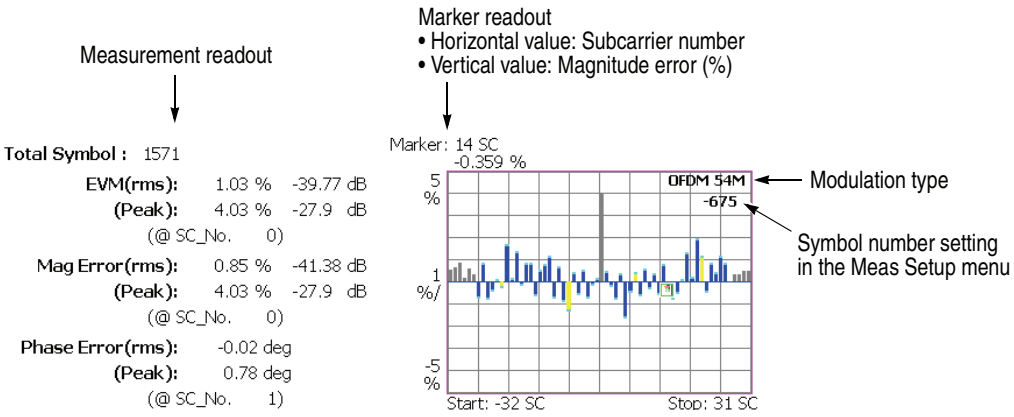


Figure 3-12: MagErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-19.

Scale Menu. Refer to the Scale menu of EVM versus SC on page 3-20.

Non-OFDM. The main view displays the magnitude error of carriers by analysis symbol in a bar graph, as shown in Figure 3-13. The vertical axis represents the magnitude error in percent and the horizontal axis represents time in seconds.

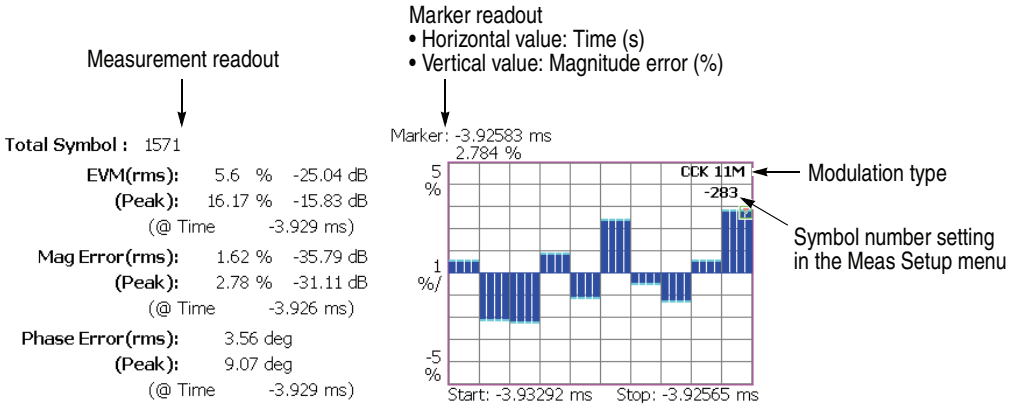


Figure 3-13: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. The Scale menu in MagErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-13.

PhaseErr versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the phase error of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-14.
The vertical axis represents phase error in degrees or radians and the horizontal axis represents the subcarrier wave number ranging from –32 to +31.

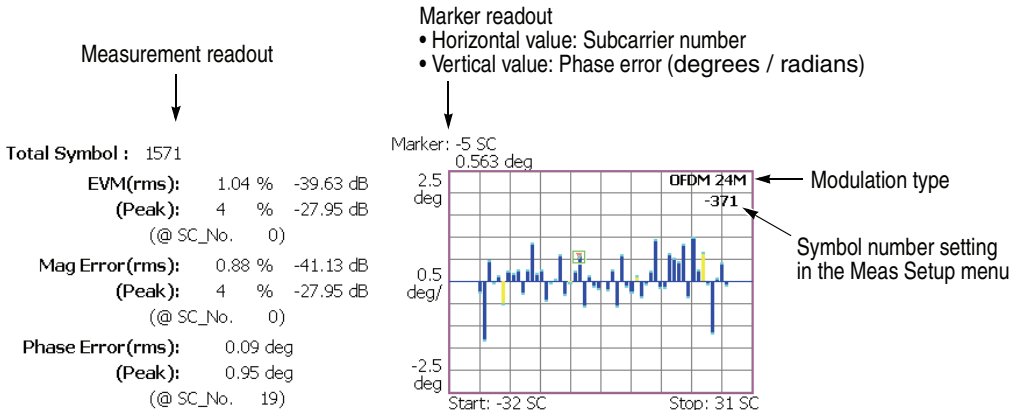


Figure 3-14: PhaseErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-19.

Scale Menu. Refer to the Scale menu of EVM versus SC on page 3-20.

Non-OFDM. The main view displays the phase error of carriers by analysis symbol in a bar graph, as shown in Figure 3-15. The vertical axis represents the phase error in degrees or radians and the horizontal axis represents time in s.

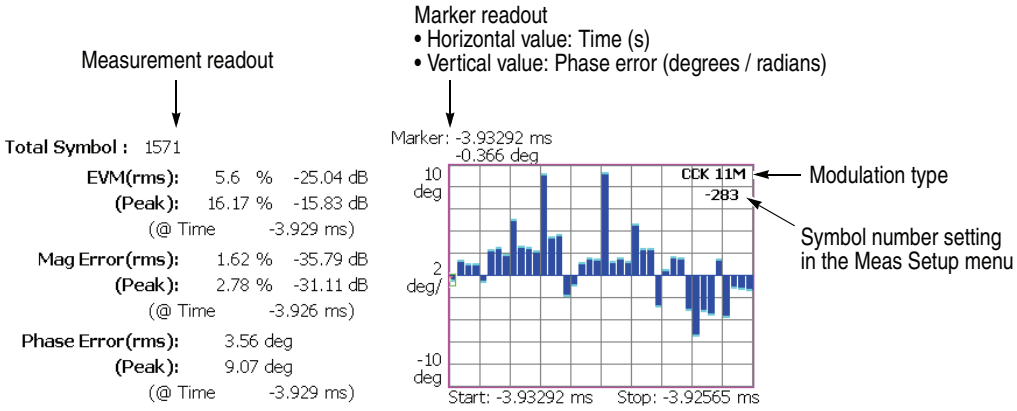


Figure 3-15: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. The Scale menu in PhaseErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-13.

Power versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view displays the power of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-16. The vertical axis represents power in dBm and the horizontal axis represents the subcarrier number ranging from –32 to +31.

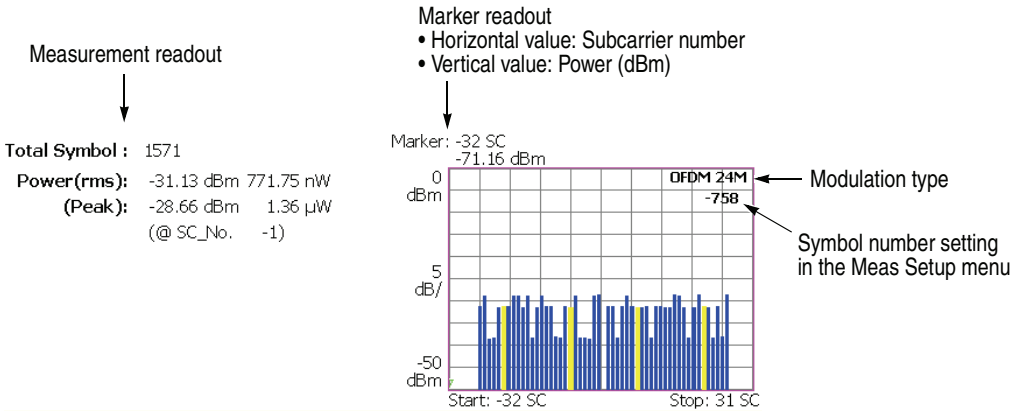


Figure 3-16: Power versus SC (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
Power (rms)	dBm, W	RMS power of all subcarriers
(Peak)	dBm, W	Peak power
(@SC_No.)	-	Subcarrier number at the peak

Scale Menu. The Scale menu in Power versus SC for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number).
Range: 8 to 64.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: −32 to 24.

Vertical Scale. Sets the range of the vertical axis.
Range: 50 µ to 50 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: −50 to 50 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Non-OFDM. The main view displays the power of carriers by analysis symbol in a bar graph, as shown in Figure 3-17. The vertical axis represents power in dBm and the horizontal axis represents time in seconds.

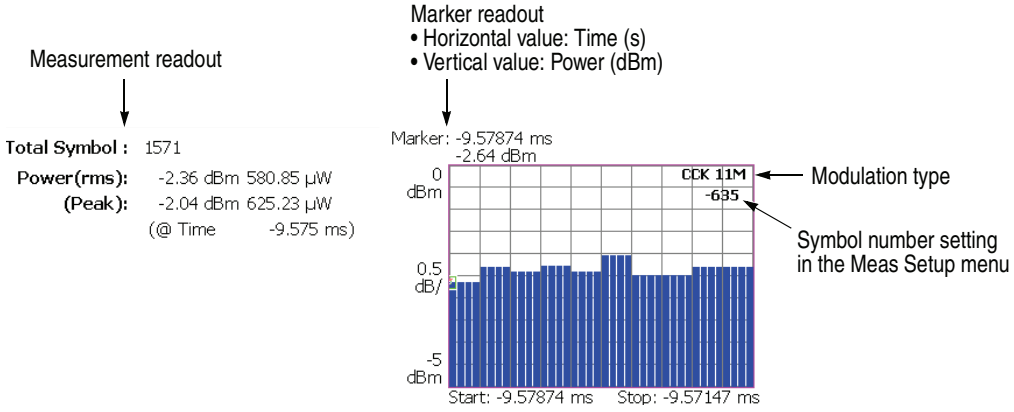


Figure 3-17: Power versus Time (main view)

The measurement readout is the same as in Power versus Time, shown in the table on page 3-16.

Scale Menu. The Scale menu in Power versus SC for Non-OFDM has the same controls as in Power versus Time. Refer to page 3-17.

SC Constellation

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The main view displays the constellation of subcarriers in a rectangular coordinate graph for an analysis symbol, as shown in Figure 3-18. The horizontal axis represents I and the vertical axis represents Q.

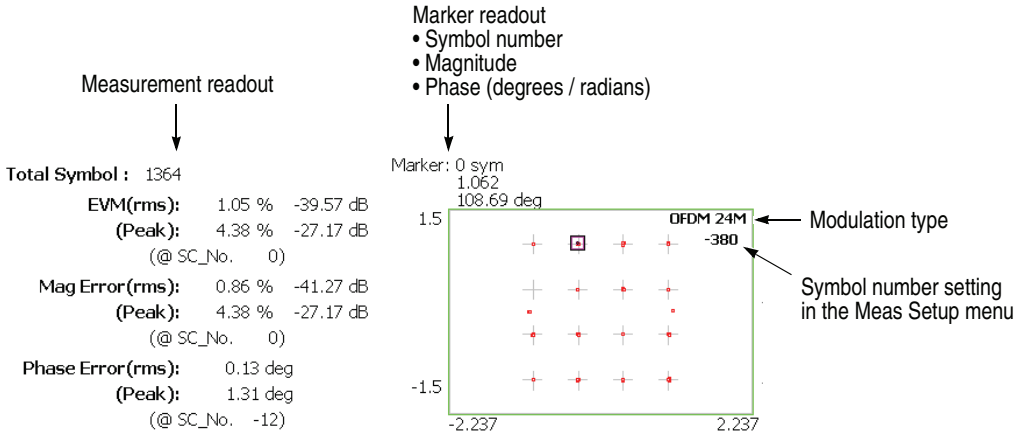


Figure 3-18: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-19.

Scale Menu. Same as in Constellation. Refer to page 3-18.

Non-OFDM. The main view displays the constellation of carriers in a rectangular coordinate graph for an analysis symbol, as shown in Figure 3-19. The horizontal axis represents I, and the vertical axis represents Q.

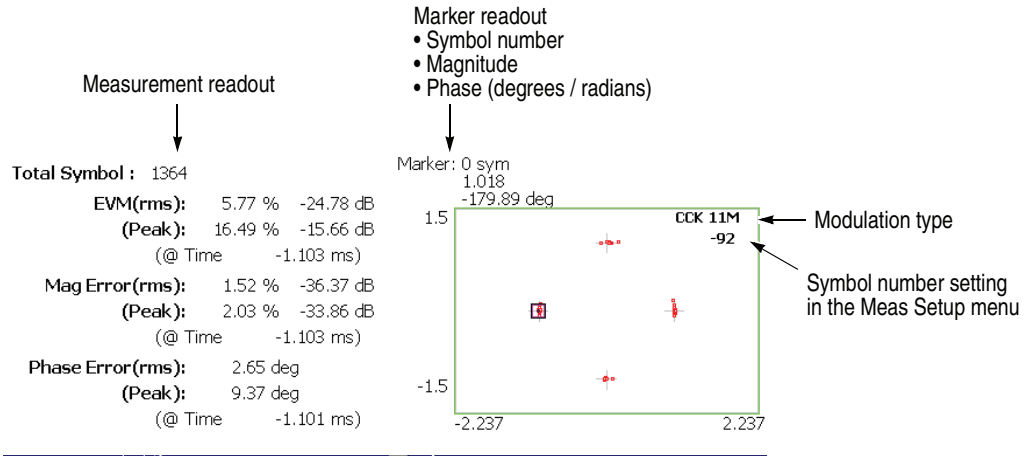


Figure 3-19: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-12.

Scale Menu. Same as in Constellation. Refer to page 3-18.

Frequency Error

The main view displays the center frequency deviation over time in a line graph, as shown in Figure 3-20. The vertical axis represents frequency error in kHz, and the horizontal axis represents time in seconds.

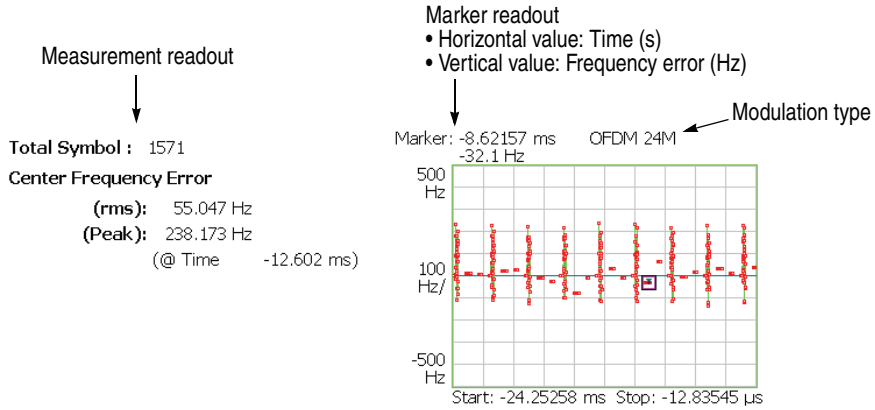


Figure 3-20: Frequency error (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
Center Frequency Error (rms)	kHz	RMS frequency error
(Peak)	kHz	Peak frequency error
(@Time)	s	The peak time relative to the last data point

Scale Menu. The Scale menu for Frequency Error has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis (frequency).
Range: 500 m to 500 kHz.

Vertical Offset. Sets the maximum value (top edge) of the vertical axis.
Range: −500 k to 500 kHz.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

OFDM Flatness

The main view displays each subcarrier wave flatness in a bar graph, as shown in Figure 3-21. The vertical axis represents the deviation power of average energy in dB, and the horizontal axis represents subcarrier wave number ranging from −32 to +31.

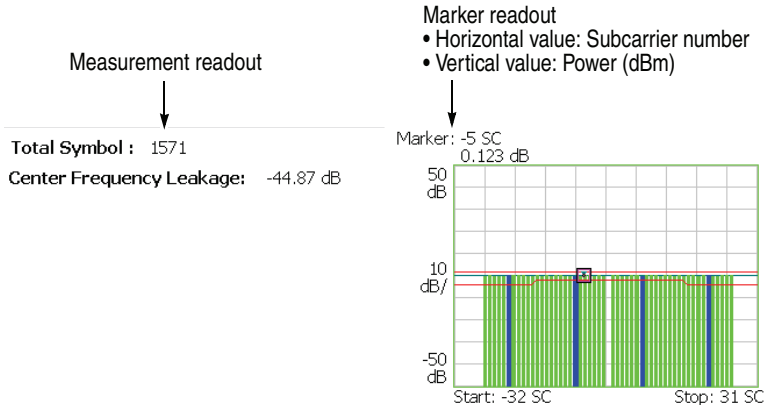


Figure 3-21: OFDM flatness (main view)

Verify that the measurement results of the bar graph fall within the threshold level displayed with two red lines.

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Total Symbol	-	Total number of analysis symbols
Center Frequency Leakage	dB	Carrier leakage power (<2 dB in IEEE802.11a standard)

Scale Menu. The Scale menu for OFDM Flatness has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number).
Range: 8 to 64.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: −32 to 24.

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: −150 to 50 dB.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

OFDM Linearity

The main view displays the linearity of OFDM modulation in a line graph, as shown in Figure 3-22. The vertical axis represents actual measurement values in mW, and the horizontal axis represents the ideal values in mW.

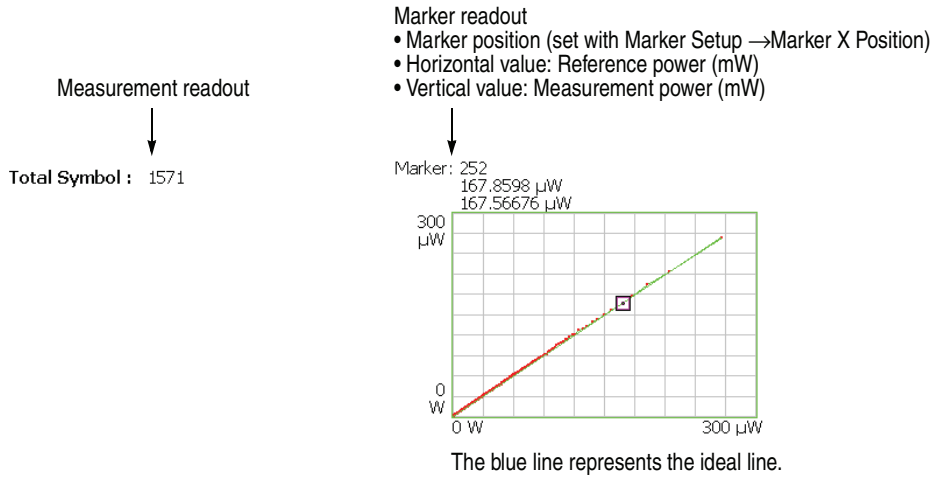


Figure 3-22: OFDM linearity (main view)

The measurement readout shows only the total number of analysis symbols.

Scale Menu. The Scale menu for OFDM Linearity has the following controls:

Measurement Content... Selects vector or dot display.

- **Vector.** Displays yellow lines between the dots (default).
- **Dot.** Displays the calculated result as a series of red dots.

The measurement results are displayed with the horizontal and vertical axes scaled automatically to fit the graph to the screen.

Symbol Table

The main view displays the symbol table, as shown in Figure 3-23. The table can be displayed with binary, octal, or hexadecimal digits.

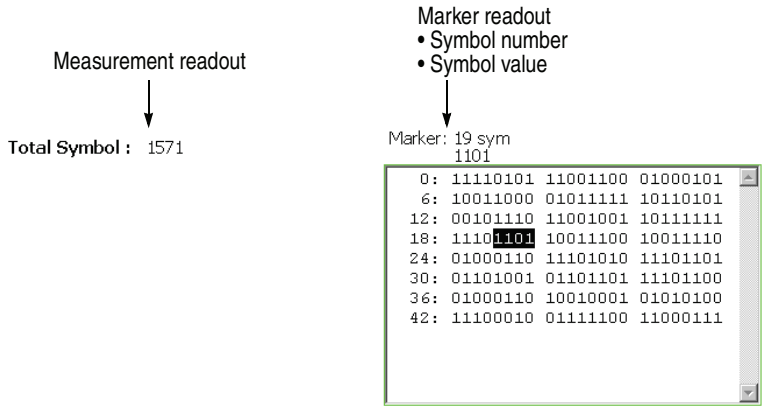


Figure 3-23: Symbol table (main view)

The measurement readout shows only the total number of analysis symbols.

Scale Menu. The Scale menu for Symbol Table has the following controls:

Radix. Selects the radix for displaying the table:

- **Hex.** Hexadecimal digit
- **Oct.** Octal digit
- **Bin.** *Default.* Binary digit

Hex and Oct indicate values of binary data string in units of modulation symbol.

View Format for Power Measurement

This subsection describes all view formats for power analysis.

Spectrum Mask

The spectrum mask measurement verifies that the base station is not transmitting excessive power outside of its designated channel.

OFDM. The screen displays the spectrum waveform and mask in a line graph, as shown in Figure 3-24. The vertical axis represents power in dBm and the horizontal axis represents frequency in Hz.

