User Manual

Tektronix

RSA3408A Option 29
WLAN 802.11a/b/g Analysis Software

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This document supports firmware version 1.0 and above.

www.tektronix.com

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

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Preface

This manual provides operating instructions for the RSA3408A Real-Time Spectrum Analyzer Option 29 WLAN 802.11a/b/g Analysis Software.

About This Manual

This manual is composed of the following sections:

- *Getting Started* provides a product description.
- *Operating Basics* describes the menu operation specific to Option 29.
- *Reference* describes the measurement view formats and settings.

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:

- *RSA3408A User Manual*
  (Standard accessory; Tektronix part number 071-1617-XX)
  Describes how to install the analyzer and how to work with the menus, and details the standard functions. Also shows the specifications.
- *RSA3408A Programmer Manual*
  (Standard accessory; PDF, Tektronix part number 077-0003-XX)
  Contains an alphabetical listing of the programming commands and other information related to controlling the analyzer over the GPIB interface.

PDF Manual

The programmer manual described above is a PDF document (the file size is about 5 MB). The file is stored in this directory on the analyzer hard disk:

C:\Program Files\Tektronix\wca200a\Manuals

Use the USB or LAN interface to copy the file onto your PC. Refer to the *RSA3408A User Manual* for using the interface.

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, or 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	www.tektronix.com/support 1-800-833-9200, select option 3* 6:00 a.m. - 5:00 p.m. Pacific time

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Getting Started

Getting Started

RSA3408A Option 29 is the WLAN analysis software that performs signal measurements for high-speed wireless LAN transmitters in 5 GHz band (IEEE 802.11a standard) and 2.4 GHz band (IEEE 802.11b and IEEE 802.11g standards). You can configure an analysis system for the IEEE 802.11a/b/g LAN transmitters.

This system provides:

- OFDM/DSSS modulation signal spectrum power analysis
- Modulation accuracy measurement (EVM)
- Constellation display
- Symbol table
- Center frequency deviation measurement
- Spectrum mask measurement

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

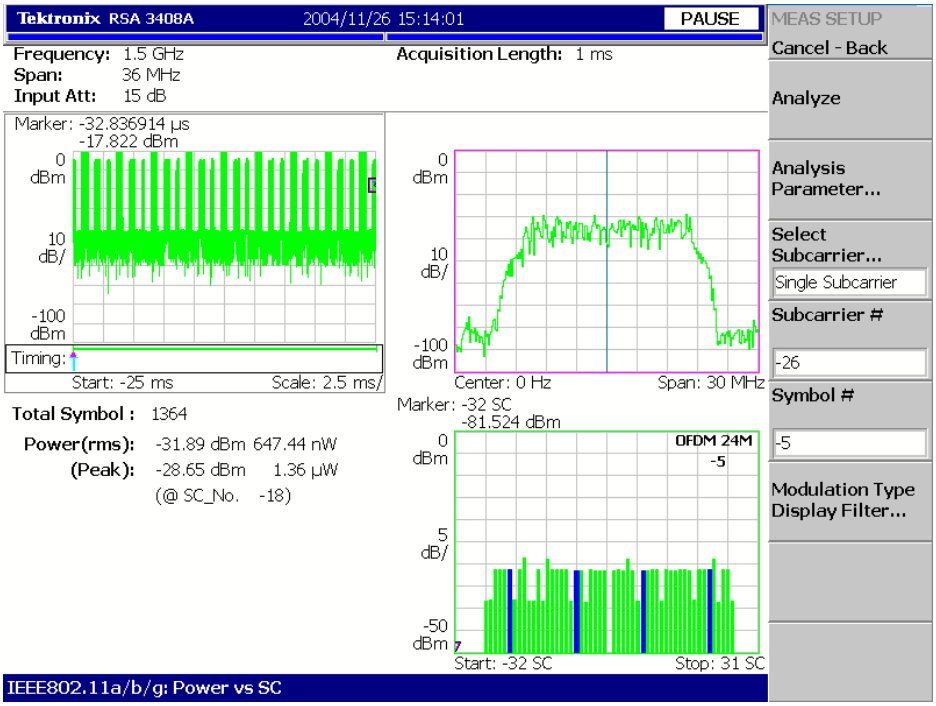

Figure 1-1: WLAN analysis display

WLAN Measurement Items

The Option 29 WLAN measurement functions are contained in the Demod mode as shown in Figure 1-2.

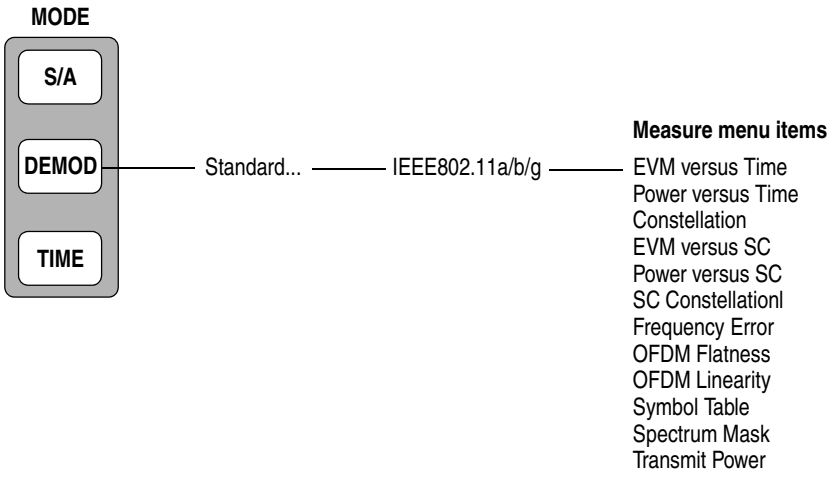

Figure 1-2: Measure menu in the WLAN analysis

Table 1-1 shows all the measurement and display items available in Option 29 WLAN analysis software and the supported standards.