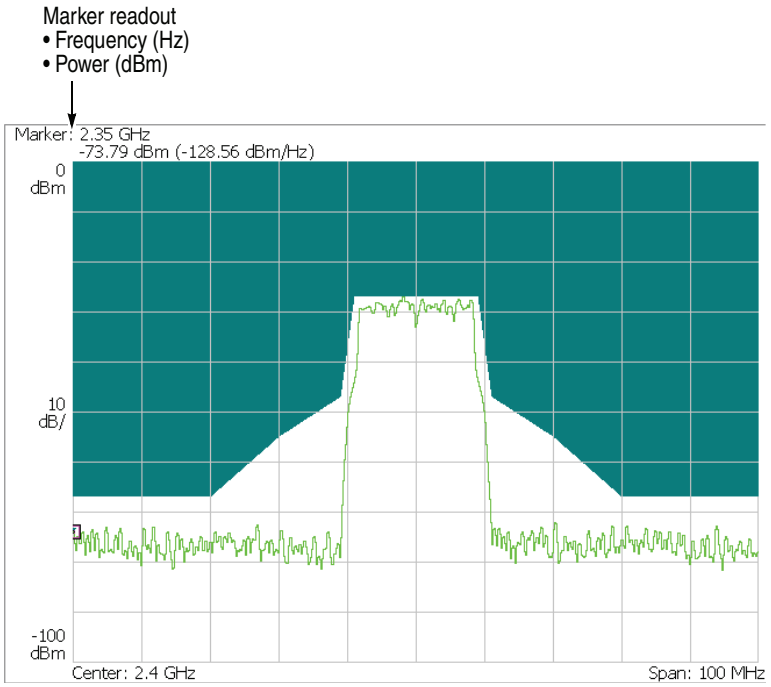


Figure 3-24: Spectrum mask (OFDM)

Verify that the measurement results (line graph) fall within the threshold level. This view does not display the measurement readouts.

Scale Menu. The Scale menu in Spectrum Mask for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis (frequency).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

Vertical Scale. Sets the scale of the vertical axis (power).
Range: 100 µ to 100 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: –100 to 100 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Non-OFDM. The screen displays the spectrum waveform and mask in a line graph, as shown in Figure 3-25. The vertical axis represents power in dBm and the horizontal axis represents frequency in Hz.

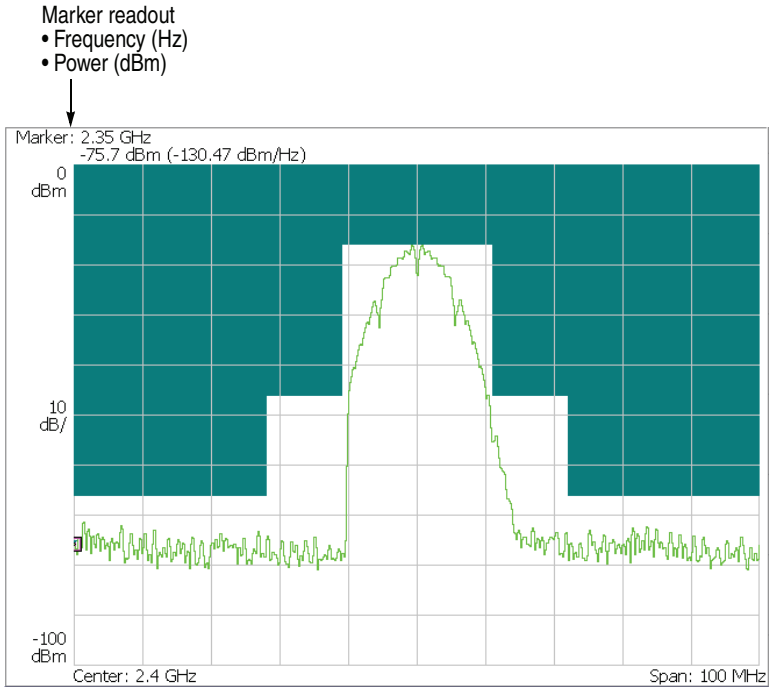


Figure 3-25: Spectrum mask (DSSS)

Verify that the measurement results of the line graph fall within the threshold level. This view does not display the measurement readouts.

Scale Menu. The Scale menu in Spectrum Mask for Non-OFDM has the same controls as for OFDM. Refer to page 3-38.

Transmit Power

Displays the transmit power on/down ramp in a line graph with the standard mask.

NOTE. *The transmit power measurement handles non-OFDM signals.*

On. The main view displays the transmit power-on ramp in a line graph.
The vertical axis represents power in watts and the horizontal axis represents time in seconds.

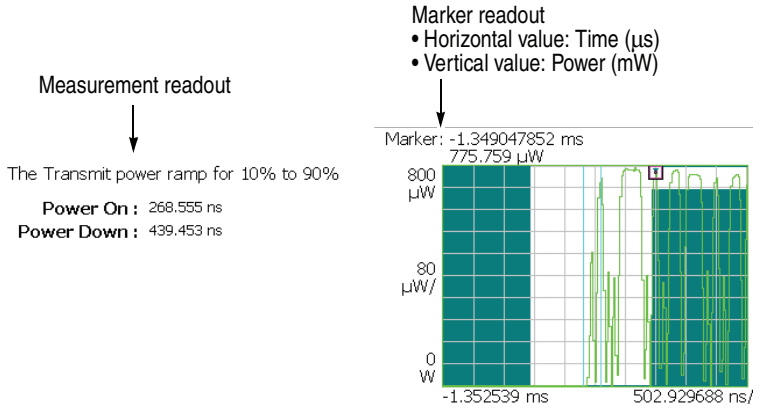


Figure 3-26: Transmit power on (main view)

Verify that the measurement results (line graph) fall within the threshold level.

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Power On	s	Transmit power-on ramp from 10 to 90%
Power Down	s	Transmit power-down ramp from 90 to 10%

Figure 3-27 shows the IEEE802.11b standard for the transmit power-on ramp.

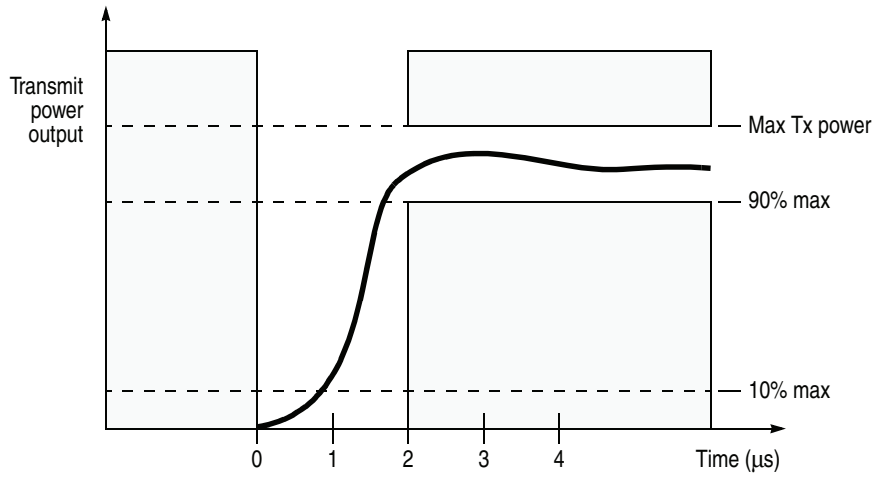


Figure 3-27: IEEE802.11b Transmit power-on ramp

Scale Menu. The Scale menu for Transmit Power On has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis (power).
Range: 800 p to 800 µW.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: 0 to 1.6 mW.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Down. The main view displays the transmit power-down ramp in a line graph. The vertical axis represents power in watts and the horizontal axis represents time in seconds.

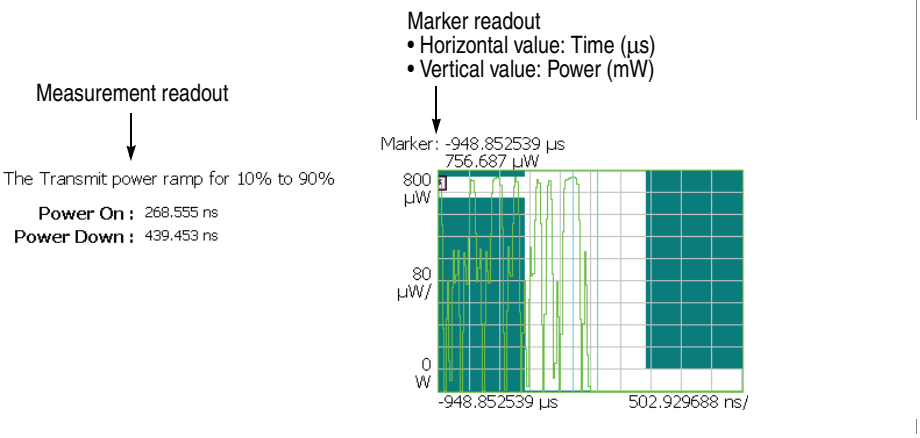


Figure 3-28: Transmit power down (main view)

Verify that the measurement results (line graph) fall within the threshold level. The readout is the same as Transmit Power-On. Refer to page 3-40.

Figure 3-29 shows the IEEE802.11b standard for the transmit power-down ramp.

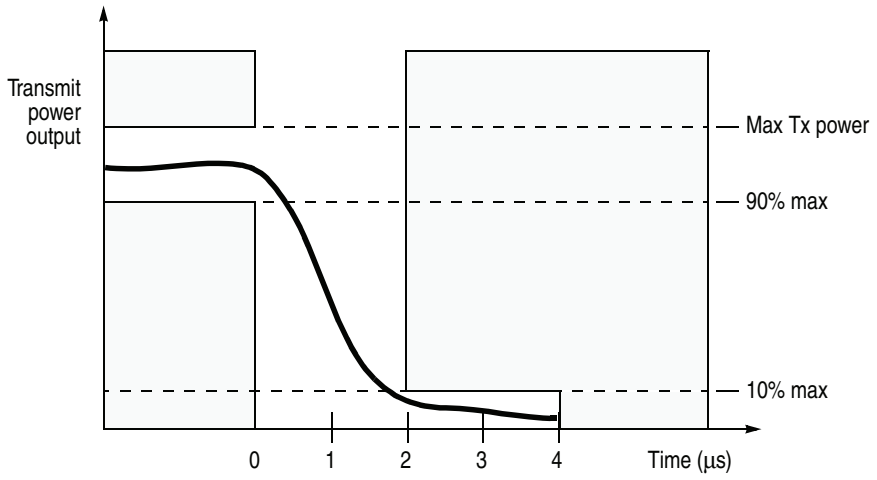


Figure 3-29: IEEE802.11b Transmit power-down ramp

Scale Menu. The Scale menu for Transmit Power Down has the same controls as for Transmit Power On. Refer to page 3-41.

802.11n (nx1) Analysis

This section describes the basic operation of the IEEE802.11n (nx1, Multi-Input Single-Output) analysis. You can access the measurement items by pressing **Demod →Standard... →802.11n (nx1)** as shown in Figure 3-30.

NOTE. *The 802.11n (nx1) analysis includes the 1x1 (SISO: Single-Input Single-Output) and the 2x1 (MISO: Multi-Input Single-Output) measurements. The measurements other than Transfer Function and Delay Profile are for SISO only.*

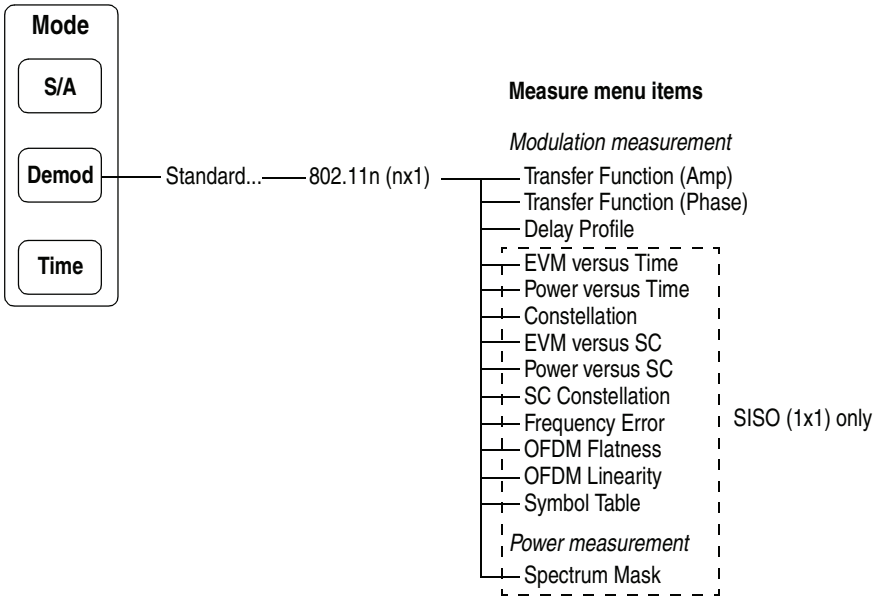


Figure 3-30: IEEE802.11n (nx1) measurement menu

While SISO is a traditional one-to-one communication method, MISO is a many-to-one system for improving the communication speed. The next section explains how the analyzer processes data in MISO (2x1).

Data Process Flow for MISO (2x1)

Figure 3-31 shows the data process flow in MISO (2x1). Packet 1 and 2 transmitted from Tx antenna 1 and 2 respectively are received by an Rx antenna. Packet 1 and 2 acquired by the analyzer are processed to extract LTF (Long Training Field). Then, the transfer function is calculated using the LTF parts. For MISO (2x1), two transfer functions are obtained according to the combination of the Tx and Rx antennas so the delay profile as well as the amplitude and phase transfer functions can be observed on the screen.

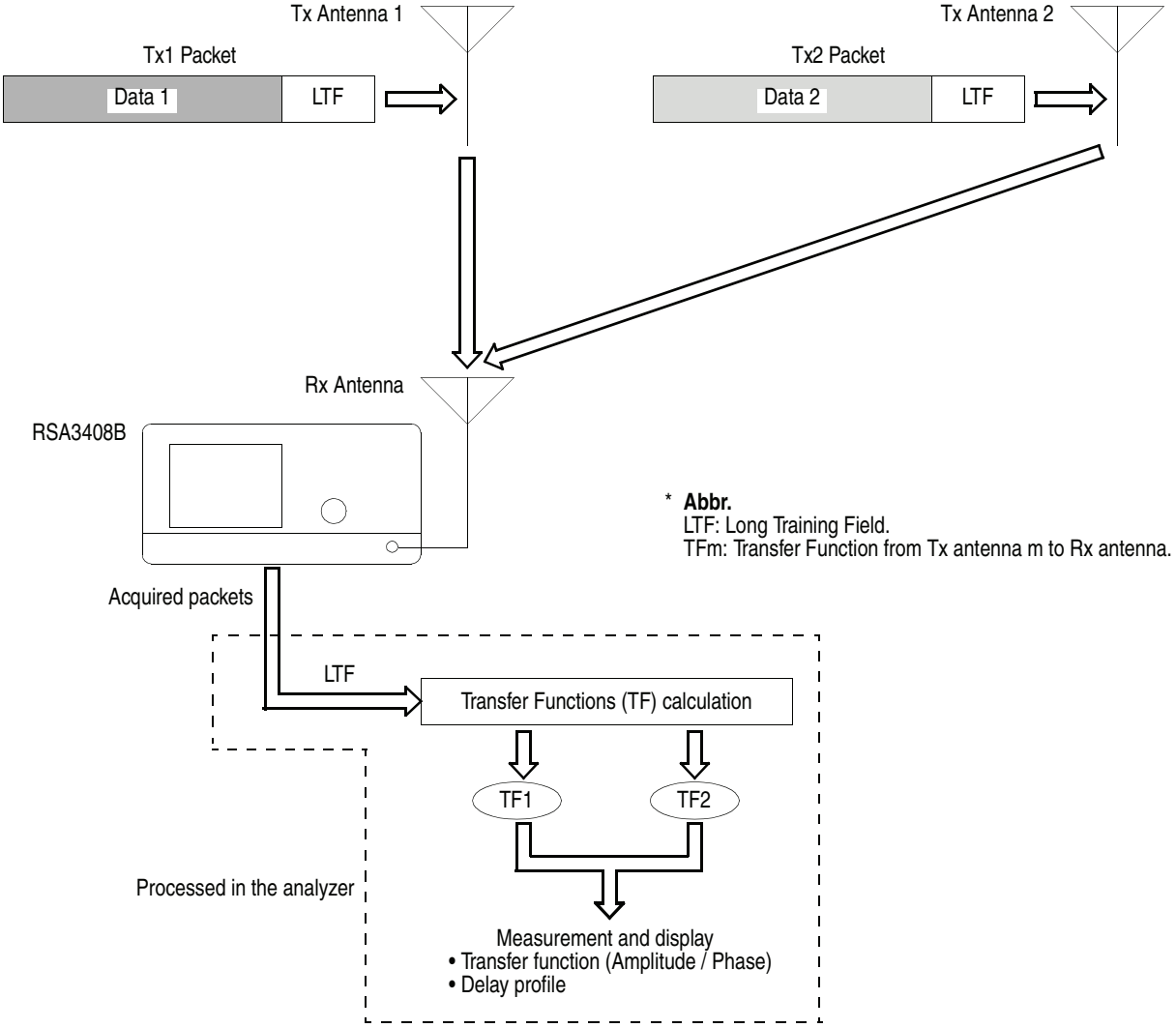


Figure 3-31: Data process flow for MISO (2x1)

Basic Measurement Procedure

The basic measurement procedures are described for the modulation analysis and the power analysis.

Modulation Measurement

Do the following steps to perform the modulation measurement.

1. Press **Demod** → **Standard...** → **802.11n (nx1)**.
2. Set frequency and span appropriately using the **Frequency/Channel** and the **Span** keys. Refer to *Setting Frequency and Span* on page 2-3.
3. Set the amplitude appropriately using the **Amplitude** key.

NOTE. *If the input signal level is too high, "Overrange - increase RefLev or Atten" will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

4. Press the **Acquisition/Analysis** key and set the acquisition and analysis parameters. Refer to *Setting Acquisition and Analysis Parameters* on page 2-6.
5. After acquiring measurement data, stop the data acquisition using the **Run/Stop** key.
6. Press the **Measure** key and select a measurement item.
   For example, press the **Transfer Function (Amp)** side key to observe the amplitude transfer function.
7. Press **Meas Setup** to set the measurement parameters.

   For details on setting the Measurement Setup menu, refer to page 3-47.
8. Press **Meas Setup** → **Analyze** to start the analysis for the acquired data with the specified parameters.

   If you cancel the analysis, press the **Cancel-Back** (top) side key.
9. Use the View menu to modify the displayed graph.
   For details on setting the views, refer to *View Format* on page 3-55.

Power Measurement

The power analysis includes only the Spectrum Mask measurement. Do the following steps to perform the measurement.

1. Press **Demod** → **Standard...** → **802.11n (nx1)**.
2. Set frequency and span appropriately using the **Frequency/Channel** and the **Span** keys. Refer to *Setting Frequency and Span* on page 2-3.
3. Set the amplitude appropriately using the **Amplitude** key.

NOTE. *If the input signal level is too high, "Overrange - increase RefLev or Atten" will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

4. Press **Measure** → **Spectrum Mask** to observe the spectrum mask.
5. Press the **Meas Setup** key and set the measurement parameters.

   For details on setting the Measurement Setup menu, refer to page 3-52.
6. Use the View menu to modify the displayed graph.

   For details on setting the views, refer to *View Format* on page 3-55.

Meas Setup Menu

Press the **Meas Setup** key to set the measurement parameters. The Meas Setup menu varies among the measurement items. Refer to the section shown in Table 3-8.

Table 3-8: Measurement setup reference for the 802.11n (nx1) analysis

Measurement item	Reference section
Modulation measurements	
Transfer Function	Measurement Setup for Modulation Measurements on page 3-47
Delay Profile	
EVM versus Time	
Power versus Time	
Constellation	
EVM versus SC	
Power versus SC	
SC Constellation	
Frequency Error	
OFDM Flatness	
OFDM Linearity	
Symbol Table	
Power measurements	
Spectrum Mask	Measurement Setup for Spectrum Mask on page 3-52

*** SC: Subcarrier**

Measurement Setup for Modulation Measurements

The Meas Setup menu for the modulation analysis has the following controls:

Analyze Performs measurements for packets in the analysis range.

NOTE. *When you change settings in the Meas Setup menu described below, press the* **Analyze** *side key to perform the measurement for the modified settings.*

Analysis Parameter... You need to set the analysis parameters before pressing the **Analyze** side key.

Synchronization. Selects the synchronization method.

- **LTF.** *Default*. Synchronizes with the Long Training Field.
- **Pilot.** Synchronizes with the pilot signals.

Equalization. Determines whether to apply the data correction using the long training symbol during the analysis.

- **On.** *Default.* Enables the data correction.
- **Off.** Disables the data correction.

Signal Format. Selects the signal format.

- **1x1.** *Default.* Selects the communication by one Tx and one Rx antenna.
- **2x1.** Selects the communication by two Tx antennas and one Rx antenna.

Select Tx Antenna... *For Transfogram (Amplitude/Phase) or Delayogram in the subview only.* Selects the transmission antenna. This item is available when the analysis is done with **Signal Format** set to **2x1**.

- **Tx Antenna 1.** Displays the measurement results for signals transmitted by Tx Antenna 1.
- **Tx Antenna 2.** Displays the measurement results for signals transmitted by Tx Antenna 2.

Packet # Selects a packet to analyze.
Range: –[(the number of packets in the analysis range) – 1] to 0.
Zero (0) represents the latest packet.

Select Subcarrier... Selects the subcarrier type for displaying the graph.

- **Data + Pilot.** *Default.* Displays the measurement results for data and pilot.
- **Data.** Displays the measurement results for data only.
- **Pilot.** Displays the measurement results for pilot only.
- **Single Subcarrier.** Displays the measurement results for the subcarrier specified using the **Subcarrier #** side key below.

Subcarrier # Specifies the subcarrier number for the measurement. Range: –64 to +63. The function varies by measurement as shown in Table 3-9.

Symbol # Specifies the analysis symbol number for the measurement. The function varies by measurement as shown in Table 3-9. Range: –[(the number of symbols in the analysis range) – 1] to 0. Zero (0) represents the latest analysis symbol.

NOTE. *For definition of the analysis symbol, refer to page 3-50.*

The **Packet #**, **Select Subcarrier...**, **Subcarrier #**, *and* **Symbol #** *menu items have different effect by measurement as shown in Table 3-9.*

Table 3-9: Submenu availability

Measure menu item	Packet #	Select Subcarrier...	Subcarrier #	Symbol #
Transfer Function	D	-	M	D
Delay Profile	D	-	-	D
EVM versus Time	M	D	S	M
Power versus Time	M	D	S	M
Constellation	M	D	S	M
EVM versus SC	D	-	M	D
Power versus SC	D	-	M	D
SC Constellation	D	-	M	D
Frequency Error	M	D	S	M
OFDM Flatness	-	-	M	-
OFDM Linearity	-	-	-	-
Symbol Table	D	-	M	D

D: Changing the setting updates the measurement data.
M: Changing the setting updates the marker position.
S: Changing the setting updates the measurement data only when Select Subcarrier is set to Single Subcarrier.

Abbreviation. SC: Subcarrier

Definition of the Analysis Symbol. In the modulation analysis, it is important to calculate average values of RMS voltage or center frequency error for enough time to get good analysis results. The length of a signal to calculate the RMS voltage or center frequency error is called "analysis symbol" in the WLAN analysis software. For example, frequency error by the analysis symbol is displayed on the center frequency error view. Although "symbol" is defined for OFDM in the 802.11n standard, "analysis symbol" is used in the WLAN analysis software taking the other modulation types into account.

The following views display the averaged values by analysis symbol for power, EVM, magnitude error, and phase error, respectively.

- Power versus Time
- EVM versus Time
- MagErr versus Time
- PhaseErr versus Time

The following views display analysis results of power, EVM, magnitude error, and phase error, respectively for each data point, chip, or subcarrier contained in one analysis symbol.

- Power versus SC
- EVM versus SC
- MagErr versus SC
- PhaseErr versus SC

The length of an analysis symbol depends on the modulation type as follows:

Table 3-10: Length of an analysis symbol, IEEE802.11n

Part of a signal	Type of the signal	Length of an analysis symbol
Data part	OFDM	80 (20 MHz) / 160 (40 MHz) sample points
	DSSS	88 chips
	CCK	80 chips
	PBCC	80 data points
Preamble/Header part	Short OFDM training field	16 (20 MHz) / 32 (40 MHz) sample points
	Long OFDM training field	160 (20 MHz) / 320 (40 MHz) sample points
	PLCP preamble	1584 chips
	Short PLCP preamble	792 chips
	PLCP header	528 chips
	Short PLCP header	264 chips

Modulation Type Display Filter...

Selects the modulation type(s) to display the measurement results on the screen. The results and graph are shown only for the types set to On. See Figure 3-32.

Select cell to edit. Selects an item to change the on/off setting in the table on screen. The table consists of five blocks as shown in Figure 3-32. The selected item appears on the second side key where you can turn on or off.

- **11bg.** Turns on or off the 802.11b and g formats.

All PLCP Packet format On/Off. Turns on or off all of the following PLCP (Physical Layer Convergence Protocol) packet formats.

- **Legacy.** Packets are transmitted in the legacy 802.11a/g format.
- **Mixed Mode**. Packets are transmitted with a preamble compatible with the legacy 802.11a/g. The rest of the packet has a new format.
- **Green Field.** High throughput packets are transmitted without a legacy compatible part.

All Preambles On/Off. Turns on or off all of the following preambles.

- Signal (HT-SIG)
- Short Training Field (HT-STF)
- Long Training Field (HT-LTF)

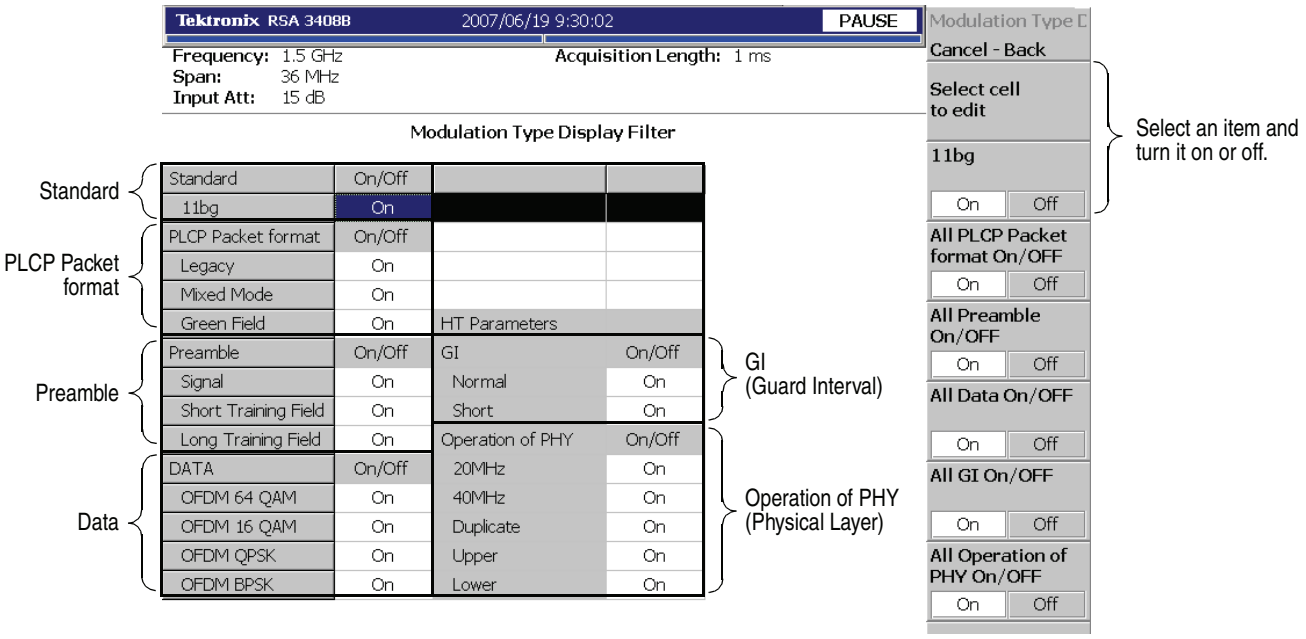


Figure 3-32: Modulation Type Display Filter setting in the nx1 analysis

All Data On/Off. Turns on or off all of the following data.

- OFDM 64QAM
- OFDM 16QAM
- OFDM QPSK
- OFDM BPSK

All GI On/Off. Turns on or off all of the following GI (Guard Interval).

- Normal (800 ns)
- Short (400 ns)

All Operation of PHY On/Off. Turns on or off all of the following operations of PHY (physical layer).

- **20MHz.** 20 MHz bandwidth HT (High Throughput) mode.
- **40MHz.** 40 MHz bandwidth HT (High Throughput) mode.
- **Duplicate.** Duplicate Legacy Mode in which the device operates in a 40 MHz channel composed of two adjacent 20 MHz channels.
- **Upper.** 40 MHz Upper Mode used to transmit a legacy or HT packet in the upper 20 MHz channel of a 40 MHz channel.
- **Lower.** 40 MHz Lower Mode used to transmit a legacy or HT packet in the lower 20 MHz channel of a 40 MHz channel.

Measurement Setup for Spectrum Mask

The Meas Setup menu for the Spectrum Mask has the following controls:

Spectrum Mask Selects the transmit spectral mask specified in the IEEE802.11n standard. (See Figure 3-33.)

- **20MHz.** *Default.* Selects the mask for 20 MHz transmission.
- **40MHz.** Selects the mask for 40 MHz transmission.

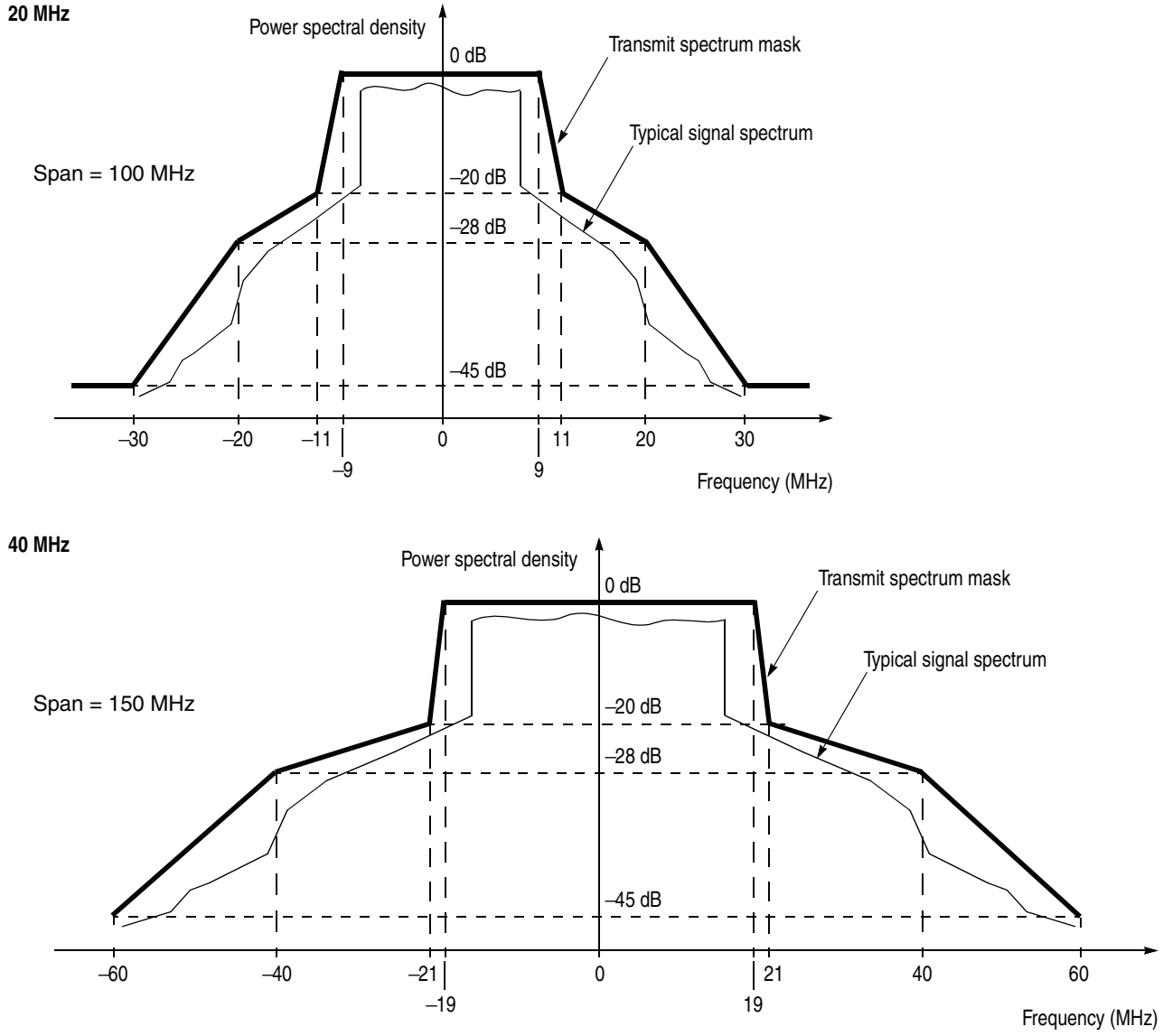


Figure 3-33: 802.11n (nx1) spectrum mask

Limits... You can edit the spectral mask. Modify the offset frequency and limit level for the points A to D shown in Figure 3-34. The setting values are indicated for each point in the limits table on the bottom of the screen. Use the following controls:

Select column to edit. Selects the column (A to D) to edit in the limits table.

Lower Offset Frequency. Sets the frequency offset from the center frequency for the selected point in the lower side.

Range: –75 MHz to –20 MHz (20 MHz mask) / –40 MHz (40 MHz mask).

Lower Limit. Sets the limit level for the selected point in the lower side.

Range: –200 to 200 dBr.

Upper Offset Frequency. Sets the frequency offset from the center frequency for the selected point in the upper side.

Range: 20 MHz (20 MHz mask) / 40 MHz (40 MHz mask) to 75 MHz.

Upper Limit. Sets the limit level for the selected point in the upper side.

Range: –200 to 200 dBr.

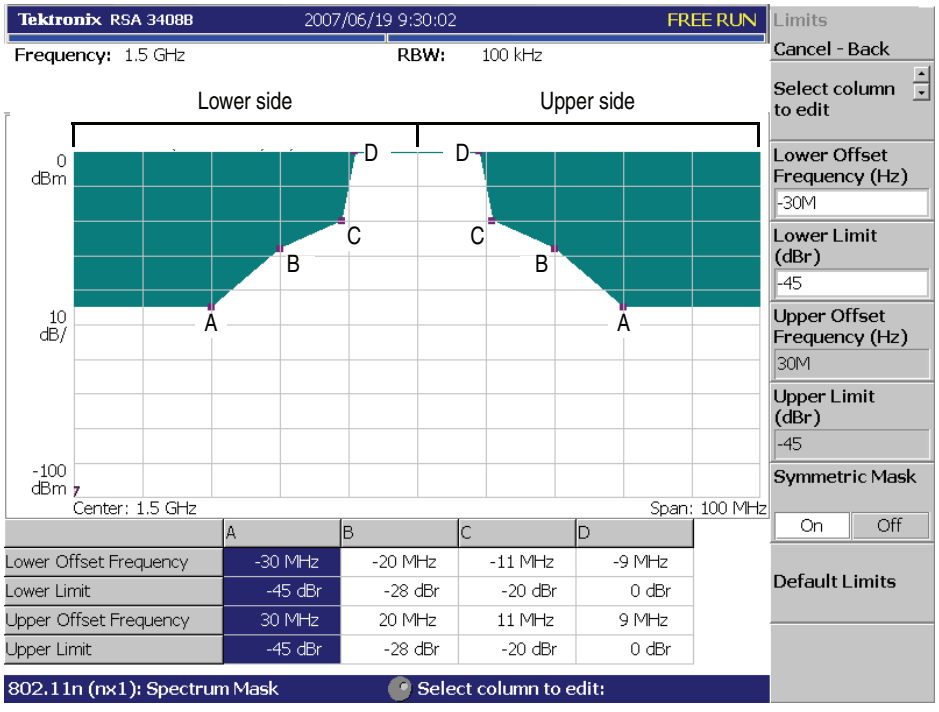


Figure 3-34: Editing the spectral mask

Symmetric Mask. Determines whether the mask is symmetrical or not.

- **On.** Creates a symmetrical mask. Set the frequency offset and limit values for the lower side only.
- **Off.** Allows you to set the frequency offset and limit values for the lower and the upper side separately.

Default Limits. Returns the offset and limit settings to the default values.

View Format

This section provides information about the view formats specific to the 802.11n (nx1) analysis. It consists of two parts:

- View Format for Modulation Measurements
- View Format for Power Measurements

Selecting View Content

You can change the view content with the View: **Define** key on the front panel. The view contents depend on the measurement items as shown in Table 3-11. In the EVM measurement, you can change the measurement content pressing View: **Scale/Lines →View Scale...**.

Table 3-11: View content selection, 802.11n (nx1)

Measurement item	View: Define → Overview content	View: Define → Subview content	View: Scale/Lines → View Scale... → Measurement content
Modulation measurement			
Transfer Function (Amplitude)	Waveform (default) Spectrogram	Spectrum (default) Transogram (Amplitude / Phase) Transfer Function (Amplitude / Phase) Delayogram Delay Profile Constellation EVM versus Time Power versus Time SC Constellation EVM versus SC Power versus SC Frequency Error OFDM Flatness OFDM Linearity Symbol Table	-
Transfer Function (Phase)			-
Delay Profile			-
EVM versus Time			EVM Mag Err Phase Err
Power versus Time			-
Constellation			Vector / Constellation
EVM versus SC			EVM Mag Err Phase Err
Power versus SC			-
SC Constellation			Vector / Constellation
Frequency Error			-
OFDM Flatness			-
OFDM Linearity			Vector / Dot
Symbol Table			-
Power measurement			
Spectrum Mask	-	-	-

*** SC: Subcarrier**

NOTE. *The View menu for Spectrum Mask is the same as in the S/A (Spectrum Analysis) mode. Refer to the* RSA3408B User Manual.

List Display

The measurement results are represented in graph form by default. You can select the list display as shown in Figure 3-35. Press View: **Define → Display → List**.

IEEE 802.11n

Modulation : LongPreamble Packet Mode : Legacy Mode
Tx Antenna Number :
Number of Symbol : 13

	Unit	Min	Mean	Max
EVM	%	1.288	1.37	1.471
	dB	-37.805	-37.263	-36.651
Mag Error	%	0.55	0.793	0.93
	dB	-45.188	-42.018	-40.63
Phase Error	deg	0.409	0.474	0.55
Power	dBm	-13.705	-13.688	-13.663
	W	42.611 µ	42.772 µ	43.023 µ
Freq Error	Hz	-224.965	-133.659	-22.574
Origin Offset	dB			

Figure 3-35: List display

View Format for Modulation Measurements

The modulation measurement result is displayed in the main view, showing the packet information and measured values on the left side and the measurement graph on the right side (see Figure 3-36).

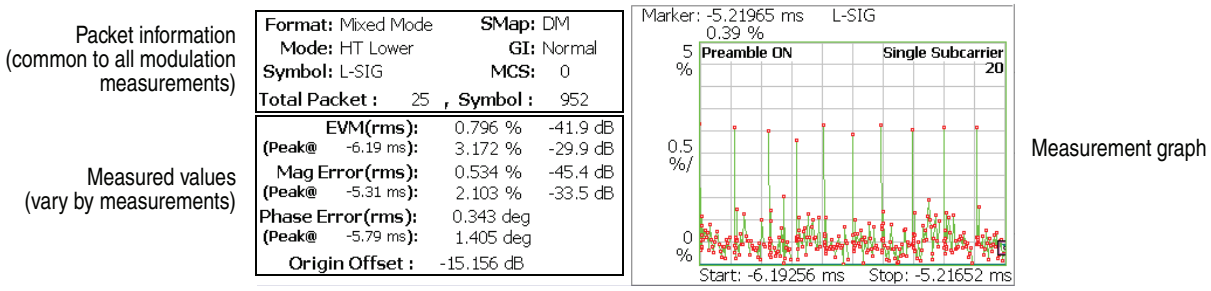


Figure 3-36: Measurement result display (an example of EVM versus Time)

Packet Information

The packet information displayed on the left side of the main view is common to all modulation measurements, containing the following fields:

Format. indicates the signal format.

- **Legacy.** Packets are transmitted in the legacy 802.11a/b/g format.
- **Mixed Mode.** Packets are transmitted with a preamble compatible with the legacy 802.11a/g and the rest of the packet has a new format.
- **Green Field.** HT packets are transmitted without a legacy 802.11a/b/g compatible part.

Mode. Indicates the operating mode. There are two major modes:

- **Legacy.** The legacy mode equivalent to 802.11a/b/g.
- **HT.** The HT (High Throughput) mode specified in 802.11n.

Each mode is further divided to the following modes by the frequency band used:

- **20 MHz.** Uses 20 MHz bandwidth.
- **40 MHz.** Uses 40 MHz bandwidth (HT mode only).
- **Duplicate.** Uses a 40 MHz channel composed of two adjacent 20 MHz channel.
- **Upper.** Uses the upper 20 MHz channel of a 40 MHz channel.
- **Lower.** Uses the lower 20 MHz channel of a 40 MHz channel.

Symbol. Indicates the type of preamble, header, or data of the analysis symbol.

- Long or Short Preamble
- L-STF (Legacy Short Training Field)
- L-LTF (Legacy Long Training Field)
- Long or Short Header
- L-SIG (Legacy Signal Field)
- DSSS 1M or 2M
- CCK 5.5M or 11M
- PBCC 5.5M, 11M, 22M, or 33M
- OFDM BPSK, QPSK, 16QAM, or 64QAM
- HT-STF (High Throughput Short Training Field)
- HT-LTF (High Throughput Long Training Field)
- HT-SIG (High Throughput Signal Field)

SMap. Indicates the spatial mapping.

- DM (Direct Mapping)
- STBC (Space Time Block Coding)

GI. Indicates the guard interval.

- Normal (800 ns)
- Short (400 ns)

MCS. Indicates the MCS (Modulation and Coding Scheme) index (0 to 76) specified in 802.11n. For the details on MCS, refer to the 802.11n specification.

Total Packet / Symbol. Indicates the total number of packets and analysis symbols in the analysis range, respectively.

Transfer Function (Amplitude)

The main view displays the amplitude transfer function as shown in Figure 3-37. This graph indicates an amplitude variation for each subcarrier during the signal propagation from Tx system to Rx system. The horizontal axis represents subcarrier number and the vertical axis represents amplitude variation in dBm.

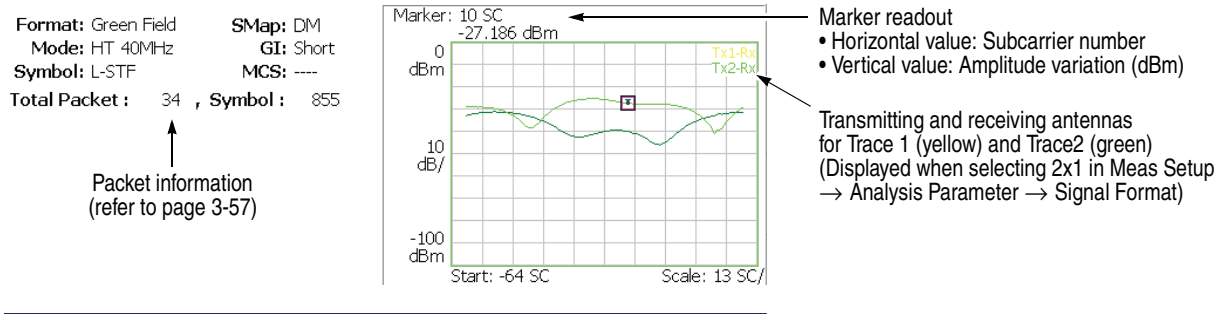


Figure 3-37: Transfer function, amplitude (main view)

Scale Menu. The Scale menu for Transfer Function (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to 8.

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 0 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfogram (Amplitude)

Subview only. It displays the time series of amplitude transfer function. The amplitude at a given subcarrier and time (packet number) is displayed as a color map in a two dimensional diagram as shown in Figure 3-38.