Table 1-1: Option 29 WLAN measurement items

Measure menu item	Measurement contents [1]	802.11a	802.11b	802.11g
Modulation analysis				
EVM versus Time	EVM	✓	✓	✓
	Mag Err	✓	✓	✓
	Phase Err	✓	✓	✓
Power versus Time	-	✓	✓	✓
Constellation	-	✓	✓	✓
EVM versus SC	EVM	✓	✓	✓
	Mag Err	✓	✓	✓
	Phase Err	✓	✓	✓
Power versus SC	-	✓	✓	✓
SC Constellation	-	✓	✓	✓
Frequency Error	-	✓	✓	✓
OFDM Flatness	-	✓		✓
OFDM Linearity	-	✓		✓
Symbol Table	-	✓	✓	✓
Power analysis				
Spectrum Mask	-	✓		✓
Transmit Power	-		✓	✓

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

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

Measurement Functions

Table 1-2 summaries the functions for each measurement item. The measurement results are displayed in the main view and the subview (except Spectrum Mask, which uses a single view).

Table 1-2: Measurement functions

Measure menu item	Signal type	Display	Vertical axis	Horizontal axis
Modulation analysis				
EVM versus Time	OFDM	EVM of one or all subcarriers in a line graph.	EVM [%] Magnitude error [%] Phase error [degree or radian]	Time [s]
	Non-OFDM	EVM of the carrier in a line graph.		
Power versus Time	OFDM	Power of one or all subcarriers in a line graph.	Power [dBm]	Time [s]
	Non-OFDM	Total power of the carrier in a line graph.		
Constellation	OFDM	Constellation of all subcarriers in a rectangular coordinate graph over multiple analysis symbol periods.	Q level	I level
	Non-OFDM	Constellation of the carrier in a rectangular coordinate graph over multiple analysis symbol periods.		
EVM versus SC	OFDM	EVM of each subcarrier in a bar graph for one analysis symbol period.	EVM [%] Magnitude error [%] Phase error [degree or radian]	Subcarrier wave No. [−26 to +26]
	Non-OFDM	EVM by analysis symbol in a bar graph.		Time [s]
Power versus SC	OFDM	Power of each subcarrier in a bar graph for one analysis symbol period.	Power [dBm]	Subcarrier wave No. [−26 to +26]
	Non-OFDM	Total carrier power by analysis symbol in a bar graph.		Time [s]
SC Constellation	OFDM	Constellation of one or all subcarriers in a rectangular coordinate graph for one analysis symbol period.	Q level	I level
	Non-OFDM	Constellation of the carrier in a rectangular coordinate graph for one analysis symbol period.		
Frequency Error	OFDM	Carrier frequency deviation by analysis symbol in a line graph over the analysis window.	Frequency deviation [Hz]	Time [ms]
	Non-OFDM			
OFDM Flatness	OFDM only	Flatness of each subcarrier in a bar graph for one analysis symbol period over the analysis window.	Average power [dB relative to the zero carrier]	Subcarrier wave No. [−26 to +26]
OFDM Linearity	OFDM only	Linearity of OFDM modulation in a line graph (also called “AM/AM”)	Actually measured values [mW]	Ideal values [mW]
Symbol Table	OFDM	Table of symbol values (binary, octal, or hexadecimal) for one analysis symbol period.	-	-
	Non-OFDM			
Power analysis				
Spectrum Mask	All	Spectrum waveform in a line graph with the standard mask under Peak Hold condition. (Single view only)	Power [dBm]	Frequency [Hz]
Transmit Power	Non-OFDM	Transmit power on/down ramp in a line graph.	Power [W]	Time [s]

*** For the definition of “analysis symbol”, refer to page 2-12.**

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 Timing Parameters
- Basic Measurement Procedure

NOTE. *For complete details on operating the analyzer, refer to the* RSA3408A 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 (except for the spectrum mask measurement, which 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 timing parameters such as acquisition length and analysis length (refer to *Setting Timing Parameters* on page 2-5).
- **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 3-1 and *View Format* on page 3-5.