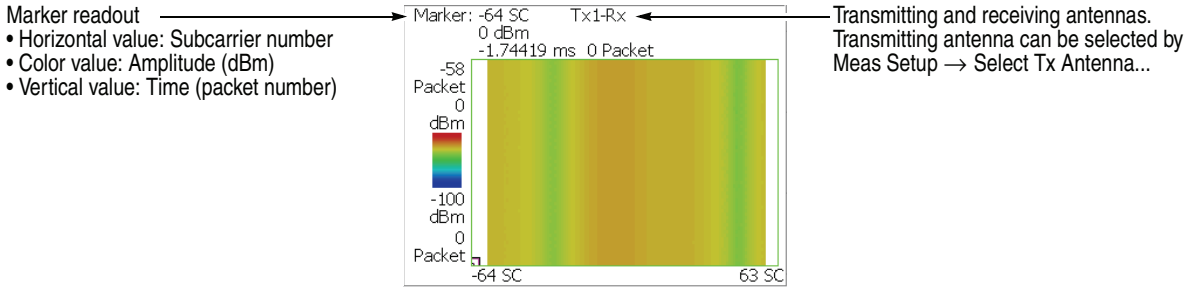


Figure 3-38: Transogram, amplitude (subview)

Scale Menu. The Scale menu for Transogram (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the start subcarrier number of the horizontal axis.
Range: –64 to 8.

Vertical Size. Sets the full scale of the vertical axis.
Range: 58 to 59392 packets.

Vertical Start. Sets the start packet number of the vertical axis.
Range: – [(the number of packets in the analysis range) – 1] to 0.
Zero (0) represents the latest packet.

Color Scale. Sets the range of the color axis.
Range: 10 to 100 dB in a 1-2-5 sequence.

The transfogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to 100 [dB].

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

Transfer Function (Phase)

The main view displays the phase transfer function as shown in Figure 3-39. This graph indicates a phase lead or lag for each subcarrier during the signal propagation from Tx system to Rx system. The horizontal axis represents subcarrier number and the vertical axis represents phase lead or lag in degrees or radians.

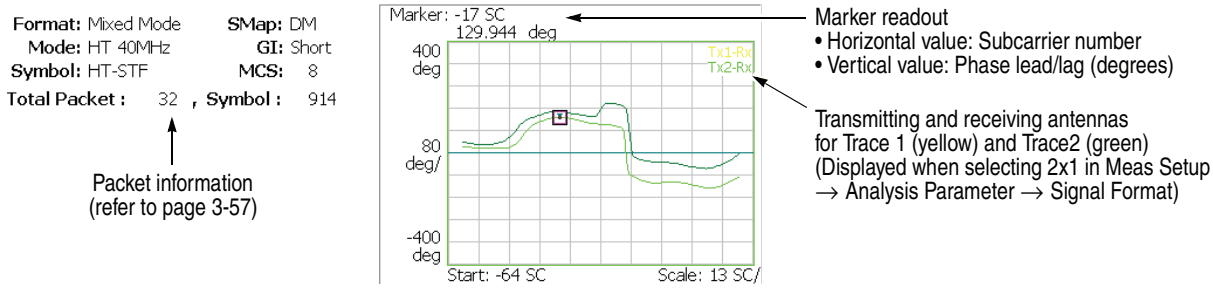


Figure 3-39: Transfer function, phase (main view)

Scale Menu. The Scale menu for Transfer Function (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to 8.

Vertical Scale. Sets the range of the vertical axis.
Range: 800 µ to 800 degrees.

Vertical Star. Sets the minimum value (bottom edge) of the vertical axis.
Range: –1200 to 400 degrees.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfogram (Phase) *Subview only.* It displays the time series of phase transfer function. The phase at a given subcarrier and time (packet number) is displayed as a color map in a two dimensional diagram as shown in Figure 3-40.

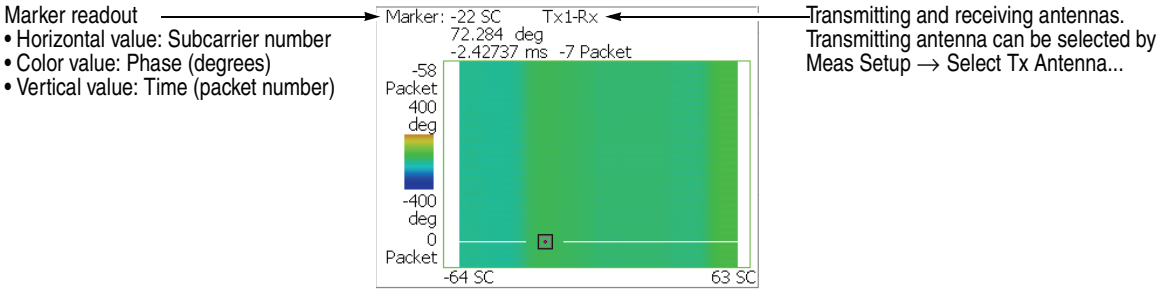


Figure 3-40: Transfogram, phase (subview)

Scale Menu. The Scale menu for Transogram (Phase) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the start channel number of the horizontal axis.
Range: –64 to 8.

Vertical Size. Sets the full scale of the vertical axis.
Range: 58 to 59392 packets.

Vertical Start. Sets the start packet number of the vertical axis.
Range: – [(the number of packets in the analysis range) – 1] to 0.
Zero (0) represents the latest packet.

Color Scale. Sets the range of the color axis:
Range: 10 to 100 dB in 1-2-5 sequence.

The transogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to +100 dB.

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

Delay Profile

The main view shows the delay profile as shown in Figure 3-41. In the n×1 communication method, transmitted signals propagate through multipath with different distance to reach a receiving antenna. The path difference causes the received signals some temporal dispersion. The delay profile shows the power distribution to the delay time. The vertical axis represents amplitude in dBm and the horizontal axis represents delay time in seconds.

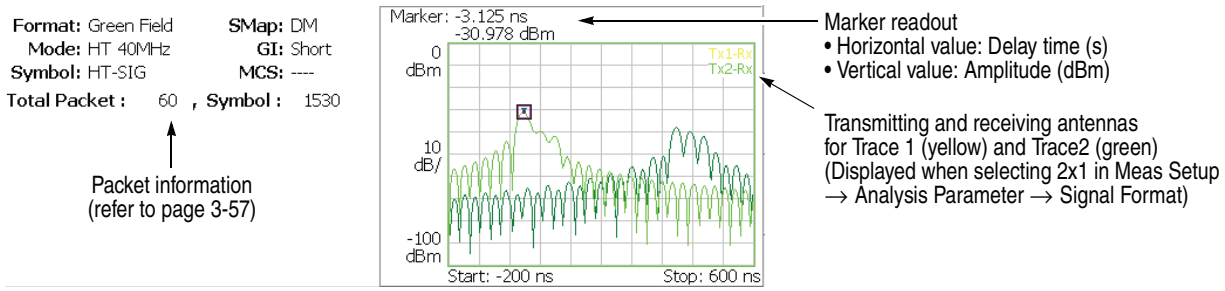


Figure 3-41: Delay profile (main view)

Scale Menu. The Scale menu for Delay Profile has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: $S_0/16$ to S_0 (sec) where S_0 is the initial horizontal scale.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: $-S_0/2$ to $[S_0/2 - (\text{Horizontal Scale})]$ (sec).

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Star. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 0 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Delayogram *Subview only.* It displays the time series of delay profile.
The power at a given delay time and packet number is displayed as a color map in a two dimensional diagram as shown in Figure 3-42.

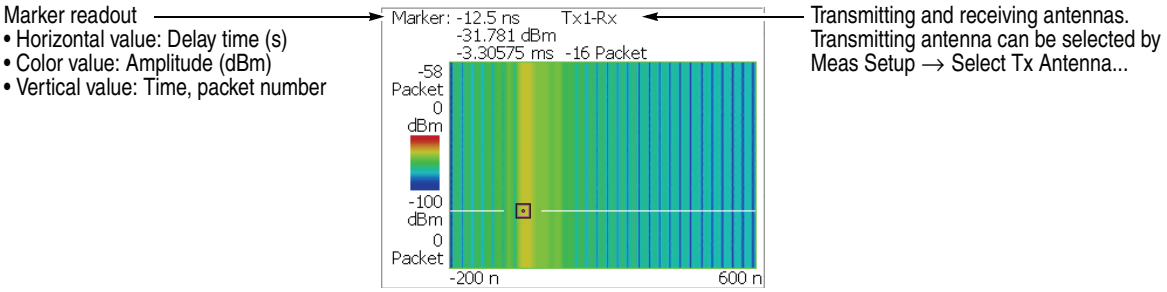


Figure 3-42: Delayogram (subview)

Scale Menu. The Scale menu for Delayogram has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: $S_0/16$ to S_0 (sec) where S_0 is the initial horizontal scale.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: $-S_0/2$ to $[S_0/2 - (\text{Horizontal Scale})]$ (sec).

Vertical Size. Sets the full scale of the vertical axis in frames.
Range: 58 to 59392.

Vertical Start. Sets the start packet number of the vertical axis.
Range: – [(the number of packets in the analysis range) – 1] to 0.
Zero (0) represents the latest packet.

Color Scale. Sets the range of the color axis:
Range: 10 to 100 dB in 1-2-5 sequence.

The delayogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to +100 dB.

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

EVM versus Time

The main view shows the EVM of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-43. The vertical axis represents EVM in percent and the horizontal axis represents time in seconds.

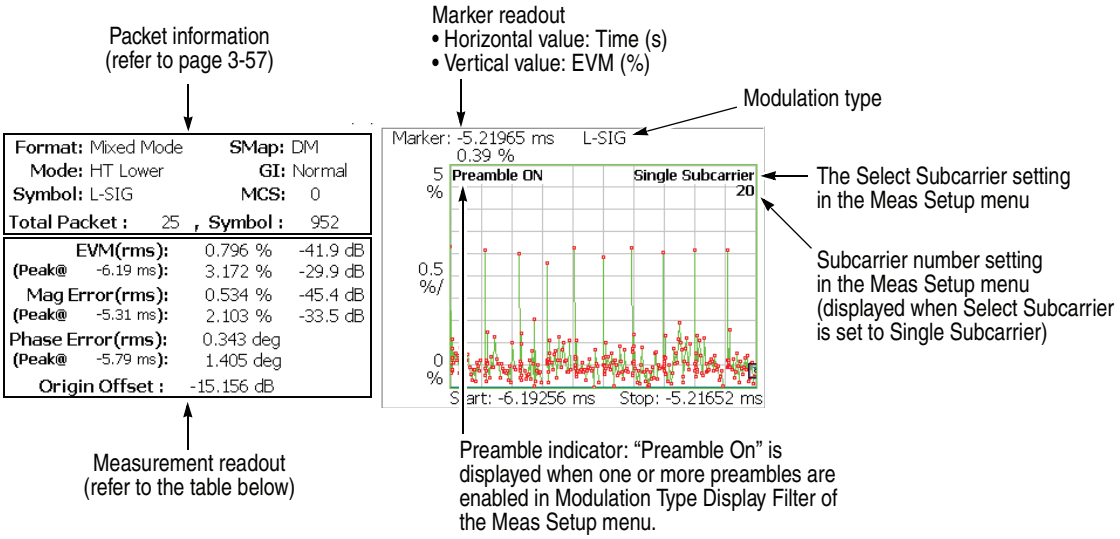


Figure 3-43: EVM versus Time (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
EVM (rms)	%, dB	RMS value of EVM
(Peak @ time)	%, dB	Peak value of EVM at the time [1]
Mag Error (rms)	%, dB	RMS value of Mag Error
(Peak @ time)	%, dB	Peak value of Mag Error at the time [1]
Phase Error (rms)	degrees or radians	RMS value of Phase Error
(Peak @ time)	degrees or radians	Peak value of Phase Error at the time [1]
Origin Offset	dB	Origin offset (IQ feedthrough)

1. **The time is relative to the last data point.**

Scale Menu. The Scale menu for EVM versus Time has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Refer to Table 3-12 for the setting range.

Vertical Start. When the measurement content is EVM, sets the minimum value (bottom edge) of the vertical axis. Refer to Table 3-12 for the setting range.

Vertical Offset. When the measurement content is Mag Error or Phase Error, sets the center value ((maximum + minimum) / 2) of the vertical axis.
Refer to Table 3-12 for the setting range.

Table 3-12: Vertical setting range

Measurement	Vertical Scale	Vertical Start	Vertical Offset
EVM	100 µ to 100%	−100 to 100%	-
Magnitude error	200 µ to 200%	-	−200 to 200%
Phase error	450 µ to 450°	-	−450 to 450°

Full Scale. Sets the scale of vertical axis to the default full-scale value.

Measurement Content... Selects how to display the vertical axis:

- **EVM.** Represents the vertical axis with EVM (Error Vector Magnitude).
- **Mag Error.** Represents the vertical axis with magnitude error.
- **Phase Error.** Represents the vertical axis with phase error.

MagErr versus Time

The main view shows the magnitude error of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-44. The vertical axis represents magnitude error in percent and the horizontal axis represents time in seconds.

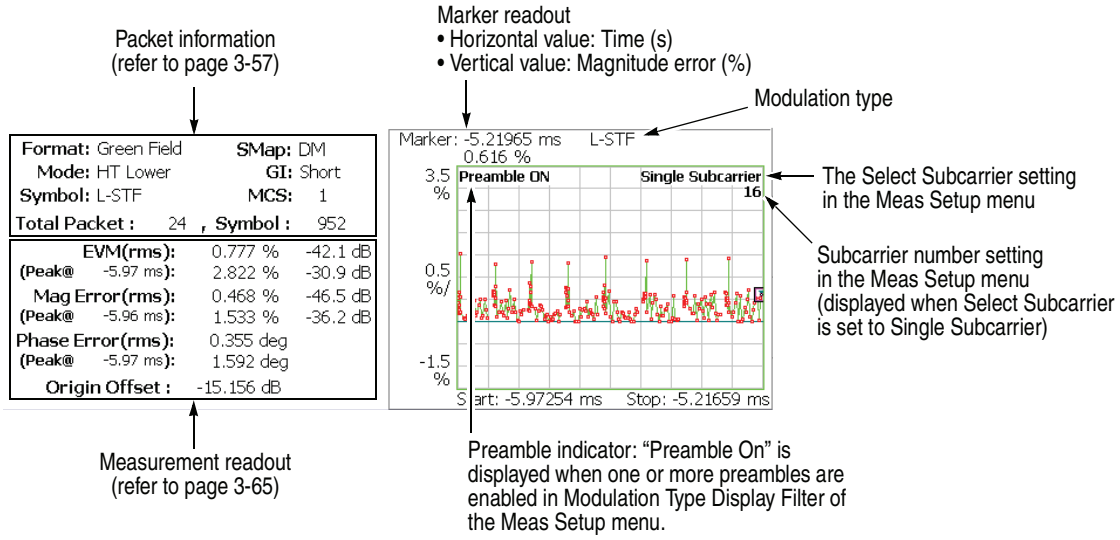


Figure 3-44: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. Refer to the Scale menu of EVM versus Time on page 3-66.

PhaseErr versus Time

The main view shows the phase error of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-45. The vertical axis represents phase error in degrees or radians and the horizontal axis represents time in seconds.

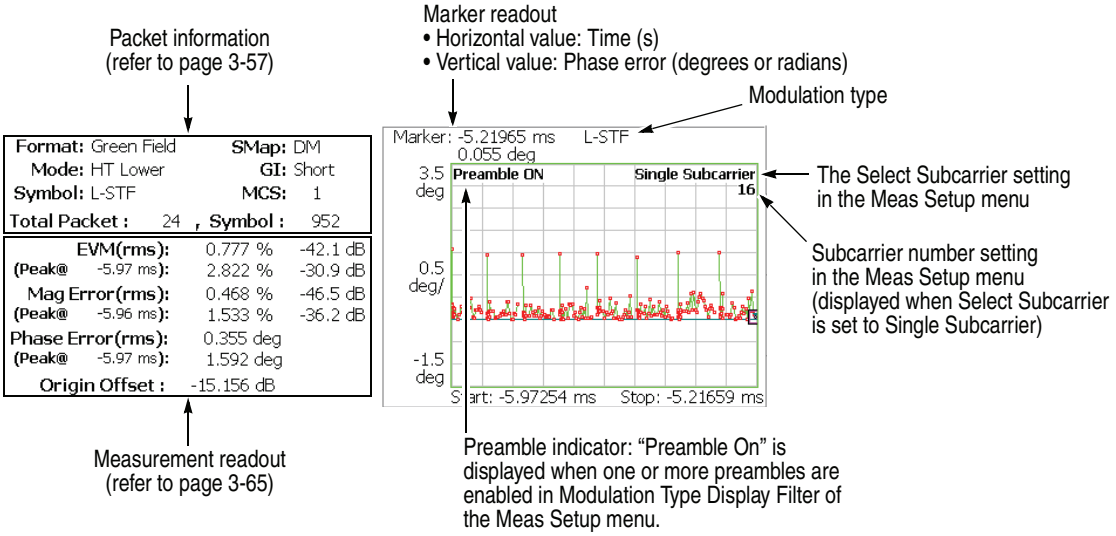


Figure 3-45: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. Refer to the Scale menu of EVM versus Time on page 3-66.

Power versus Time

The main view shows the power of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-46. The vertical axis represents power in dBm and the horizontal axis represents time in seconds.

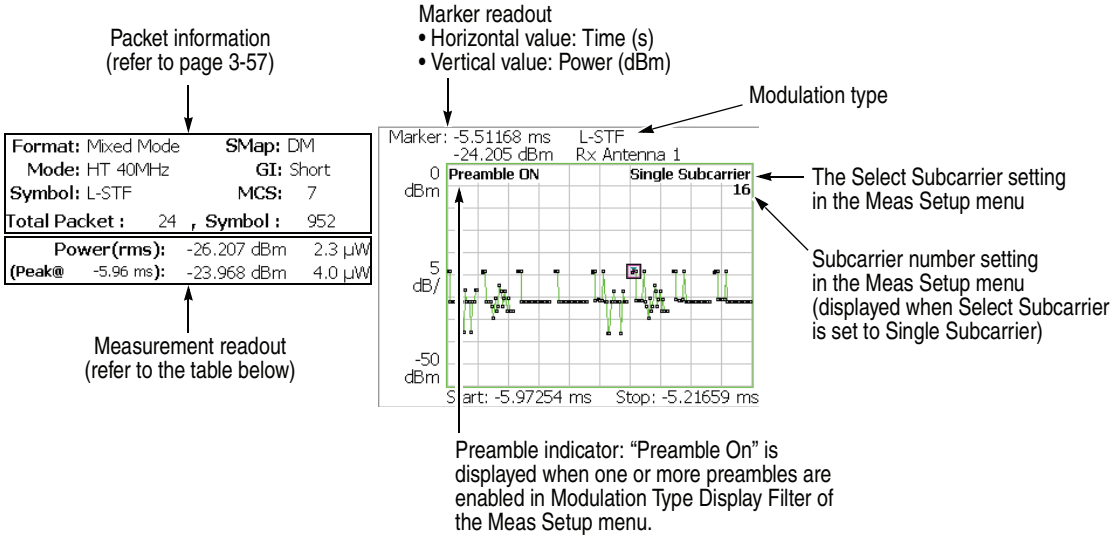


Figure 3-46: Power versus Time (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Power (rms)	dBm, W	RMS power of one or all subcarriers
(Peak @ time)	dBm, W	Peak power of one or all subcarriers at the time (The time is relative to the last data point.)

Scale Menu. The Scale menu for Power versus Time has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Range: 50 µ to 50 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: –50 to 50 dB.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Constellation

The main view displays the constellation of one or all subcarriers in a rectangular coordinate graph, as shown in Figure 3-47. The horizontal axis represents I and the vertical axis represents Q.

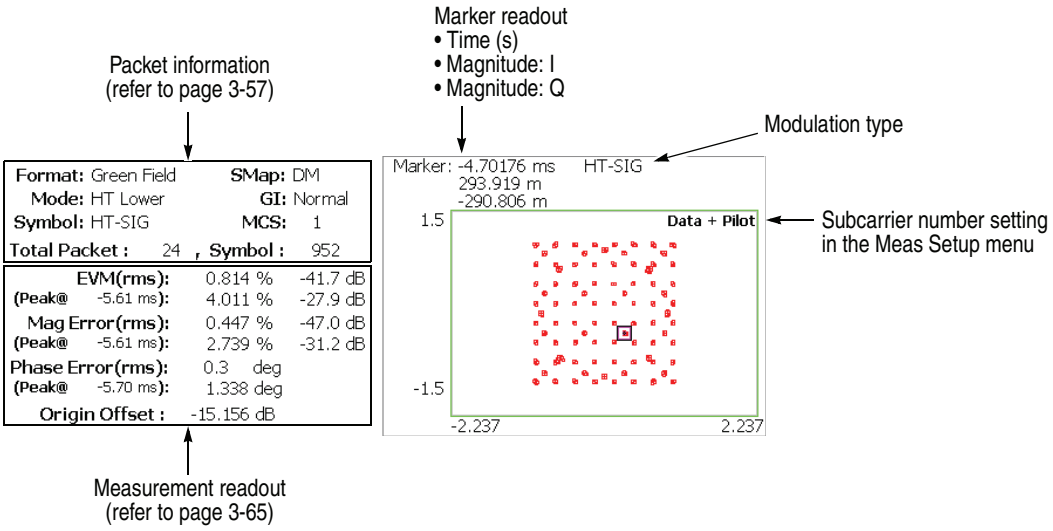


Figure 3-47: Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. The Scale menu for the constellation has the following controls:

Measurement Content... Selects vector or constellation display.

- **Vector.** Selects vector display. A signal represented by phase and amplitude is displayed in polar coordinate or IQ diagram. The red point indicates the symbol position of the measured signal, and the yellow trace indicates the locus of the signal between symbols.
- **Constellation.** Selects constellation display. It is the same as the vector display, except that only symbols of the measured signal are indicated in red, and the locus between symbols is not shown. The cross marks indicate the symbol positions of an ideal signal.

EVM versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the EVM of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-48. The vertical axis represents EVM in percent and the horizontal axis represents subcarrier number ranging from –64 to +63.

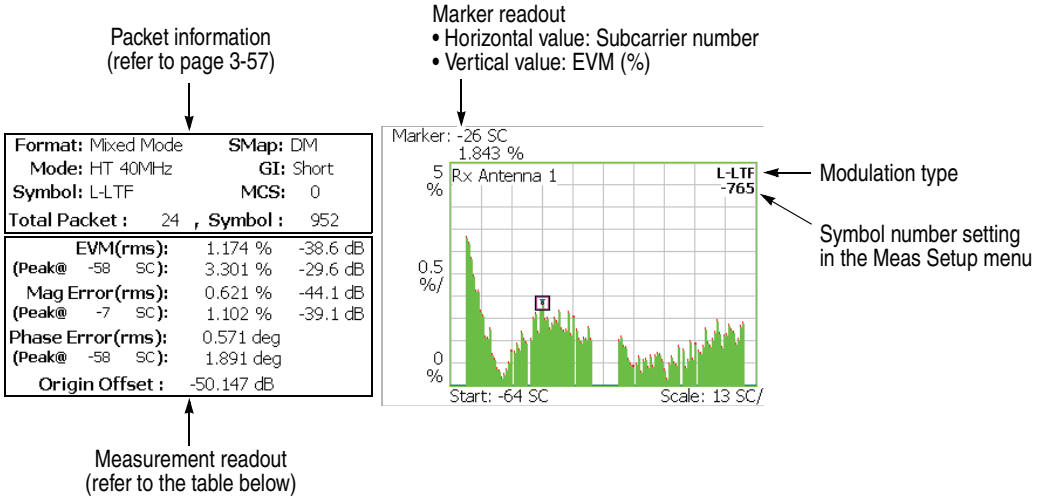


Figure 3-48: EVM versus SC (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
EVM (rms)	%, dB	RMS value of EVM
(Peak @ SC)	%, dB	Peak value of EVM at the subcarrier number
Mag Error (rms)	%, dB	RMS value of Mag Error
(Peak @ SC)	%, dB	Peak value of Mag Error at the subcarrier number
Phase Error (rms)	degrees or radians	RMS value of Phase Error
(Peak @ SC)	degrees or radians	Peak value of Phase Error at the subcarrier number
Origin Offset	dB	Origin offset (IQ feedthrough)

Scale Menu. The Scale menu in EVM versus SC for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number). Range: 16 to 128.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis. Range: –64 to [64 – (Horizontal Scale)].

Vertical Scale. Sets the range of the vertical axis.
Refer to Table 3-13 for the setting range.

Vertical Start. When the measurement content is EVM, sets the minimum value (bottom edge) of the vertical axis. Refer to Table 3-13 for the setting range.

Vertical Offset. When the measurement content is Mag Error or Phase Error, sets the center value ((maximum + minimum) / 2) of the vertical axis. Refer to Table 3-13 for the setting range.

Table 3-13: Vertical setting range

Measurement	Vertical Scale	Vertical Start	Vertical Offset
EVM	100 µ to 100%	–100 to 100%	-
Magnitude error	200 µ to 200%	-	–200 to 200%
Phase error	450 µ to 450°	-	–450 to 450°

Full Scale. Sets the scale of vertical axis to the default full-scale value.

Measurement Content... Selects how to display the vertical axis:

- **EVM.** Represents the vertical axis with EVM (Error Vector Magnitude).
- **Mag Error.** Represents the vertical axis with magnitude error.
- **Phase Error.** Represents the vertical axis with phase error.

Non-OFDM. The main view displays the EVM of carriers by analysis symbol in a bar graph, as shown in Figure 3-49. The vertical axis represents EVM in percent and the horizontal axis represents time in seconds.

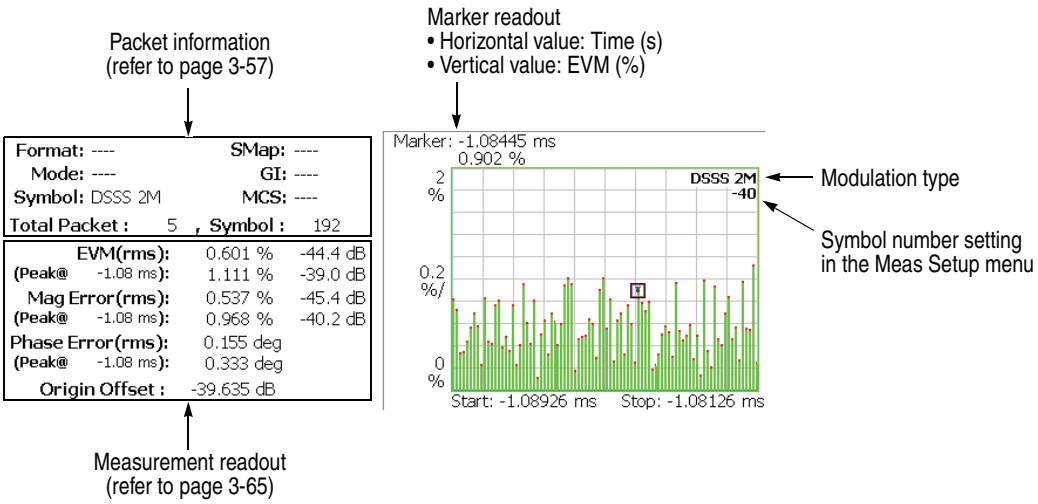


Figure 3-49: EVM versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. The Scale menu in EVM versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-66.

MagErr versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the magnitude error of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-50.
The vertical axis represents magnitude error in percent and the horizontal axis represents the subcarrier wave number ranging from −64 to +63.

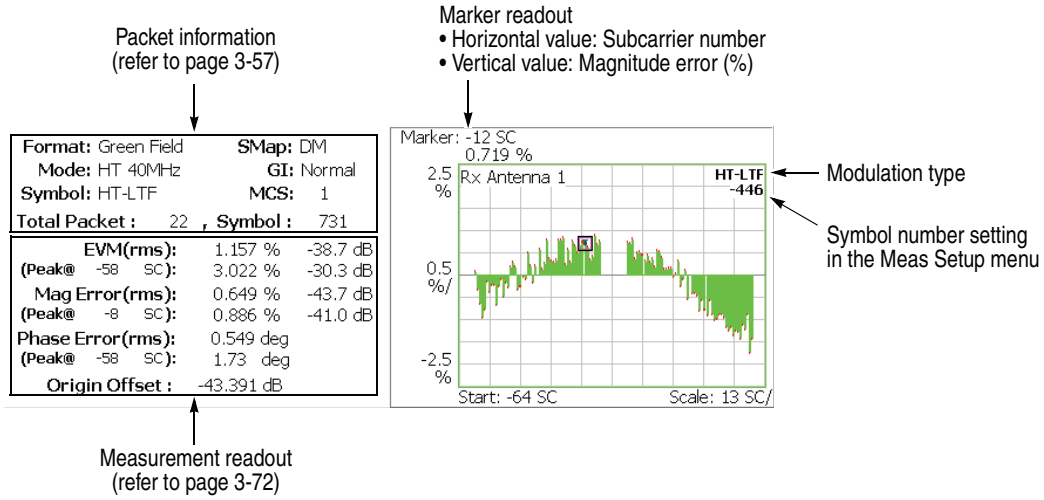


Figure 3-50: MagErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-72.

Scale Menu. Refer to the Scale menu of EVM versus SC on page 3-73.

Non-OFDM. The main view displays the magnitude error of carriers by analysis symbol in a bar graph, as shown in Figure 3-51. The vertical axis represents the magnitude error in percent and the horizontal axis represents time in seconds.

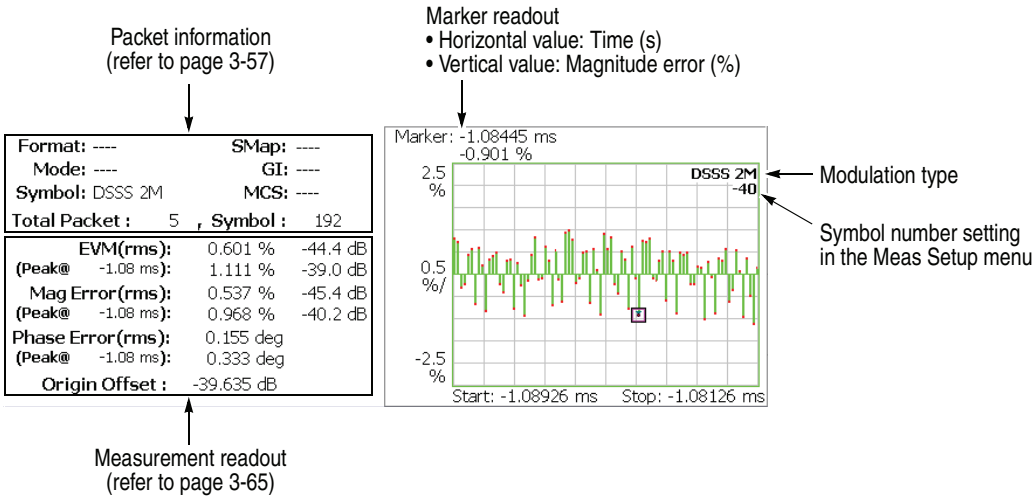


Figure 3-51: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. The Scale menu in MagErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-66.

PhaseErr versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view shows the phase error of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-52.
The vertical axis represents phase error in degrees or radians and the horizontal axis represents the subcarrier wave number ranging from −64 to +63.

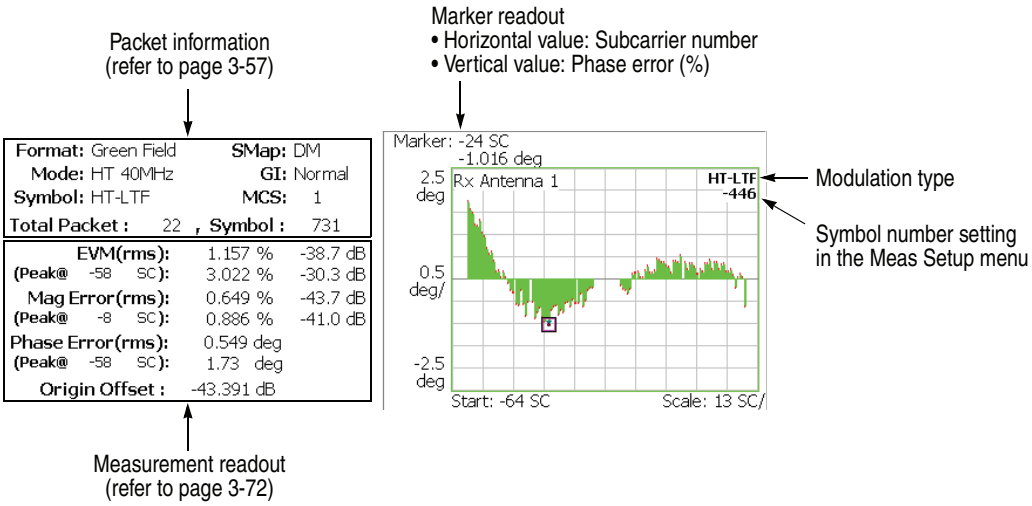


Figure 3-52: PhaseErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-72.

Scale Menu. Refer to the Scale menu of EVM versus SC on page 3-73.

Non-OFDM. The main view displays the phase error of carriers by analysis symbol in a bar graph, as shown in Figure 3-53. The vertical axis represents the phase error in degrees or radians and the horizontal axis represents time in seconds.

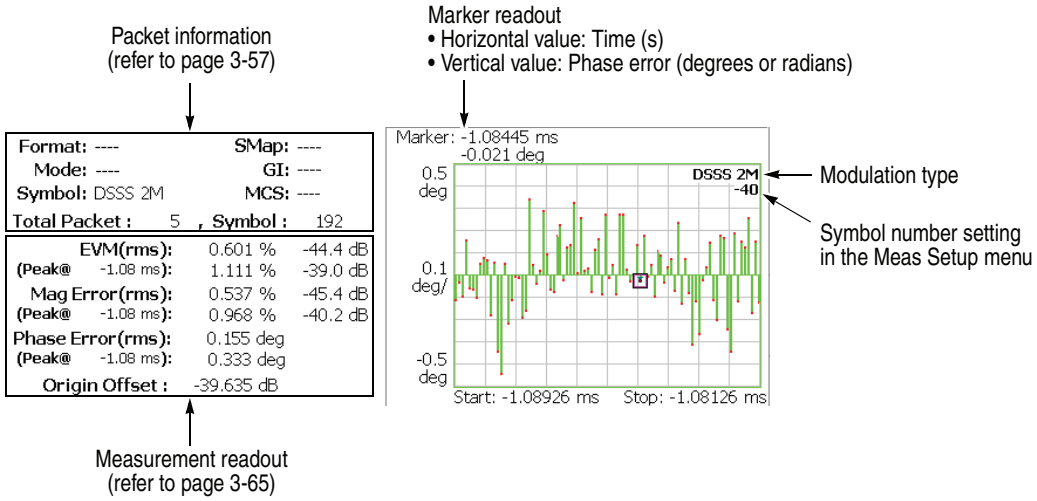


Figure 3-53: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. The Scale menu in PhaseErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-66.

Power versus SC

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The bar graph in the main view displays the power of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-54. The vertical axis represents power in dBm and the horizontal axis represents the subcarrier number ranging from −64 to +63.

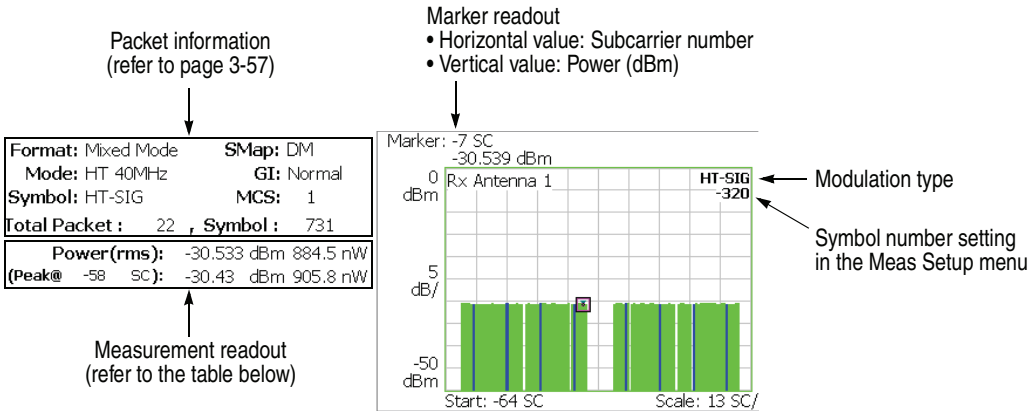


Figure 3-54: Power versus SC (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Power (rms)	dBm, W	RMS power of all subcarriers
(Peak @ SC)	dBm, W	Peak power at the subcarrier number

Scale Menu. The Scale menu in Power versus SC for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number).
Range: 16 to 128.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to [64 – (Horizontal Scale)].

Vertical Scale. Sets the range of the vertical axis.
Range: 50 µ to 50 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: –50 to 50 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Non-OFDM. The main view displays the power of carriers by analysis symbol in a bar graph, as shown in Figure 3-55. The vertical axis represents power in dBm and the horizontal axis represents time in seconds.

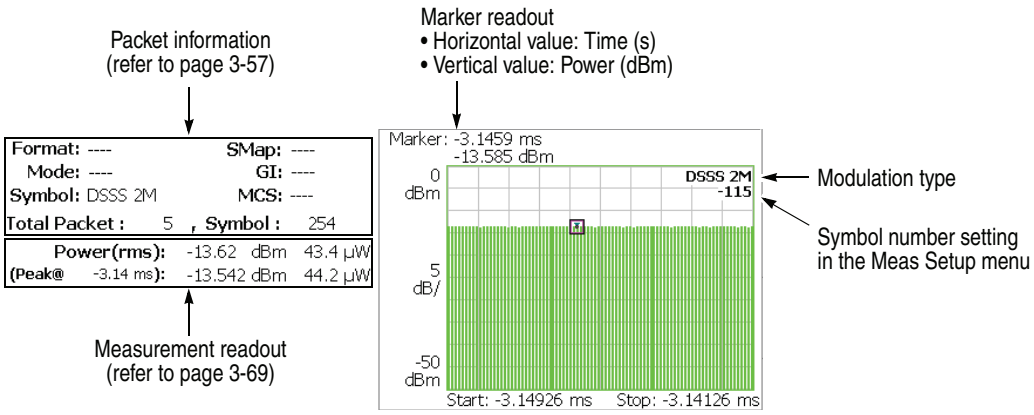


Figure 3-55: Power versus Time (main view)

The measurement readout is the same as in Power versus Time, shown in the table on page 3-69.

Scale Menu. The Scale menu in Power versus SC for Non-OFDM has the same controls as in Power versus Time. Refer to page 3-59.

SC Constellation

The displayed graph automatically toggles depending on the modulation format (OFDM or Non-OFDM).

OFDM. The main view displays the constellation of subcarriers in a rectangular coordinate graph for an analysis symbol, as shown in Figure 3-56. The horizontal axis represents I and the vertical axis represents Q.

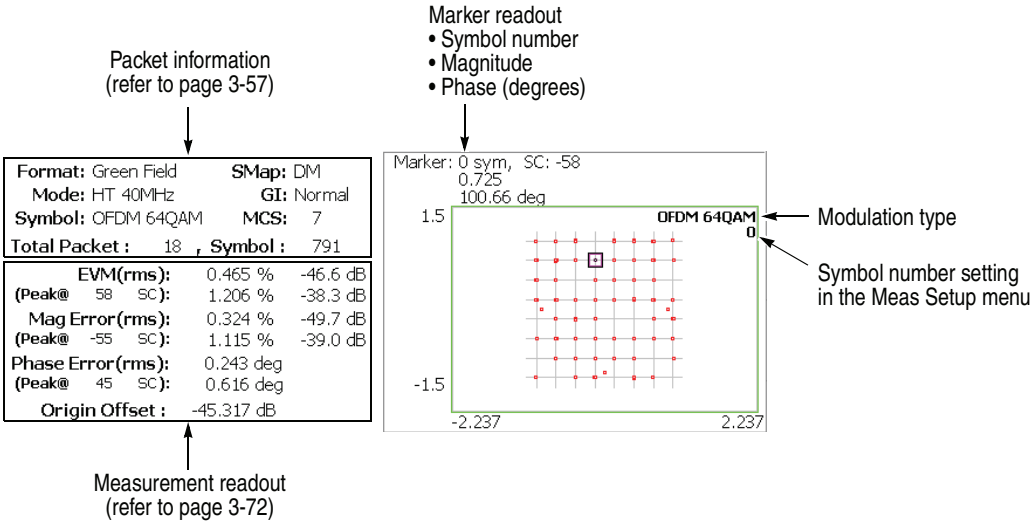


Figure 3-56: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-72.

Scale Menu. Same as in Constellation. Refer to page 3-71.

Non-OFDM. The main view displays the constellation of carriers in a rectangular coordinate graph for an analysis symbol, as shown in Figure 3-57. The horizontal axis represents I, and the vertical axis represents Q.

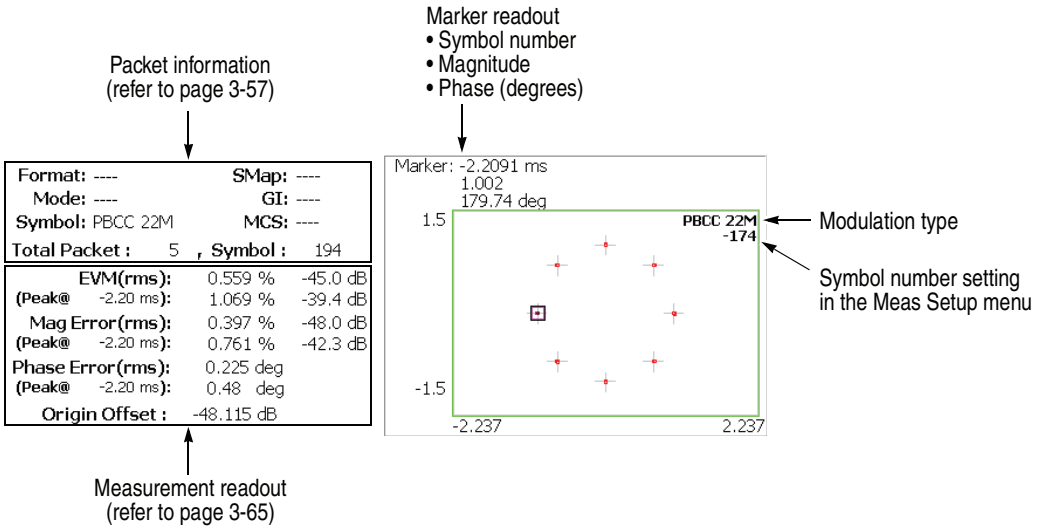


Figure 3-57: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-65.

Scale Menu. Same as in Constellation. Refer to page 3-71.

Frequency Error

The main view displays the center frequency deviation over time in a line graph, as shown in Figure 3-58. The vertical axis represents frequency error in Hz, and the horizontal axis represents time in seconds.