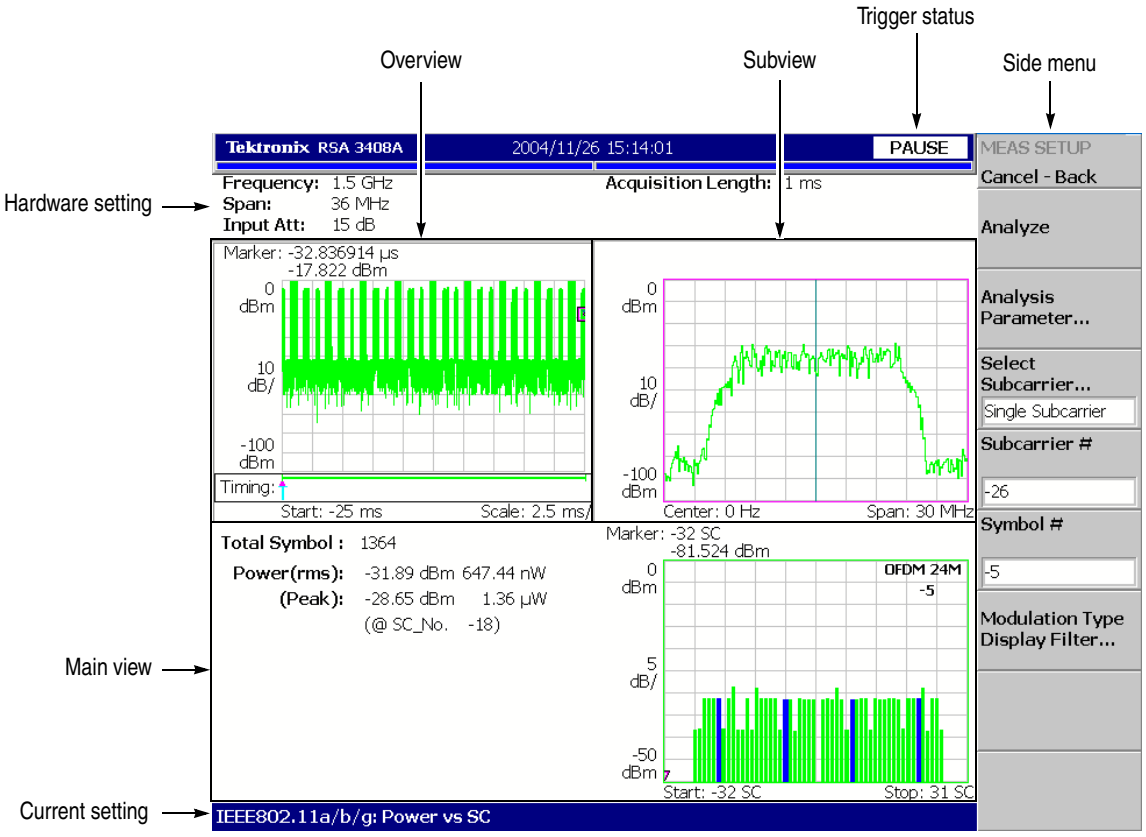

Figure 2-1: Screen elements

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

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	EVM versus Time	20 or 36 MHz (The default is 36 MHz)
	Power versus Time	
	Constellation	
	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 Timing Parameters

Press the **TIMING** key to set the timing 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 *RSA3408A User Manual*.

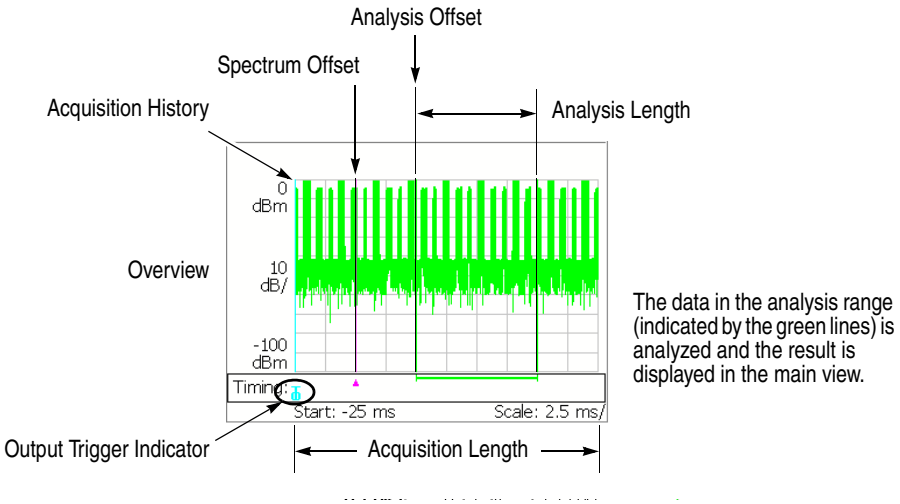

Figure 2-2: Timing parameters

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

Basic Measurement Procedure

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

Modulation Analysis

Do the following steps to perform the modulation analysis.

1. Press the **DEMOD** key on the front panel.
2. Press the side key **Standard...** and then **IEEE 802.11a/b/g**.
3. Set frequency and span appropriately using the **FREQUENCY/CHANNEL** key and the **SPAN** key. Refer to *Setting Frequency and Span* on page 2-3.
4. Set the amplitude appropriately using the **AMPLITUDE** key.

NOTE. *If the input signal level is too high, A/D OVERFLOW will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

5. Press the **TIMING** key and set the timing parameters. Refer to *Setting Timing Parameters* on page 2-5.
6. After acquiring measurement data, stop the data acquisition using the **RUN/STOP** key.
7. Press the **MEASURE** key and select the measurement item. For example, press the **Power vs Time** side key to observe power variance.
8. Press the **MEAS SETUP** key and then the **Analysis Parameter...** side key 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 2-9.
9. Press the **MEAS SETUP** key and then the **Analyze** side key to start the analysis for the acquired data with the specified parameters. If you cancel the analysis, press the **Cancel-Back** (top) side key.
10. Use the View menu to modify the displayed graph. For details on setting the views, refer to *View Format* on page 3-5.

Power Analysis

The power analysis consists of Spectrum Mask and Transmit Power. Do the following steps to perform the power analysis.

1. Press the **DEMOD** key on the front panel.
2. Press the side key **Standard...** and then **IEEE 802.11a/b/g**.
3. Set frequency and span appropriately using the **FREQUENCY/CHANNEL** key and the **SPAN** key. Refer to *Setting Frequency and Span* on page 2-3.
4. Set the amplitude appropriately using the **AMPLITUDE** key.

NOTE. *If the input signal level is too high, A/D OVERFLOW will be displayed in the red box at the center top of the screen. In this case, raise the reference level.*

5. *Transmit Power only.* Press the **TIMING** key and set the timing parameters. Refer to *Setting Timing Parameters* on page 2-5.
6. Press the **MEASURE** key and select the measurement item. For example, press the **Spectrum Mask** side key to observe the spectrum mask.
7. Press the **MEAS SETUP** key and set the measurement parameters. For details on setting the Measurement Setup menu, refer to page 2-9.
8. Use the View menu to modify the displayed graph. For details on setting the views, refer to *View Format* on page 3-5.

Measurement 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 2-3.

Table 2-3: Measurement setup reference

Measurement item	Reference
Modulation analysis	
EVM versus Time	Modulation Analysis on page 2-10
Power versus Time	
Constellation	
EVM versus SC	
Power versus SC	
SC Constellation	
Frequency Error	
OFDM Flatness	
OFDM Linearity	
Symbol Table	
Power analysis	
Spectrum Mask	Spectrum Mask on page 2-14
Transmit Power	Transmit Power on page 2-14

Modulation Analysis

The Meas Setup menu for the modulation analysis 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 2-4: 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 data and pilot.
- **Data.** Displays only data.
- **Pilot.** Displays only pilot.
- **Single Subcarrier.** Displays the subcarrier specified using the **Subcarrier #** side key below. This menu item is available when you specify one of the following formats for a measurement display.
  - EVM versus Time
  - Power versus Time
  - Constellation

Subcarrier # Specifies the subcarrier number when you select **Single Subcarrier** with the **Select Subcarrier...** side key above. Range: –32 to +31.