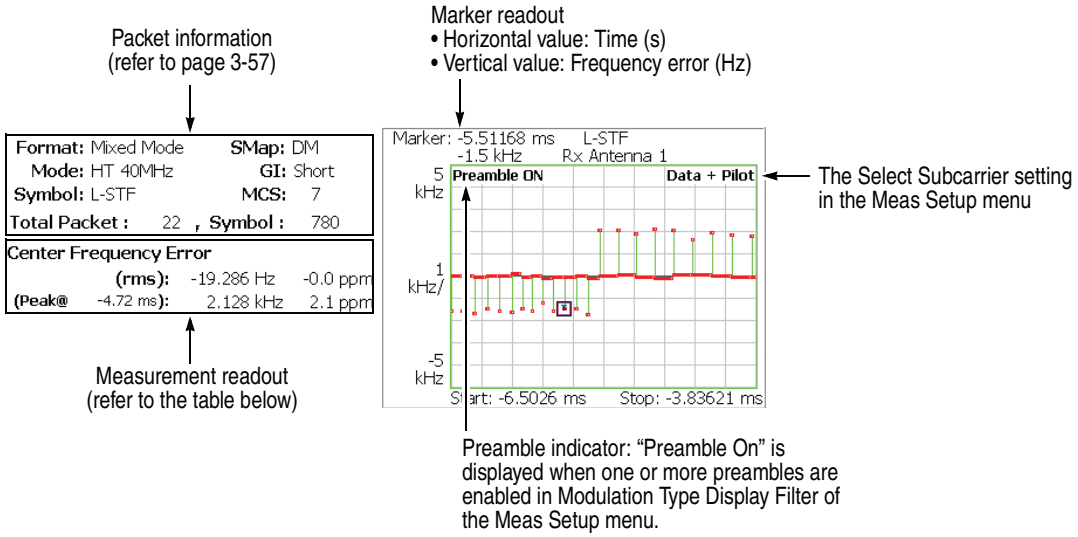


Figure 3-58: Frequency error (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Center Frequency Error (rms)	Hz, ppm	RMS frequency error
(Peak @ time)	Hz, ppm	Peak frequency error at the time (The time is relative to the last data point.)

Scale Menu. The Scale menu for Frequency Error has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis (frequency).
Range: 500 m to 500 kHz.

Vertical Offset. Sets the maximum value (top edge) of the vertical axis.
Range: –500 k to 500 kHz.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Vertical Unit. Selects the unit of vertical axis.

- Hz
- ppm

OFDM Flatness

The main view displays each subcarrier wave flatness in a bar graph, as shown in Figure 3-59. The vertical axis represents the deviation power of average energy in dB, and the horizontal axis represents subcarrier number ranging from –64 to +63.

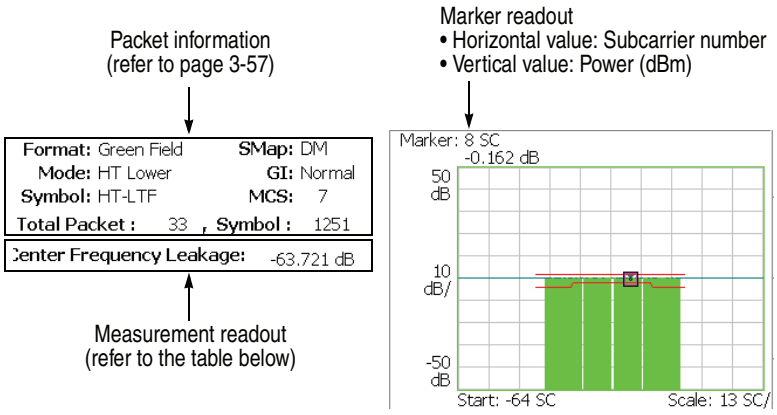


Figure 3-59: OFDM flatness (main view)

Verify that the measurement results of the bar graph fall within the threshold level displayed with two red lines.

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
Center Frequency Leakage	dB	Carrier leakage power (<2 dB in IEEE802.11a standard)

Scale Menu. The Scale menu for OFDM Flatness has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number). Range: 16 to 128.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis. Range: –64 to [64 – (Horizontal Scale)].

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Offset. Sets the maximum value (top edge) of the vertical axis.
Range: –100 to [50 + (Vertical Scale)/2] dB.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Channel Bandwidth. Selects the channel bandwidth.

- **20MHz.** Selects 20 MHz bandwidth HT (High Throughput) mode.
- **40MHz.** Selects 40 MHz bandwidth HT (High Throughput) mode.

Carrier Position. Selects the carrier position for the 20 MHz channel.

- **Upper.** Selects the upper 20 MHz of a 40 MHz channel as the carrier position.
- **Center.** *Default.* Selects the center of a 40 MHz channel as the carrier position.
- **Lower.** Selects the lower 20 MHz of a 40 MHz channel as the carrier position.

The carrier position is fixed to the center for the 40 MHz channel.

OFDM Linearity

The main view displays the linearity of OFDM modulation in a line graph, as shown in Figure 3-60. The vertical axis represents actual measurement values in mW, and the horizontal axis represents the ideal values in mW.

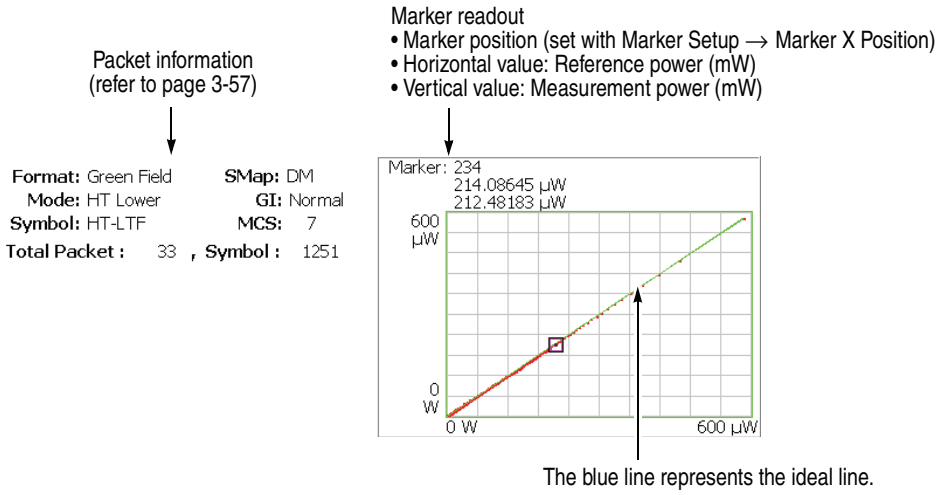


Figure 3-60: OFDM linearity (main view)

Scale Menu. The Scale menu for OFDM Linearity has the following controls:

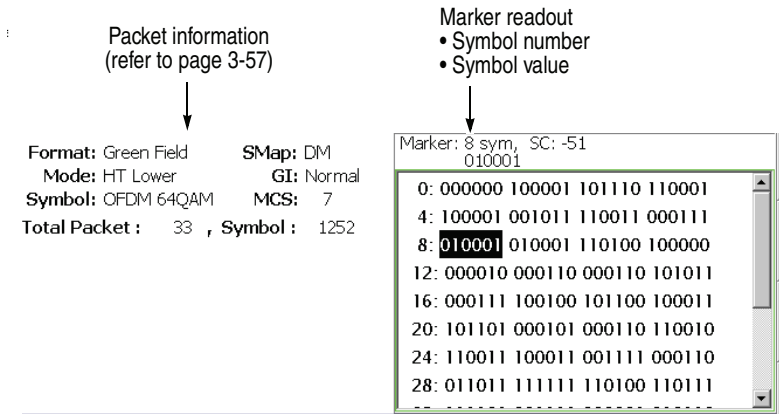
Measurement Content... Selects vector or dot display.

- **Vector.** *Default.* Displays yellow lines between the dots.
- **Dot.** Displays the calculated result as a series of red dots.

The measurement results are displayed with the horizontal and vertical axes scaled automatically to fit the graph to the screen.

Symbol Table

The main view displays the symbol table, as shown in Figure 3-61. The table can be displayed with binary, octal, or hexadecimal digits.



NOTE. To turn on the marker readout, press Marker Setup →Marker →On.

Figure 3-61: Symbol table (main view)

Scale Menu. The Scale menu for Symbol Table has the following controls:

Radix. Selects the radix for displaying the table:

- **Hex.** Hexadecimal digit
- **Oct.** Octal digit
- **Bin.** *Default.* Binary digit

Hex and Oct indicate values of binary data string in units of modulation symbol.

View Format for Power Measurement

This subsection describes all view formats for power analysis.

Spectrum Mask

The spectrum mask measurement verifies that the base station is not transmitting excessive power outside of its designated channel. The screen displays the spectrum waveform and mask as shown in Figure 3-62. The vertical axis represents power in dBm and the horizontal axis represents frequency in Hz.

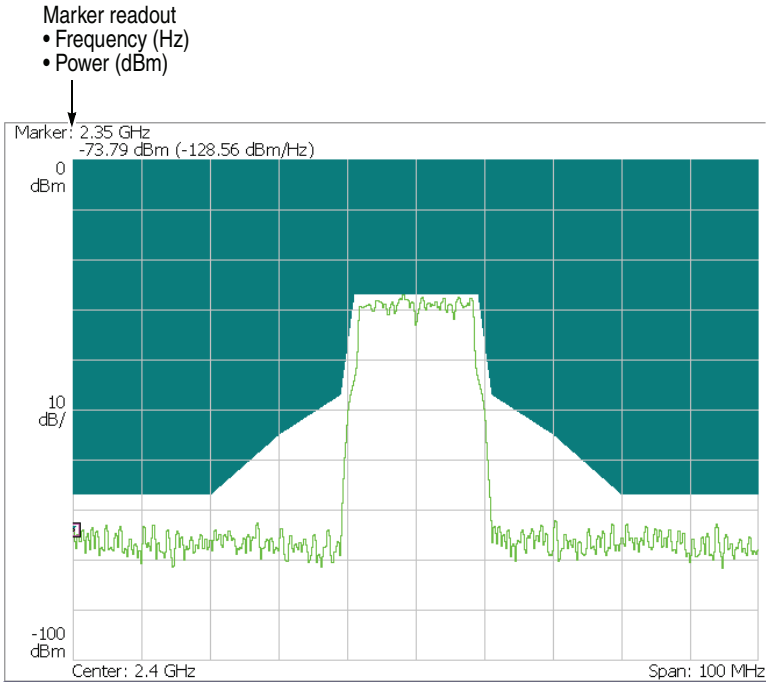


Figure 3-62: Spectrum mask (OFDM)

Verify that the measurement results (line graph) fall within the threshold level. This view does not display the measurement readouts.

Scale Menu. The Scale menu in Spectrum Mask for OFDM has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis (frequency).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

Vertical Scale. Sets the scale of the vertical axis (power).
Range: 100 µ to 100 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: –100 to 100 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Using Video Filter. The spectrum mask measurement in the 802.11n (nx1) analysis has a video filter function for compatibility with measurement data from conventional swept spectrum analyzers. Normally swept spectrum analyzers smooth the detected signal with a video filter having a bandwidth equal to the resolution bandwidth. However, you can set the bandwidth and sweep time on this analyzer. When you use the video filter, press the **RBW/FFT** key on the front panel to set the following items:

Video Filter. Determines whether to use the video filter. When you use the filter, select On. Then the following items appear:

VBW. Sets the frequency bandwidth of the video filter. Range: 1 Hz to 1 GHz. The setting value may be limited by the sweep time setting.

Sweep Time for VBW. Sets the sweep time to scan a set span.
Range: 1 ms to 100 s.

802.11n MIMO Analysis

This section describes the basic operation of the IEEE802.11n MIMO (Multi-Input Multi-Output) 2x2 analysis. You can access the measurement items by pressing **Demod →Standard... →802.11n MIMO (2x2)** as shown in Figure 3-63. The MIMO analysis performs only the modulation measurement and does not have the power measurement.

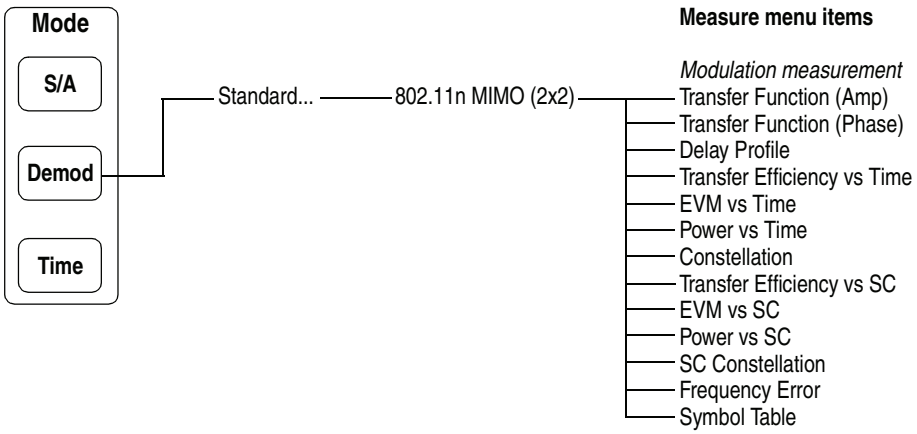


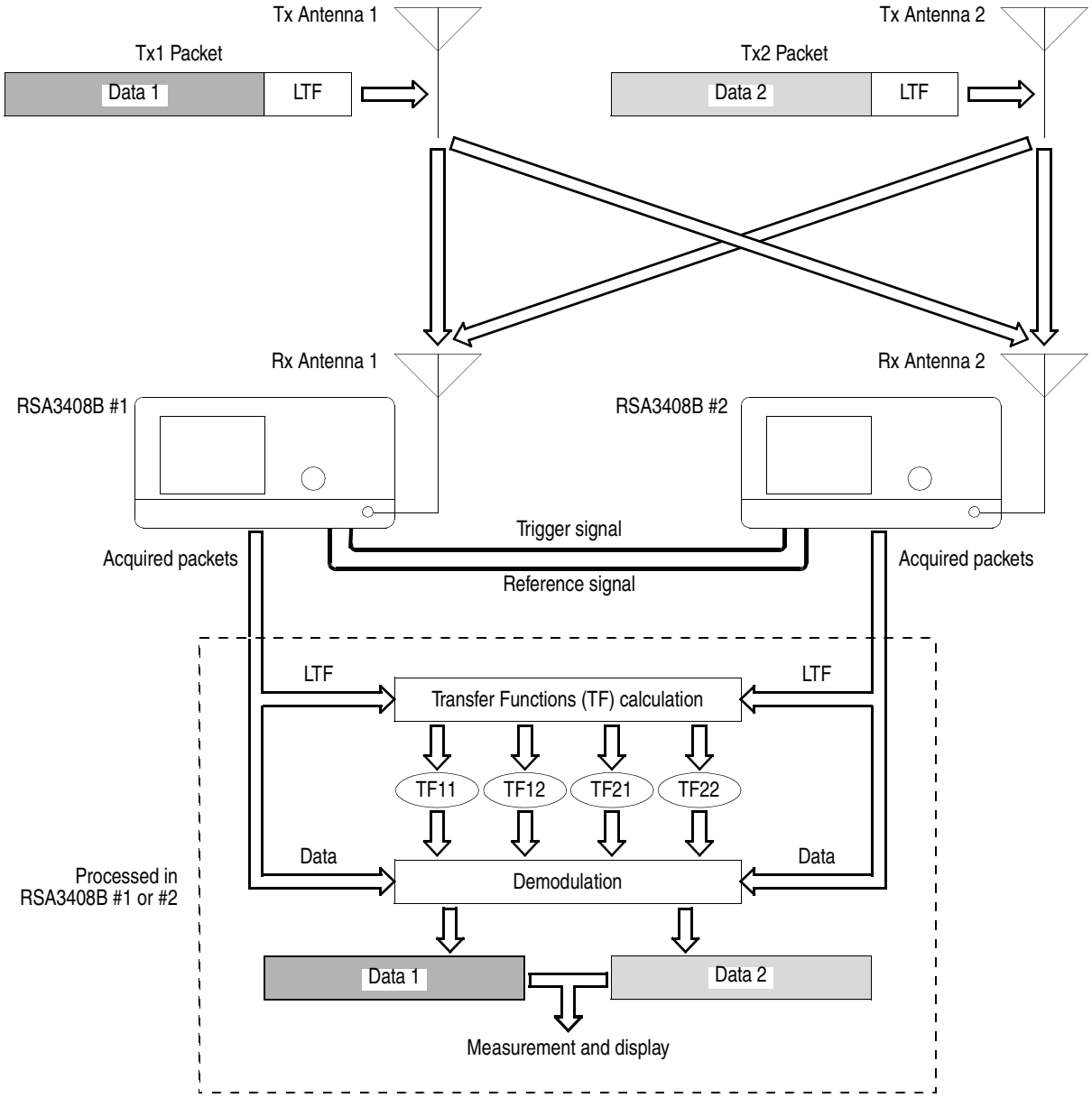
Figure 3-63: IEEE802.11n MIMO 2x2 measurement menu

Data Process Flow

MIMO is a wireless communication technology that broadens data transmission /reception bandwidth combining multiple antennas. Figure 3-64 shows the data process flow of the MIMO (2x2) analysis.

The MIMO (2x2) analysis uses two RSA3408B analyzers, which are synchronized using the trigger and reference signals input/output to/from the rear panel connectors. Packet 1 and 2 transmitted from Tx antenna 1 and 2 respectively are received by Rx antenna 1 and 2. For analysis, you have to load the packet data acquired in one analyzer to another. (Refer to *Basic Measurement Procedure* on page 3-95.)

Packet 1 and 2 acquired by the two analyzers are divided into two parts: LTF (Long Training Field) and data. Then, the transfer function is calculated using the LTF parts. For MIMO 2x2, four transfer functions are obtained according to the combination of the Tx and Rx antennas. Applying these transfer functions to the data part, Data 1 and 2 are demodulated for further measurement and display.



* **Abbr.**
LTF: Long Training Field.
TFmn: Transfer Function from Tx antenna m to Rx antenna n.

Figure 3-64: MIMO (2x2) data process flow

Basic Measurement Procedure

In the MIMO (2x2) analysis, two synchronized analyzers acquire input signals and either analyzer perform measurements. The following is the basic procedure.

Synchronizing Analyzers

Synchronize Analyzer #1 and #2.

1. Connect these connectors on the rear panel using 50 Ω BNC cables:
   - TRIG OUT of Analyzer #1 to TRIG IN of Analyzer #2
   - REF OUT of Analyzer #1 to REF IN of Analyzer #2

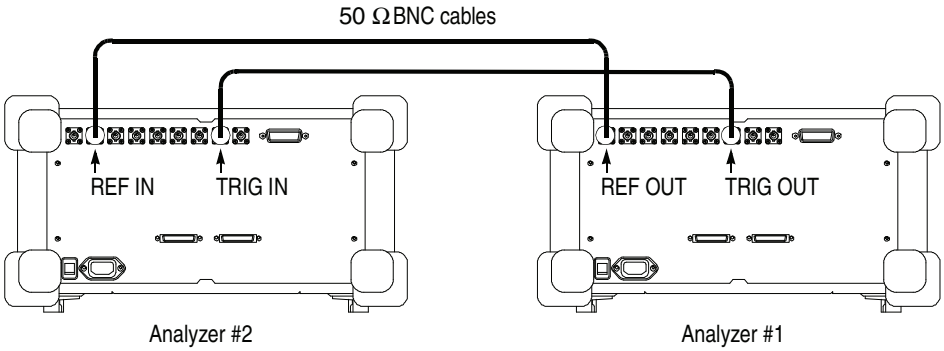


Figure 3-65: Connecting the rear panel connectors

2. Press **Demod** → **Standard...** → **802.11n MIMO (2x2)** on Analyzer #1 and #2.
3. On Analyzer #1, set the trigger conditions appropriately using the Trig menu. For details on the trigger, refer to the *RSA3408B User Manual*.

NOTE. *Do not use the frequency mask trigger (Option 02 only) that may cause an inaccurate synchronization.*

4. On Analyzer #2, set the reference source and trigger conditions.
   a. Press the **Input** key to select the reference source as follows:
      - **Reference Source** → **Ext** (External)
   b. Press the **Trig** key to set trigger conditions as follows:
      - **Mode...** → **Triggered**
      - **Source...** → **External**
      - **Level** → 1.4 V (default)

Acquiring Input Signals

On Analyzer #1 and #2, set measurement parameters to acquire input signals.

1. Set frequency and span appropriately using the **Frequency/Channel** and the **Span** keys. Refer to *Setting Frequency and Span* on page 2-3.

NOTE. *Set the span to the same value for Analyzer #1 and #2. If it is different, the analysis cannot be performed.*

2. Set the amplitude appropriately using the **Amplitude** key.

NOTE. *If the input signal level is too high, "Overrange - increase RefLev or Atten" will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

3. Press the **Acquisition/Analysis** key and set the acquisition and analysis parameters. Refer to *Setting Acquisition and Analysis Parameters* on page 2-6.
4. Press the **Run/Stop** key on Analyzer #1 to start data acquisition.
5. Wait for the trigger event.

Transferring Captured Data

After acquiring input signals, gather the data in either analyzer before analysis. Here, transfer data acquired in Analyzer #2 to #1. You can use the following media:

- Ethernet LAN
- USB memory
- Floppy disk

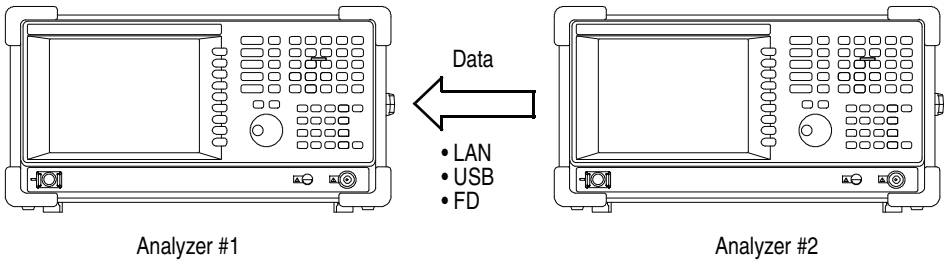


Figure 3-66: Transferring captured data

1. On Analyzer #2, press **Save** → **Save Data...** → **Current Block** to save the acquired data.

   For details on the file operation, refer to the *RSA3408B User Manual*.

2. Make the media available on Analyzer #1.
   For example, when you use a USB memory, store the data acquired in the Analyzer #2, and then insert it to the USB connector on the Analyzer #1.
3. On Analyzer #1, press **Load → Load Rx2**.

NOTE. *When you load data acquired in Analyzer #1 itself and saved on a file, use the* ***Load Rx1*** *side key.*

4. Select the data file with the *.iqt* extension and then press **Load File Now** to load the data acquired by Analyzer #2.

Analyzing Data

On Analyzer #1, use these steps to perform measurements.

1. Press the **Measure** key and select a measurement item.
   For example, press the **Transfer Function (Amp)** side key to observe the amplitude transfer function.
2. Press **Meas Setup** to set the measurement parameters.

   For details on setting the Measurement Setup menu, refer to page 3-98.
3. Press **Meas Setup → Analyze** to start the analysis for the acquired data with the specified parameters.

   If you cancel the analysis, press the **Cancel-Back** (top) side key.
4. Use the View menu to modify the displayed graph.

   For details on setting the views, refer to *View Format* on page 3-102.

Meas Setup Menu

Press the **Meas Setup** key to set the measurement parameters. The Meas Setup menu in the MIMO analysis is common to all the measurement items and has the following controls:

Analyze Performs measurements for packets in the analysis range.

NOTE. *When you change settings in the Meas Setup menu described below, press the* **Analyze** *side key to perform the measurement for the modified settings.*

The analysis is not performed with the **Analyze** side key disabled in the following conditions:

- Off is selected in the Measure menu.
- The analyzer is acquiring data.
- Both Rx1 and Rx2 data are not loaded.

Analysis Parameter... You need to set the analysis parameters before pressing the **Analyze** side key.

Synchronization. Selects the synchronization method.

- **LTF.** *Default*. Synchronizes with the Long Training Field.
- **Pilot.** Synchronizes with the pilot signals.

Select Tx Antenna... Selects the transmission antenna.

- **Tx Antenna 1.** Displays the measurement results for signals transmitted by Tx Antenna 1.
- **Tx Antenna 2.** Displays the measurement results for signals transmitted by Tx Antenna 2.

Packet # Selects a packet to analyze.
Range: –[(the number of the packets in the analysis range) – 1] to 0.
Zero (0) represents the latest packet.

Select Subcarrier... Selects the subcarrier type for displaying the graph.

- **Data + Pilot.** *Default.* Displays the measurement results for data and pilot.
- **Data.** Displays the measurement results for data only.
- **Pilot.** Displays the measurement results for pilot only.
- **Single Subcarrier.** Displays the measurement results for the subcarrier specified using the **Subcarrier #** side key below.

Subcarrier # Specifies the subcarrier number for the measurement. Range: –64 to +63. The function varies by measurement as shown in Table 3-14.

Symbol # Specifies the analysis symbol number for the measurement. The function varies by measurement as shown in Table 3-14. Range: –[(the number of symbols in the analysis range) – 1] to 0. Zero (0) represents the latest analysis symbol.

NOTE. *For definition of the analysis symbol, refer to page 3-49 in the* 802.11n (nx1) Analysis *section.*

The **Packet #***,* **Select Subcarrier...***,* **Subcarrier #***, and* **Symbol #** *menu items have different effect by measurement as shown in Table 3-14.*

Table 3-14: Submenu availability

Measure menu item	Packet #	Select Subcarrier...	Subcarrier #	Symbol #
Transfer Function	D	-	M	D
Delay Profile	D	-	-	D
Transfer Efficiency versus Time	M	D	S	M
EVM versus Time	M	D	S	M
Power versus Time	M	D	S	M
Constellation	M	D	S	M
Transfer Efficiency versus SC	D	-	D	D
EVM versus SC	D	-	D	D
Power versus SC	D	-	D	D
SC Constellation	D	-	D	D
Frequency Error	M	D	S	M
Symbol Table	D	-	M	D

D: Changing the setting updates the measurement data.
M: Changing the setting updates the marker position.
S: Changing the setting updates the measurement data only when Select Subcarrier is set to Single Subcarrier.

Abbreviation. SC: Subcarrier

Modulation Type Display Filter... Selects the modulation type(s) to display the measurement results on the screen. The results and graphs are shown only for the types set to On. See Figure 3-67.

Select cell to edit. Selects an item to change the on/off setting in the table on screen. The table consists of four blocks as shown in Figure 3-67. The selected item appears on the second side key where you can turn on or off.

All PLCP Packet format On/Off. Turns on or off all of the following PLCP (Physical Layer Convergence Protocol) packet formats.

- **Legacy.** Packets are transmitted in the legacy 802.11a/g format.
- **Mixed Mode**. Packets are transmitted with a preamble compatible with the legacy 802.11a/g. The rest of the packet has a new format.
- **Green Field.** High throughput packets are transmitted without a legacy compatible part.

All Preambles On/Off. Turns on or off all of the following preambles.

- Signal (HT-SIG)
- Short Training Field (HT-STF)
- Long Training Field (HT-LTF)

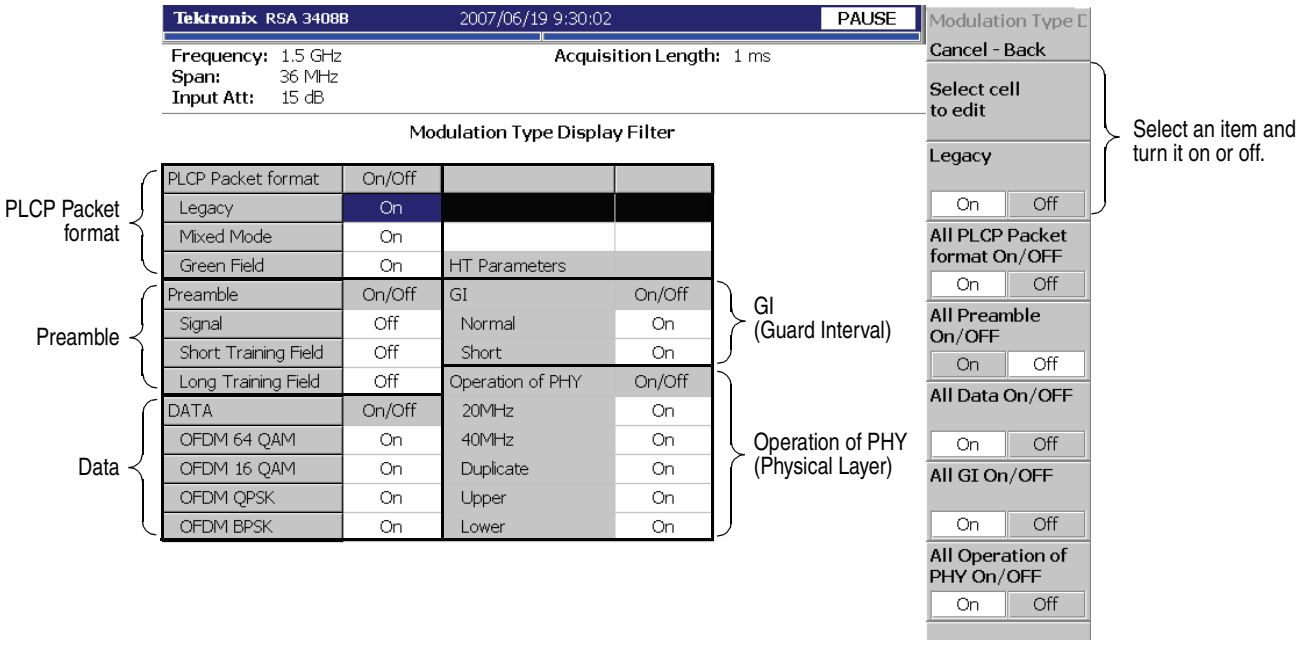


Figure 3-67: Modulation Type Display Filter setting in the MIMO analysis

All Data On/Off. Turns on or off all of the following data.

- OFDM 64QAM
- OFDM 16QAM
- OFDM QPSK
- OFDM BPSK

All GI On/Off. Turns on or off all of the following GI (Guard Interval).

- Normal (800 ns)
- Short (400 ns)

All Operation of PHY On/Off. Turns on or off all of the following operations of PHY (physical layer).

- **20MHz.** 20 MHz bandwidth HT (High Throughput) mode.
- **40MHz.** 40 MHz bandwidth HT (High Throughput) mode.
- **Duplicate.** Duplicate Legacy Mode in which the device operates in a 40 MHz channel composed of two adjacent 20 MHz channels.
- **Upper.** 40 MHz Upper Mode used to transmit a legacy or HT packet in the upper 20 MHz channel of a 40 MHz channel.
- **Lower.** 40 MHz Lower Mode used to transmit a legacy or HT packet in the lower 20 MHz channel of a 40 MHz channel.

View Format

This section describes the format of the following views specific to the 802.11n MIMO analysis.

- Waveform Rx1/2
- Transfer function (amplitude / phase)
- Transfogram (amplitude / phase)
- Delay profile
- Delayogram
- Transfer efficiency vs Time / SC

NOTE. *The other views are the same as in IEEE802.11n (nx1) analysis.*
Refer to View Format *on page 3-11.*

Selecting View Content

You can change the view content with the View: **Define** key on the front panel. The view contents depend on the measurement items as shown in Table 3-15.
In the EVM measurement, you can change the measurement content pressing View: **Scale →View Scale...**

Table 3-15: View content selection, 802.11n MIMO (2x2)

Measurement item	View: Define → Overview content	View: Define → Subview content	View: Scale/Lines → View Scale... → Measurement content
Modulation measurement			
Transfer Function (Amplitude)	Waveform (default) Spectrogram	Spectrum (default) Waveform Rx1/2 Transfogram (Amplitude / Phase) Transfer Function (Amplitude / Phase) Delayogram Delay Profile Transfer Efficiency versus Time Constellation EVM versus Time Power versus Time Transfer Efficiency versus SC SC Constellation EVM versus SC Power versus SC Frequency Error Symbol Table	-
Transfer Function (Phase)			-
Delay Profile			-
Transfer Efficiency versus Time			
EVM versus Time			EVM Mag Err Phase Err
Power versus Time			-
Constellation			Vector / Constellation
Transfer Efficiency versus SC			
EVM versus SC			EVM Mag Err Phase Err
Power versus SC			-
SC Constellation			Vector / Constellation
Frequency Error			-
Symbol Table			-

*** SC: Subcarrier.**

Selecting the Receiving Antenna

Select the receiving antenna to display the measurement results in the main view and subview. Press the View: **Define** key and set the following items:

Subview Select Rx Antenna. *For the subview of Transfer Function, Transfogram, Delay Profile or Delayogram only.*
Selects the receiving antenna to display data in the subview.

- **Rx Antenna 1.** Displays the measurement results for signals received by Rx Antenna 1.
- **Rx Antenna 2.** Displays the measurement results for signals received by Rx Antenna 2.

Mainview Select Rx Antenna. *Transfer Function and Delay Profile measurement only.* Selects the receiving antenna to display data in the main view.

- **Rx Antenna 1.** Displays the measurement results for signals received by Rx Antenna 1.
- **Rx Antenna 2.** Displays the measurement results for signals received by Rx Antenna 2.

List Display

The measurement results are represented in graph form by default. You can select the list display as shown in Figure 3-68. Press View: **Define** → **Display** → **List**.

IEEE 802.11n

Modulation : LongPreamble Packet Mode : Legacy Mode

Tx Antenna Number :

Number of Symbol : 13

	Unit	Min	Mean	Max
EVM	%	1.288	1.37	1.471
	dB	-37.805	-37.263	-36.651
Mag Error	%	0.55	0.793	0.93
	dB	-45.188	-42.018	-40.63
Phase Error	deg	0.409	0.474	0.55
Power	dBm	-13.705	-13.688	-13.663
	W	42.611 µ	42.772 µ	43.023 µ
Freq Error	Hz	-224.965	-133.659	-22.574
Origin Offset	dB			

Figure 3-68: List display

Waveform Rx1/2

Subview only. Displays the time-domain waveforms of signals received by Rx antenna 1 and 2 in the analysis range as shown in Figure 3-69.

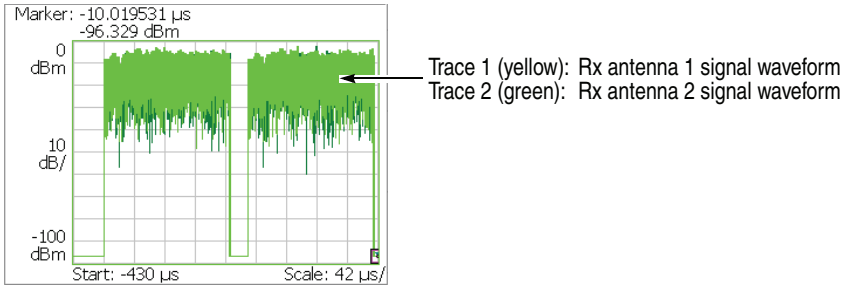


Figure 3-69: Waveform Rx1/2 (subview)

Scale Menu. The Scale menu for Waveform Rx1/2 has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Timing menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Stop. Sets the maximum value (top edge) of the vertical axis.
Range: −100 to Vertical Scale [dBm].

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfer Function (Amplitude)

The main view displays the amplitude transfer function as shown in Figure 3-70. This graph indicates an amplitude variation for each subcarrier during the signal propagation from Tx system to Rx system. The horizontal axis represents subcarrier number and the vertical axis represents amplitude variation in dBm.

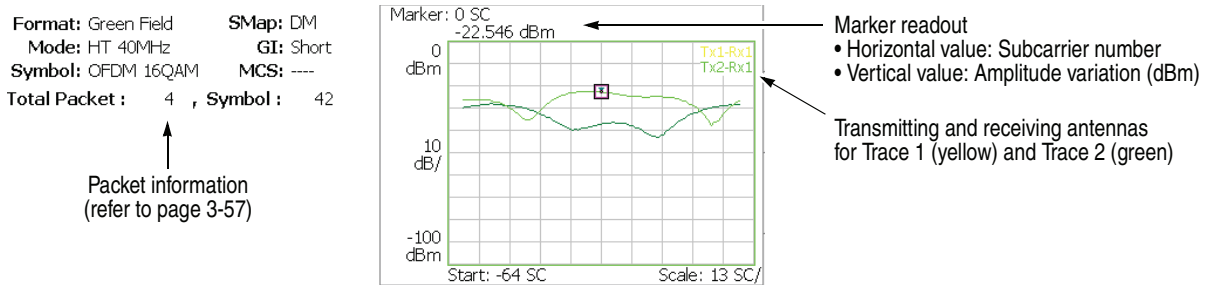


Figure 3-70: Transfer function, amplitude (main view)

The packet information displayed on the left side of the main view is the same as in the 802.11n (nx1) analysis. Refer to *Packet Information* on page 3-57.

Scale Menu. The Scale menu for Transfer Function (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to 8.

Vertical Scale. Sets the range of the vertical axis.
Range: 100µ to 100 dB.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 0 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfogram (Amplitude)

Subview only. It displays the time series of amplitude transfer function. The amplitude at a given subcarrier and time (packet number) is displayed as a color map in a two dimensional diagram as shown in Figure 3-71.

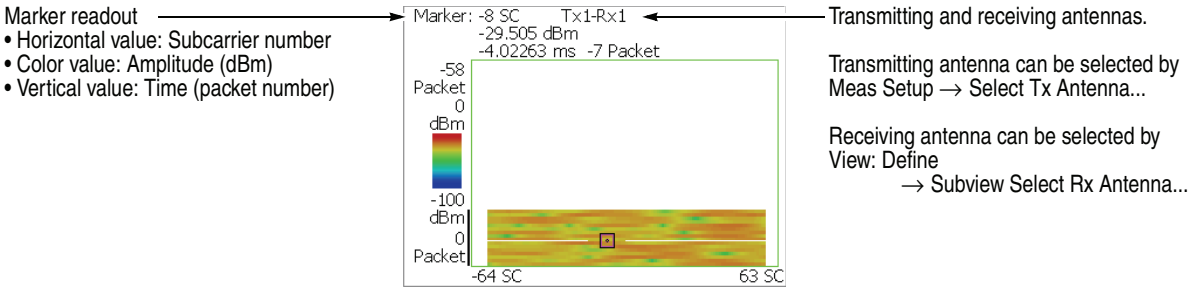


Figure 3-71: Transfogram, amplitude (subview)

Scale Menu. The Scale menu for Transfogram (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the start subcarrier number of the horizontal axis.
Range: –64 to 8.

Vertical Size. Sets the full scale of the vertical axis.
Range: 58 to 59392 packets.

Vertical Start. Sets the start packet number of the vertical axis.
Range: – [(the number of packets in the analysis range) - 1] to 0.
Zero (0) represents the latest packet.

Color Scale. Sets the range of the color axis.
Range: 10 to 100 dB in a 1-2-5 sequence.

The transfogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to 100 [dB].

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

Transfer Function (Phase)

The main view displays the phase transfer function as shown in Figure 3-72. This graph indicates a phase lead or lag for each subcarrier during the signal propagation from Tx system to Rx system. The horizontal axis represents subcarrier number and the vertical axis represents phase lead or lag in degrees.

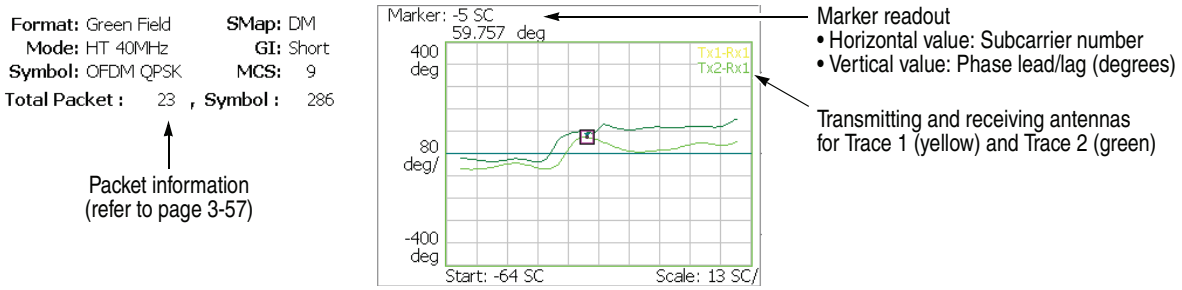


Figure 3-72: Transfer function, phase (main view)

The packet information displayed on the left side of the main view is the same as in the 802.11 (nx1) analysis. Refer to *Packet Information* on page 3-57.

Scale Menu. The Scale menu for Transfer Function (Amplitude) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to 8.

Vertical Scale. Sets the range of the vertical axis.
Range: 800µ to 800 degrees.

Vertical Star. Sets the minimum value (bottom edge) of the vertical axis.
Range: –1200 to 400 degrees.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfogram (Phase)

Subview only. It displays the time series of phase transfer function. The phase at a given subcarrier and time (packet number) is displayed as a color map in a two dimensional diagram as shown in Figure 3-73.

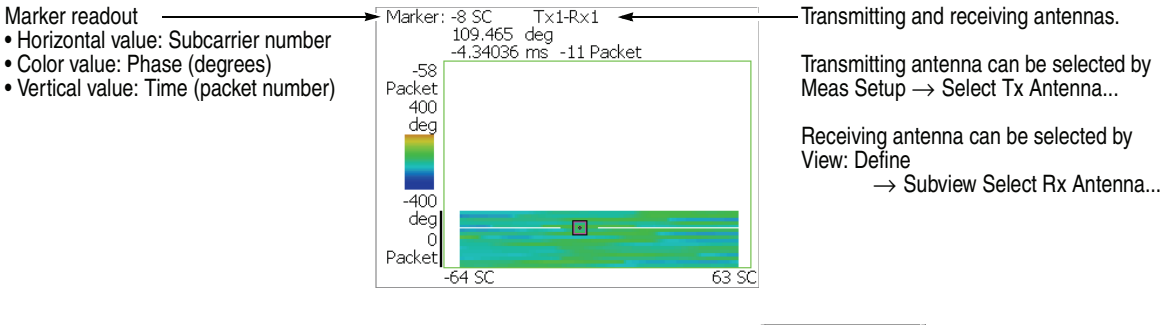


Figure 3-73: Transfogram, phase (subview)

Scale Menu. The Scale menu for Transfogram (Phase) has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the scale of the horizontal axis.
Range: 16 to 128 subcarriers.

Horizontal Start. Sets the start channel number of the horizontal axis.
Range: –64 to 8.

Vertical Size. Sets the full scale of the vertical axis.
Range: 58 to 59392 packets.

Vertical Start. Sets the start packet number of the vertical axis.
Range: – [(the number of packets in the analysis range) - 1] to 0.
Zero (0) represents the latest packet.

Color Scale. Sets the range of the color axis:
Range: 10 to 100 dB in 1-2-5 sequence.

The transfogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to +100 dB.

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

Delay Profile

The main view shows the delay profile as shown in Figure 3-74. In the MIMO communication method, transmitted signals propagate through multipath with different distance to reach receiving antennas. The path difference causes the received signals some temporal dispersion. The delay profile shows the power distribution to the delay time. The vertical axis represents amplitude in dBm and the horizontal axis represents delay time in seconds.

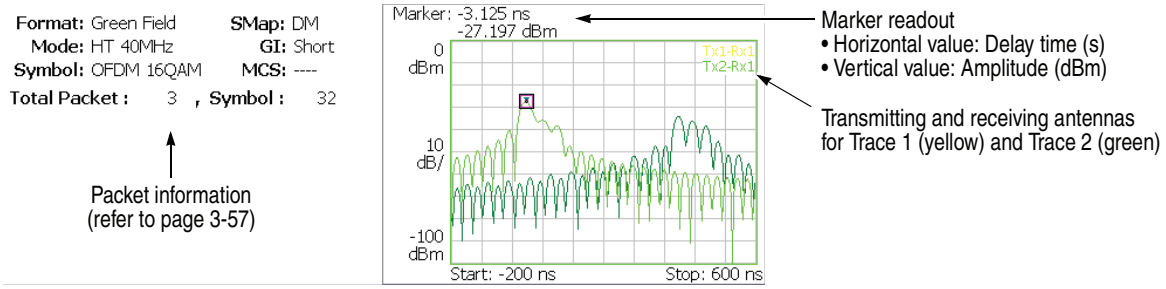


Figure 3-74: Delay profile (main view)

The packet information displayed on the left side of the main view is the same as in the 802.11 (nx1) analysis. Refer to *Packet Information* on page 3-57.