Symbol # Specifies the analysis symbol number for a measurement display when you select one of the following formats:

- EVM versus SC
- Power versus SC
- SC Constellation
- Symbol Table

For definition of the analysis symbol, refer to page 2-12.

The Select Subcarrier..., Subcarrier #, and Symbol # menu items are effective only in the measurements shown in Table 2-5.

Table 2-5: Submenu availability

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

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 2-6: Length of an analysis symbol

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 2-3. The selected item appears on the second side key where you can turn 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.

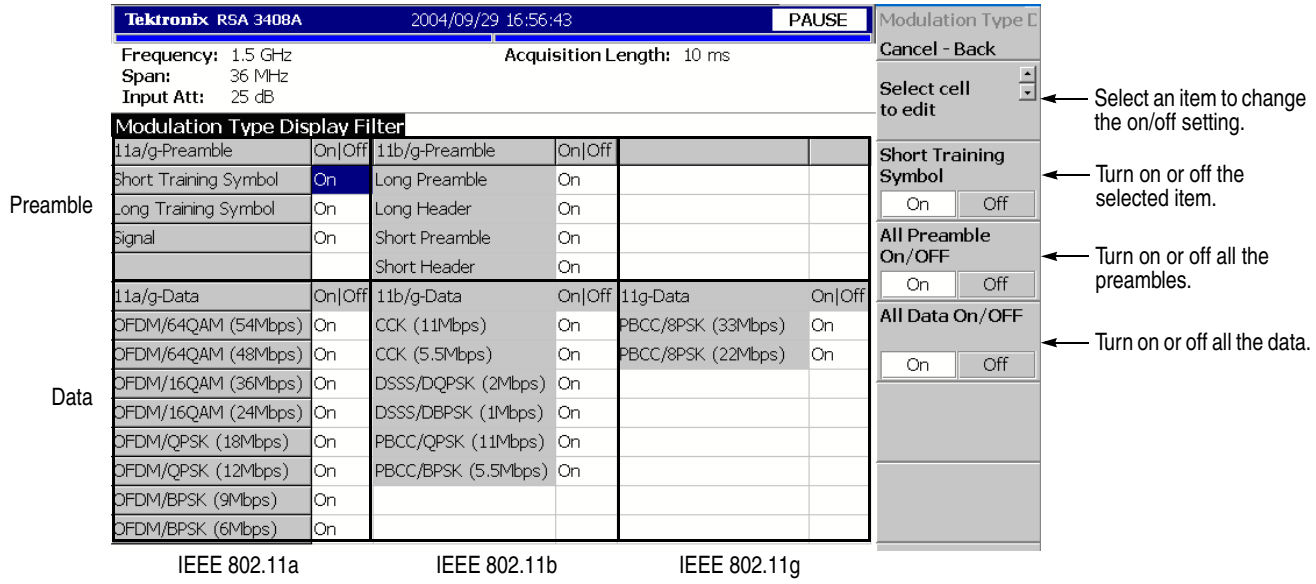

Figure 2-3: Modulation Type Display Filter setting

Spectrum Mask

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

Spectrum Mask Selects the measurement signal type from these two:

- DSSS (default)
- OFDM

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 2-4.

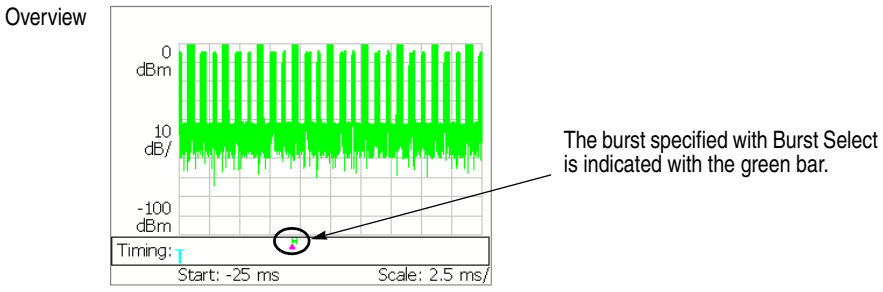

Figure 2-4: Burst indicator on the overview

Reference

View Operation

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

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

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 (Table 3-1).

Subview Content... Selects the subview content (Table 3-1).

The view contents depend on the measurement items as shown in Table 3-1. In the EVM measurement, you can change the measurement content using the VIEW: **SCALE** key**.**

Table 3-1: View content selection

Measurement item	VIEW: DEFINE → Overview content	VIEW: DEFINE → Subview content	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	-	-

NOTE. *The View Define menu for Spectrum Mask is the same as in the S/A (Spectrum Analysis) mode. Refer to the* RSA3408A User Manual.

Scaling the Graph

You can expand a waveform horizontally and vertically using the VIEW: **SCALE** key on the front panel (you can not 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 View Scale menu varies with the measurement items, it has commonly the following controls as shown in Figure 3-1.

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.

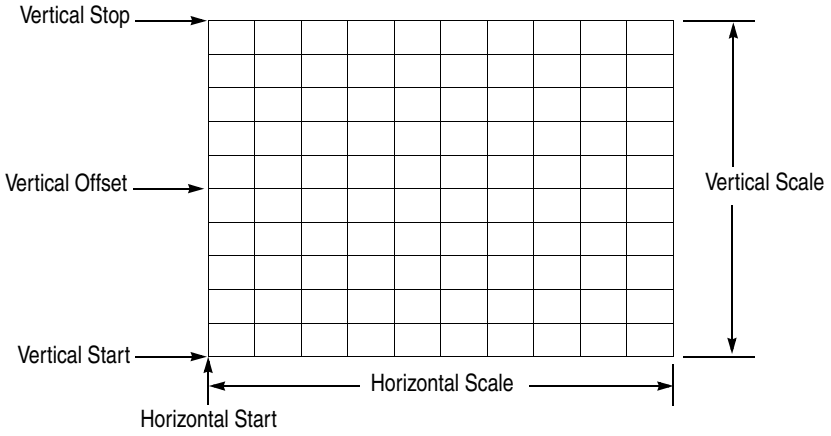

Figure 3-1: Definition of the View Scale menu items

Press the VIEW: **SELECT** key to select a view before scaling the graph using the **SCALE** key.