Scale Menu. The Scale menu for Delay Profile has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: $S_0/16$ to S_0 (sec) where S_0 is the initial horizontal scale.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: $-S_0/2$ to $[S_0/2 - (\text{Horizontal Scale})]$ (sec).

Vertical Scale. Sets the range of the vertical axis.
Range: 100 µ to 100 dB.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 0 dBm.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Delayogram *Subview only.* It displays the time series of delay profile.
The power at a given delay time and packet number is displayed as a color map in a two dimensional diagram as shown in Figure 3-75.

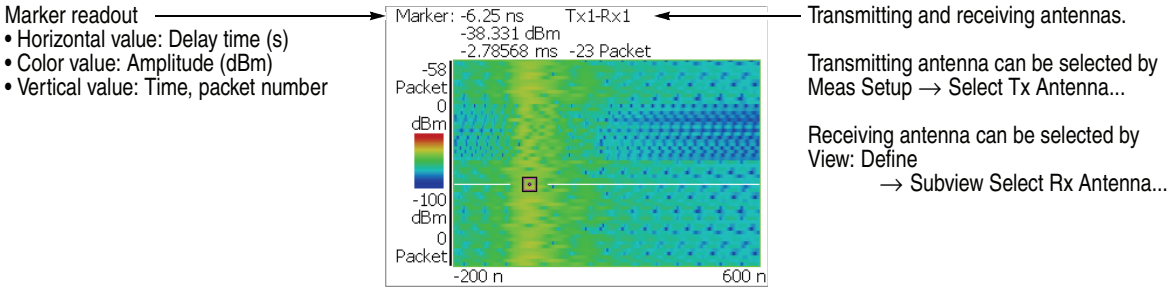


Figure 3-75: Delayogram (subview)

Scale Menu. The Scale menu for Delayogram has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis.
Range: $S_0/16$ to S_0 (sec) where S_0 is the initial horizontal scale.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: $-S_0/2$ to $[S_0/2 - (\text{Horizontal Scale})]$ (sec).

Vertical Size. Sets the full scale of the vertical axis in frames.
Range: 58 to 59392.

Vertical Start. Sets the start frame number of the vertical axis.
Range: –147 to 0.

Color Scale. Sets the range of the color axis:
Range: 10 to 100 dB in 1-2-5 sequence.

The delayogram is displayed in 100 steps (100 colors) from the minimum value (blue) to the maximum value (red) in the default state.

Color Stop. Sets the maximum value (top edge) of the color axis.
Range: –100 to +100 dB.

Full Scale. Sets Color Stop to 0 (zero) and Color Scale to 100 dBm.

Transfer Efficiency versus Time

The transfer efficiency is a powerful tool for evaluating the condition of propagation path to isolate the source of a problem in investigating degradation of receiving signals in digital communication utilizing multi-path propagation. The condition of propagation path depends on barriers (such as reflection and shield) and configuration of antennas. For Subcarrier k sent from Tx antenna i, assuming that noise levels are the same at all Rx antennas, the noise power calculated in the demodulation process is expressed by the following formula:

$$NP_{i,k} = (NA_{i,k} \times nr_k)^2$$

Where

$NP_{i,k}$: Noise Power after data demodulation of Subcarrier k sent from Tx antenna i

$NA_{i,k}$: Noise Amplification by data demodulation of Subcarrier k sent from Tx antenna i

nr_k: Noise level of Subcarrier k at Rx antenna

The Noise Amplification $NA_{i,k}$ is the factor derived from the transfer function calculation, which is inverted to obtain the transfer efficiency $TE_{i,k}$.

$$TE_{i,k} = 1/NA_{i,k}$$

The better the condition of propagation path, the larger the transfer efficiency. When the transfer efficiency is 1 (100%), the propagation path allows MIMO communication in quality nearly same as SISO. The larger transfer efficiency indicates that the propagation path is more proper for MIMO.

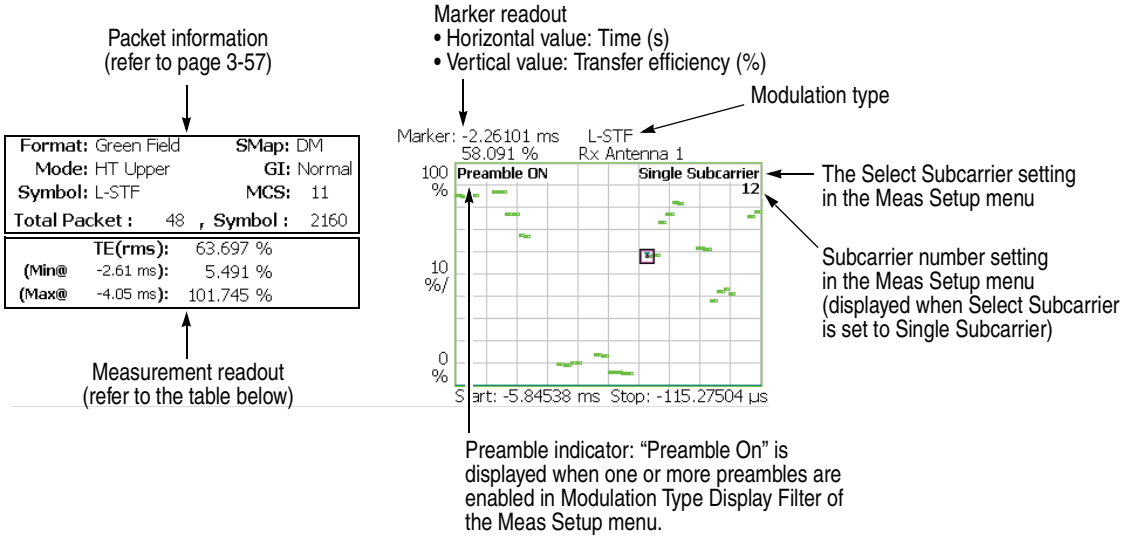


Figure 3-76: Transfer efficiency versus Time (main view)

In the transfer efficiency measurement, the main view shows the transfer efficiency of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-76. The vertical axis represents transfer efficiency in percent and the horizontal axis represents time in seconds.

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
TE (rms)	%	RMS transfer efficiency of one or all subcarriers
(Min @ time)	%	Minimum transfer efficiency of one or all subcarriers at the time (The time is relative to the last data point.)
(Max @ time)	%	Maximum transfer efficiency of one or all subcarriers at the time (The time is relative to the last data point.)

Scale Menu. The Scale menu for Power versus Time has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (time).

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.

NOTE. *The horizontal display range must be within the analysis range specified using the Acquisition/Analysis menu (refer to page 2-6).*

Vertical Scale. Sets the range of the vertical axis.
Range: 200µ to 200%.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 200%.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Transfer Efficiency versus SC

The bar graph in the main view displays the power of each subcarrier for one analysis symbol specified using the **Symbol #** side key in the Meas Setup menu, as shown in Figure 3-77. The vertical axis represents power in dBm and the horizontal axis represents the subcarrier number ranging from −64 to +63.

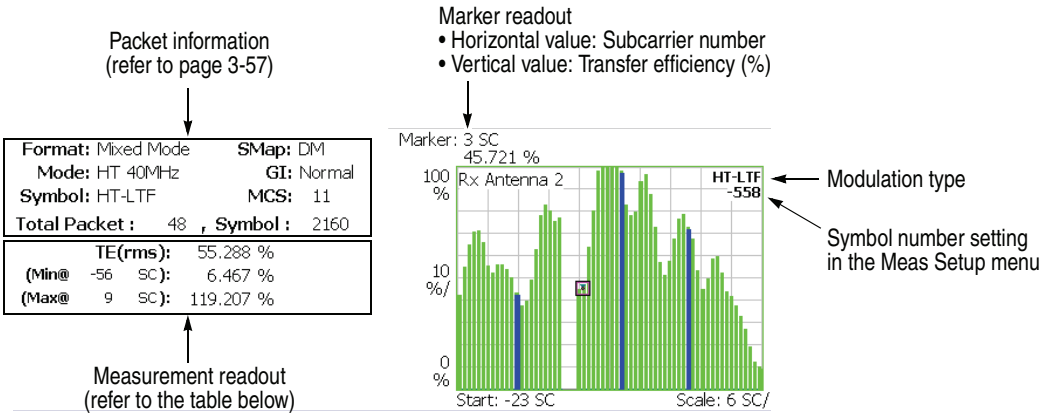


Figure 3-77: Transfer efficiency versus SC (main view)

The following table shows the measurement readout that is displayed on the left in the main view:

Measurement readout	Unit	Description
TE (rms)	%	RMS transfer efficiency of all subcarriers
(Min @ SC)	%	Minimum transfer efficiency at the subcarrier number
(Max @ SC)	%	Maximum transfer efficiency at the subcarrier number

Scale Menu. The Scale menu for Transfer efficiency versus SC has the following controls:

Auto Scale. Sets the start value and the scale of the vertical axis automatically to fit the waveform to the screen.

Horizontal Scale. Sets the range of the horizontal axis (subcarrier number).
Range: 16 to 128.

Horizontal Start. Sets the minimum value (left edge) of the horizontal axis.
Range: –64 to [64 – (Horizontal Scale)].

Vertical Scale. Sets the range of the vertical axis.
Range: 200µ to 200%.

Vertical Start. Sets the minimum value (bottom edge) of the vertical axis.
Range: –200 to 200%.

Full Scale. Sets the scale of the vertical axis to the default full-scale value.

Appendices

Appendix A: Scale Setting Range

Table A-1 shows the horizontal and vertical scale setting range for each measurement view.

Table A-1: Scale setting range

Display format	Signal	Horizontal range	Vertical range	Color range
Transfer Function (Amplitude)	All (11n only)	Subcarrier # –64 to 63	–200 to 100 dBm	-
Transfer Function (Phase)	All (11n only)	Subcarrier # –64 to 63	–1200 to 1200 °	-
Delay Profile	All (11n only)	–100 to 0 ms [1]	–200 to 100 dBm	-
Transfogram (Amplitude)	All (11n only)	Subcarrier # –64 to 63	58 to 59392 packets	–200 to 100 dBm
Transfogram (Phase)	All (11n only)	Subcarrier # –64 to 63	58 to 59392 packets	–1200 to 1200 °
Delayogram	All (11n only)	–100 to 0 ms [1]	58 to 59392 packets	–200 to 100 dBm
Transfer Efficiency versus Time	All (11n only)	–100 to 0 ms [1]	–100 to 200%	-
EVM versus Time	All	–100 to 0 ms [1]	–100 to 200%	-
MagErr versus Time	All	–100 to 0 ms [1]	–300 to 300%	-
PhaseErr versus Time	All	–100 to 0 ms [1]	–675 to 675 °	-
Power versus Time	All	–100 to 0 ms [1]	–100 to 50 dBm	-
Constellation	All	Fixed	Fixed	-
Transfer Efficiency versus SC	All (11n only)	Subcarrier # –64 to 63	–100 to 200%	-
EVM versus SC	OFDM	Subcarrier # –32 to 31 (11a/b/g) –64 to 63 (11n)	–100 to 200%	-
	Non-OFDM	–100 to 0 ms [1]		-
MagErr versus SC	OFDM	Subcarrier # –32 to 31 (11a/b/g) –64 to 63 (11n)	–300 to 300%	-
	Non-OFDM	–100 to 0 ms [1]		-
PhaseErr versus SC	OFDM	Subcarrier # –32 to 31 (11a/b/g) –64 to 63 (11n)	–675 to 675 °	-
	Non-OFDM	–100 to 0 ms [1]		-
SC Constellation	All	Fixed	Fixed	-
Frequency Error	All	–100 to 0 ms [1]	–750 to 750 kHz	-
OFDM Flatness	All	Subcarrier # –32 to 31 (11a/b/g) –64 to 63 (11n)	–150 to 150 dB	-
OFDM Linearity	All	Fixed	Fixed	-
Symbol Table	All	-	-	-

[1] The horizontal range is limited by the analysis range specified using the Timing menu in the overview.

Appendix B: Save File Format

This section describes the file format for saving measurement results. The saved file is the CSV format, consisting of the header part (comment lines beginning with #) and the data part (see Figure B-1). The format varies according to the measurements. The following sections show the format for each measurement.

	A	B	C	D	E	F	G
1	#Transfer Function (Amp)						
2	#Subcarrier=Data + Pilot						
3	#Modulation=OFDM BPSK						
4	#Modulation Type Display						
5	Legacy On						
6	Mixed Mode On						
7	Green Field On						
8	Signal Off						
9	Short Training Field Off						
10	Long Training Field Off						
11	OFDM 64 QAM On						
12	OFDM 16 QAM On						
13	OFDM QPSK On						
14	OFDM BPSK On						
15	Normal On						
16	Short On						
17	20MHz On						
18	40MHz On						
19	Duplicate On						
20	Upper On						
21	Lower On						
22	#Packet Offset=-33						
23	#Packet Range=1						
24	#Segment=-521						
25							
26	#Tx1-Rx1						
27	#<Packet>:<data2>...<datan>						
28	FALSE	-1000	-1000	-1000	-1000	-1000	-26.5754
29							
30	#Tx2-Rx1						
31	#<Packet>:<data2>...<datan>						
32	FALSE	-1000	-1000	-1000	-1000	-1000	-22.8891

Figure B-1: Measurement results file (an example of amplitude transfer function)

Transfer Function (Amplitude and Phase) and Delay Profile

The file format depends on the setting of Save →Save Mainview Results...

- **Save Mainview Results: Trace1, Trace2, and Trace 1 and 2**

Item	Description	Example
Measurement item	Setting of Measure	#Transfer Function (Amp)
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
First packet	Setting of Save Mainview Results →Packet Offset	#Packet Offset=–15
Number of packets	Setting of Save Mainview Results →Number of Packets	#Packet Range=1
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Trace number (Tx and Rx antenna number)	Trace: 1 or 2 Tx: Setting of Meas Setup →Select Tx Antenna Rx: Setting of View: Define →Mainview Select Rx Antenna	#Trace 1 (Tx1-Rx1)
Data format	Format of data that follows (<Packet>: Packet number)	#<Packet>=<data1>,<data2>,...<datan>
Waveform data	Actual waveform data values	0=–38.77978,–38.77798...

When **Save Mainview Results** is set to **Trace 1 and 2**, two files are created for Trace 1 and 2 with the file names of "1" and "2" added respectively to the specified name. For example, if you specify *Sample* as the file name, the *Sample1* file for Trace 1 and the *Sample2* file for Trace 2 are created.

■ Save Mainview Results: All Data (802.11n MIMO (2x2) analysis only)

Item	Description	Example
Measurement item	Setting of Measure	#Transfer Function (Amp)
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
First packet	Setting of Save Mainview Results →Packet Offset	#Packet Offset=–15
Number of packets	Setting of Save Mainview Results →Number of Packets	#Packet Range=1
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
(blank line)		
Tx and Rx antennas (1-1)	Combination of Tx antenna 1 and Rx antenna 1	#Tx1-Rx1
Data format	Format of data that follows (<Packet>: Packet number)	#<Packet>=<data1>,<data2>,...<datan>
Waveform data	Actual waveform data values	0=–38.77978,–38.77798...
(blank line)		
Tx and Rx antennas (2-1)	Combination of Tx antenna 2 and Rx antenna 1	#Tx2-Rx1
Data format	Format of data that follows (<Packet>: Packet number)	#<Packet>=<data1>,<data2>,...<datan>
Waveform data	Actual waveform data values	0=–34.92678,–34.92566...
...		
Tx and Rx antennas (n-n)	Combination of Tx antenna n and Rx antenna n	#Txn-Rxn
Data format	Format of data that follows (<Packet>: Packet number)	#<Packet>=<data1>,<data2>,...<datan>
Waveform data	Actual waveform data values	0=–47.38674,–47.38641...

Transfer Efficiency vs Time, EVM vs Time, Power vs Time, and Frequency Error

The file format depends on the setting of Save →Save Mainview Results...

■ Save Mainview Results: Trace Data

Item	Description	Example
Measurement item	Setting of Measure	#EVM vs Time
Tx antenna	Setting of Meas Setup →Select Tx Antenna	#Tx Antenna 1
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Display format [1]	Setting of View: Scale/Lines → View Scale... →Measurement Content...	#Format=EVM
Measurement readout	Measured values displayed on the left side of the main view	#rms[%]=28.082545 #rms[dB]=–11.031271 ... #Origin Offset[dB]=3.820609
(blank line)		
Data format	Format of data that follows	#dataX, dataY
Waveform data	Actual waveform data values (Coordinate values are displayed for each point sequentially)	–0.009747203, 84.98622 –0.009747203, 193.1672 ...

[1] **EVM versus Time measurement only.**

■ Save Mainview Results: All Data (802.11n MIMO (2x2) analysis only)

Item	Description	Example
Measurement item	Setting of Measure	#EVM vs Time
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Display format [1]	Setting of View: Scale/Lines →View Scale... → Measurement Content...	#Format=EVM
(blank line)		
Title	Tx antenna list	#Title=Tx1, Tx2
Measurement readout	Measured values displayed on the left side of the main view (The values are displayed for all Tx antennas)	#rms[%]=107.3024, 107.3087 #rms[dB]=0.6121847, 0.6127007 ... #Origin Offset[dB]= - 13.52911, - 13.52911
(blank line)		
Data format	Format of data that follows	#Tx1 dataX, Tx1 dataY, Tx2 dataX, Tx2 dataY
Waveform data	Actual waveform data values (Coordinate values are displayed for each point sequentially)	–0.009747203, 84.98622, –0.009747203, 84.98622 –0.009747203, 193.1672, –0.009747203, 193.1672 ...

[1] **EVM versus Time measurement only.**

Transfer Efficiency vs SC, EVM vs SC, Power vs SC, and OFDM Flatness

The file format depends on the setting of Save →Save Mainview Results...

■ Save Mainview Results: Trace Data

Item	Description	Example
Measurement item	Setting of Measure	#EVM vs SC
Tx antenna	Setting of Meas Setup →Select Tx Antenna	#Tx Antenna 1
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Display format [1]	Setting of View: Scale/Lines →View Scale... →Measurement Content...	#Format=EVM
Measurement readout	Measured values displayed on the left side of the main view	#rms[%]=107.3024 #rms[dB]=0.6121847 ... #Origin Offset[dB]=-13.52911
(blank line)		
Data format	Format of data that follows	#dataX
Graph data	Actual waveform data values (The vertical axis values are displayed in order of subcarrier number)	3.3866 3.0183 ...

[1] **EVM versus SC measurement only.**

■ Save Mainview Results: All Data (802.11n MIMO (2x2) analysis only)

Item	Description	Example
Measurement item	Setting of Measure	#EVM vs SC
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Display format [1]	Setting of View: Scale/Lines →View Scale... →Measurement Content...	#Format=EVM
(blank line)		
Title	Tx antenna list	#Title=Tx1, Tx2
Measurement readout	Measured values displayed on the left side of the main view (The values are displayed for all Tx antennas)	#rms[%]=126.7585, 37.08064 #rms[dB]=2.059539, 8.617055 ... #Origin Offset[dB]= - 51.67269, - 13.52911
(blank line)		
Data format	Format of data that follows	#Tx1 dataX, Tx2 dataX
Graph data	Actual waveform data values (The vertical axis values are displayed in order of subcarrier number for all Tx antennas)	3.3866, 4.3254 3.0183, 4.2038 ...

[1] **EVM versus SC measurement only.**

Symbol Table

The file format depends on the setting of Save →Save Mainview Results...

■ **Save Mainview Results: Trace Data**

Item	Description	Example
Measurement item	Setting of Measure	#Symbol Table
Tx antenna	Setting of Meas Setup →Select Tx Antenna	#Tx Antenna 1
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
Symbol data	Actual symbol values are displayed sequentially on decimal base	7 15 ...

■ **Save Mainview Results: All Data (802.11n MIMO (2x2) analysis only)**

Item	Description	Example
Measurement item	Setting of Measure	#Symbol Table
Subcarrier	Setting of Meas Setup →Select Subcarrier	#Subcarrier=Data + Pilot
Modulation	Detected modulation type	#Modulation=OFDM 64QAM
Modulation type display filter	Setting of Meas Setup →Modulation Type Display Filter	#Modulation Type Display Mixed Mode On Green Field On ... Lower On
Packet number	Setting of Meas Setup →Packet #	#Packet=0
Analysis symbol	Setting of Meas Setup →Symbol #	#Segment=–306
(blank line)		
Data format	Format of data that follows	#Tx1 dataX, Tx2 dataX
Symbol data	Actual symbol values are displayed sequentially on decimal base for all Tx antennas	7, 51 29, 27 ...

Glossary and Index

Glossary

Acronyms

BPSK
Binary Phase Shift Keying

CCK
Complementary Code Keying

DM
Direct Mapping

DSSS
Direct Sequence Spread Spectrum

EVM
Error Vector Magnitude

GI
Guard Interval

HT-LTF
First High Throughput Long Training Field

HT-SIG
High Throughput Signal Field

HT-STF
High Throughput Short Training Field

IEEE
Institute of Electrical and Electronic Engineers

LAN
Local Area Network

L-LTF
Legacy Long Training Field

L-SIG
Legacy Signal Field

L-STF
Legacy Short Training Field

MIMO
Multiple Input Multiple Output

OFDM
Orthogonal Frequency Division Multiplexing

PBCC
Packet Binary Convolutional Coding

PHY
Physical Layer

PLCP
Physical Layer Convergence Protocol

PSK
Phase Shift Keying

QAM
Quardrature Amplitude Modulation

QPSK
Quardrature Phase Shift Keying

SC
Subcarrier

SISO
Single Input Single Output

STBC
Space Time Block Coding

WLAN
Wireless Local Area Network

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