The next chapter *View Format* beginning on page 3-5 provides the View Scale menu description for each measurement item.

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.

View Format

This section provides information about the view formats of the WLAN analysis. It consists of two parts:

- Modulation Analysis View Format
- Power Analysis View Format

Modulation Analysis View Format

This subsection describes each modulation analysis view format.

EVM versus Time

The main view shows the EVM of carriers, or one or all subcarriers in a line graph, as shown in Figure 3-2. The vertical axis represents EVM in percent and the horizontal axis represents time in ms.

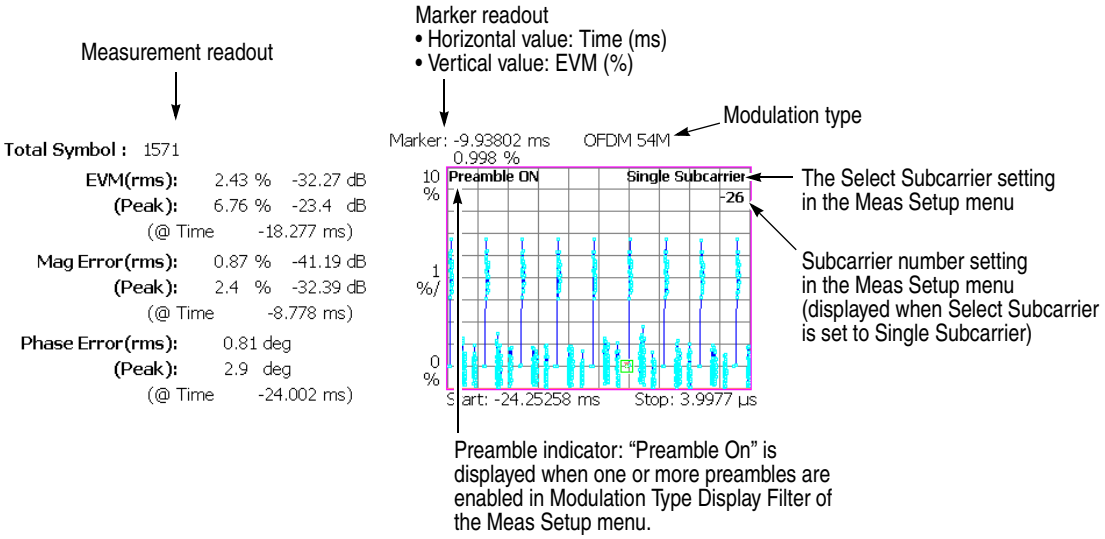

Figure 3-2: EVM versus Time (main view)

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)	ms	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)	ms	The peak time relative to the last data point
Phase Error (rms)	degree or radian	RMS value of Phase Error
(Peak)	degree or radian	Peak value of Phase Error
(@Time)	ms	The peak time relative to the last data point

View Scale Menu. The View 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 2-5).*

Vertical Scale. Sets the range of the vertical axis.
Refer to Table 3-2 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 3-2 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 3-2 for the setting range.

Table 3-2: 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 3-3. The vertical axis represents magnitude error in percent and the horizontal axis represents time in ms.

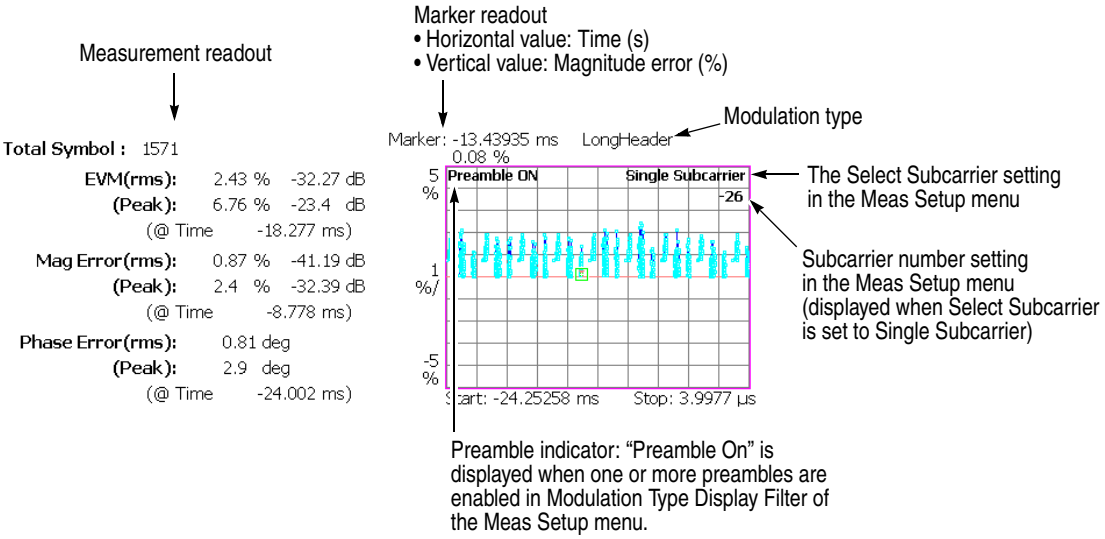

Figure 3-3: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. Refer to the View Scale menu of EVM versus Time on page 3-7.

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 3-4. The vertical axis represents phase error in degrees or radians and the horizontal axis represents time in ms.

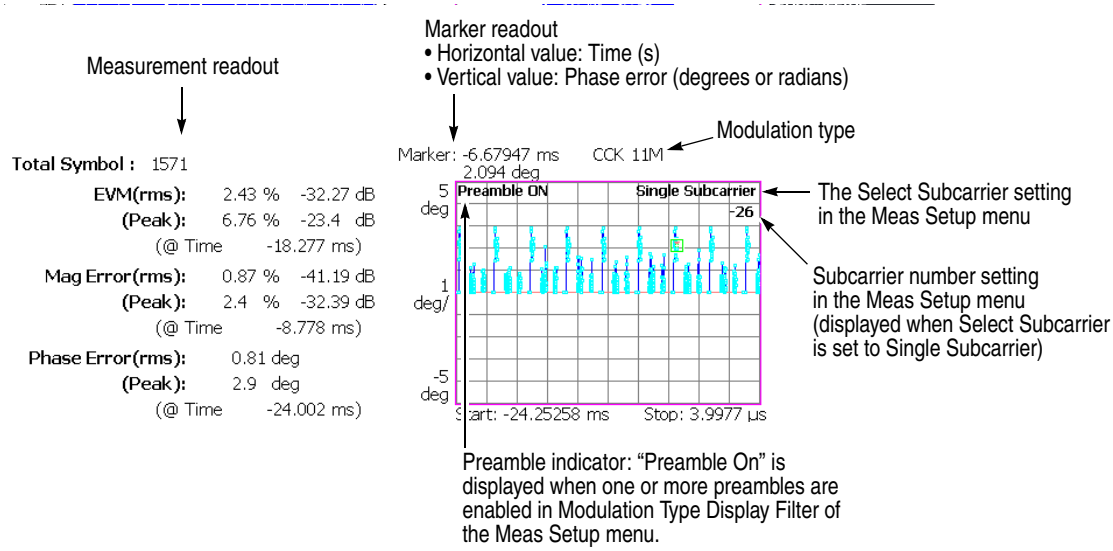

Figure 3-4: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. Refer to the View Scale menu of EVM versus Time on page 3-7.

Power versus Time

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

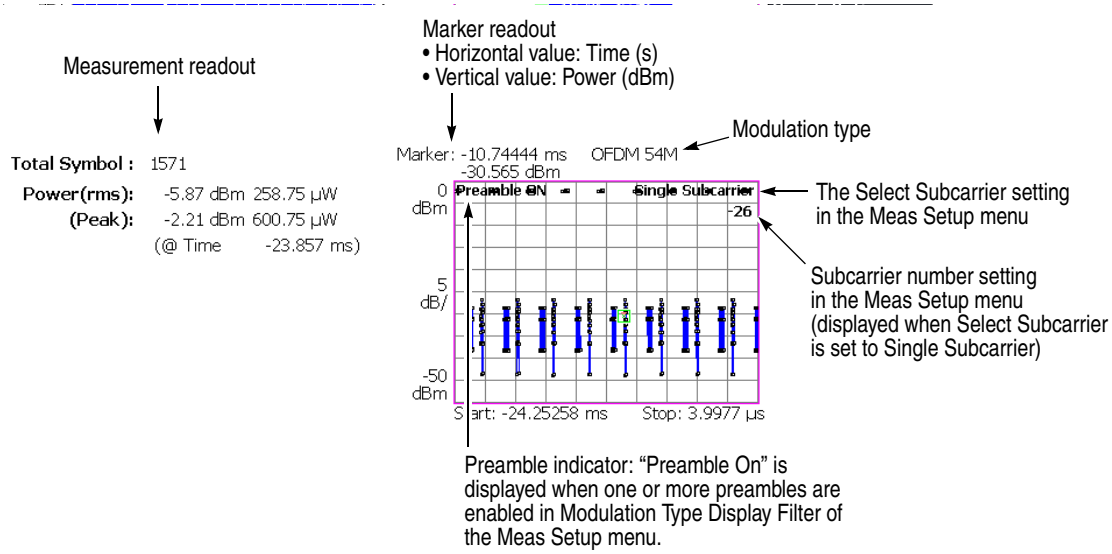

Figure 3-5: Power versus Time (main view)

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)	ms	The peak time relative to the last data point

View Scale Menu. The View 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 2-5).*

Vertical Scale. Sets the range of the vertical axis.
Range: 50µ 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 3-6. The vertical axis represents I and the horizontal axis represents Q.

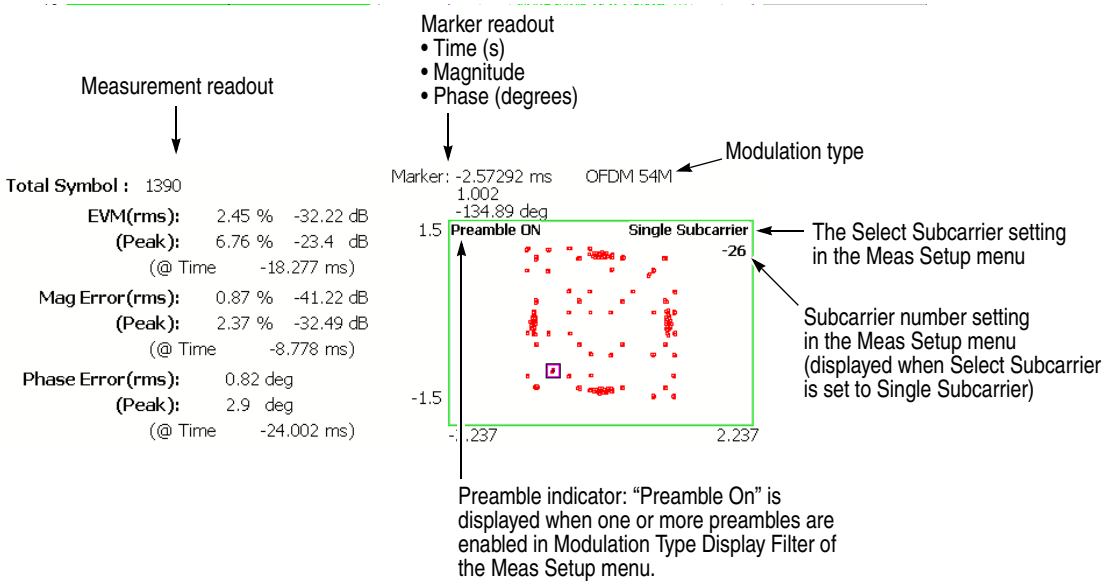

Figure 3-6: Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

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

Measurement Content... Selects vector or constellation display.

- **Vector.** Selects vector display. A signal represented with phase and amplitude is displayed in polar coordinate or IQ diagram. The red point indicates the symbol position of 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 3-7. The vertical axis represents EVM in percent and the horizontal axis represents subcarrier number ranging from –26 to +26.

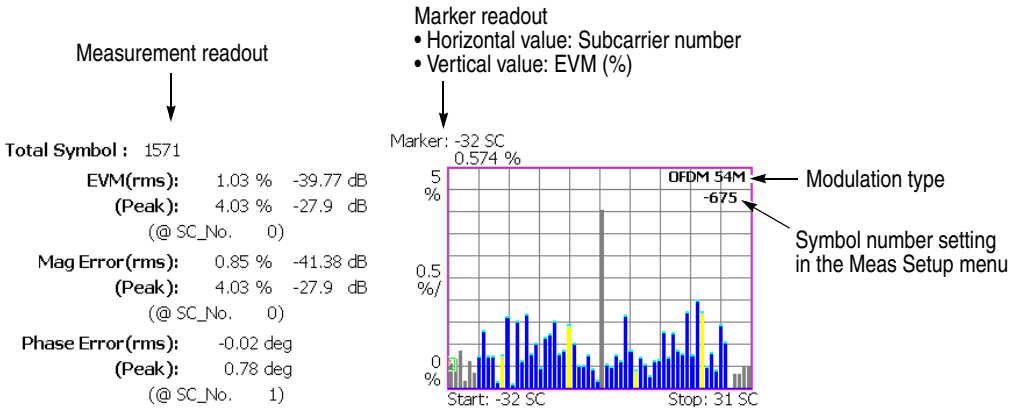

Figure 3-7: EVM versus SC (main view)

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)	degree or radian	RMS value of Phase Error
(Peak)	degree or radian	Peak value of Phase Error
(@SC_No.)	-	The subcarrier number at the peak

View Scale Menu. The View 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 3-3 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 3-3 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 3-3 for the setting range.

Table 3-3: 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.

Non-OFDM. The main view displays the EVM of carriers by analysis symbol in a bar graph, as shown in Figure 3-8. The vertical axis represents EVM in percent and the horizontal axis represents time in ms.

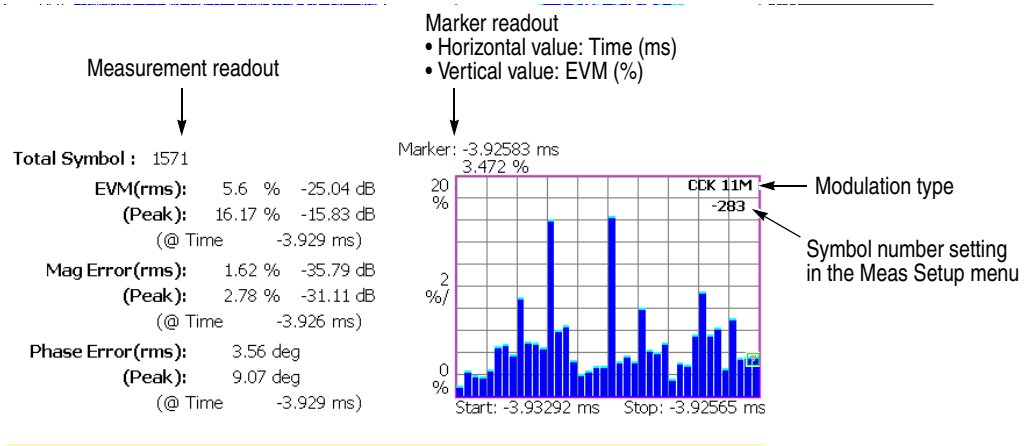

Figure 3-8: EVM versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. The View Scale menu in EVM versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-7.

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 3-9.
The vertical axis represents magnitude error in percent and the horizontal axis represents the subcarrier wave number ranging from –26 to +26.

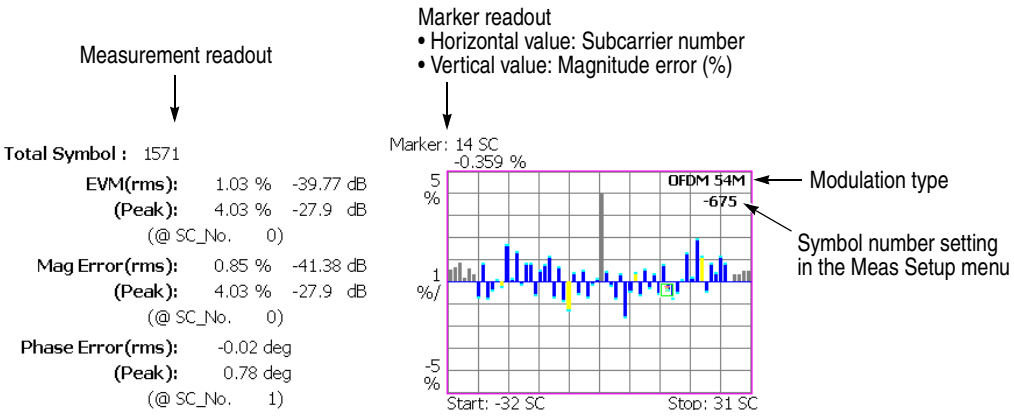

Figure 3-9: MagErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-13.

View Scale Menu. Refer to the View Scale menu of EVM versus SC on page 3-14.

Non-OFDM. The main view displays the magnitude error of carriers by analysis symbol in a bar graph, as shown in Figure 3-10. The vertical axis represents magnitude error in percent and the horizontal axis represents time in ms.

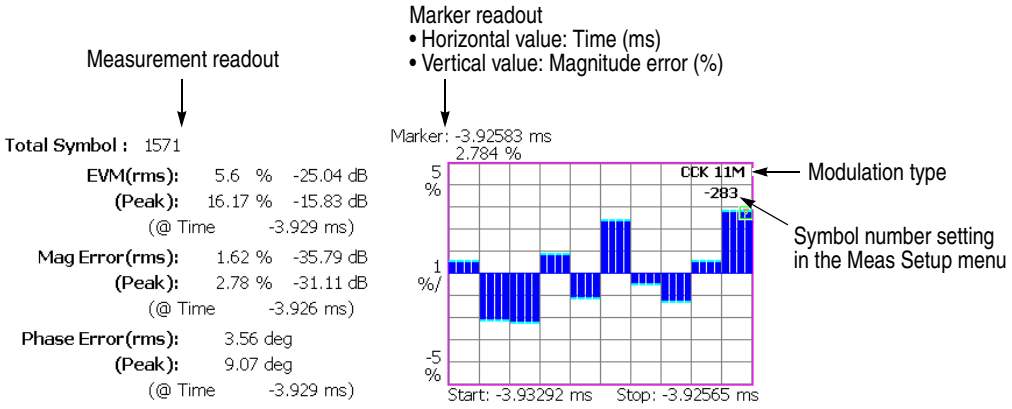

Figure 3-10: MagErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. The View Scale menu in MagErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-7.

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 3-11.
The vertical axis represents phase error in degrees and the horizontal axis represents the subcarrier wave number ranging from –26 to +26.

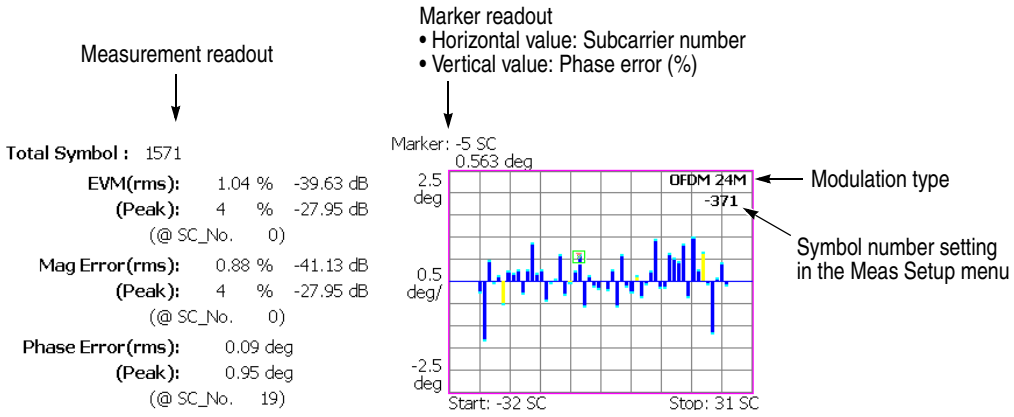

Figure 3-11: PhaseErr versus SC (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-13.

View Scale Menu. Refer to the View Scale menu of EVM versus SC on page 3-14.

Non-OFDM. The main view displays the phase error of carriers by analysis symbol in a bar graph, as shown in Figure 3-12. The vertical axis represents the phase error in degrees or radians and the horizontal axis represents time in ms.

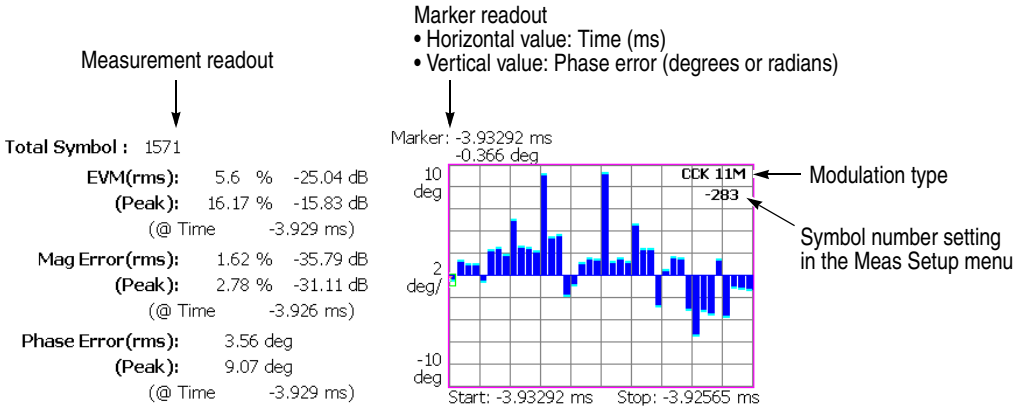

Figure 3-12: PhaseErr versus Time (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. The View Scale menu in PhaseErr versus SC for Non-OFDM has the same controls as in EVM versus Time. Refer to page 3-7.

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 3-13. The vertical axis represents power in dBm and the horizontal axis represents subcarrier number ranging from –26 to +26.

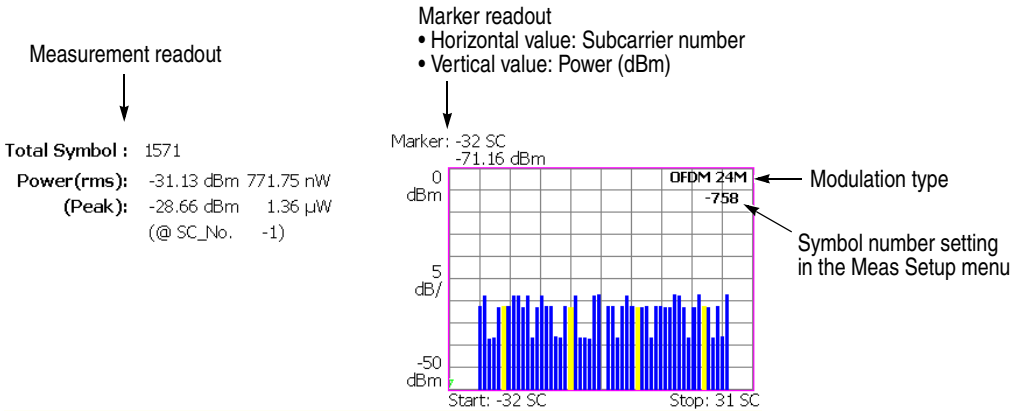

Figure 3-13: Power versus SC (main view)

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 one or all subcarriers
(Peak)	dBm, W	Peak power of one or all subcarriers
(@SC_No.)	-	Subcarrier number at the peak

View Scale Menu. The View 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: 50µ 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 3-14. The vertical axis represents power in dBm and the horizontal axis represents time in ms.

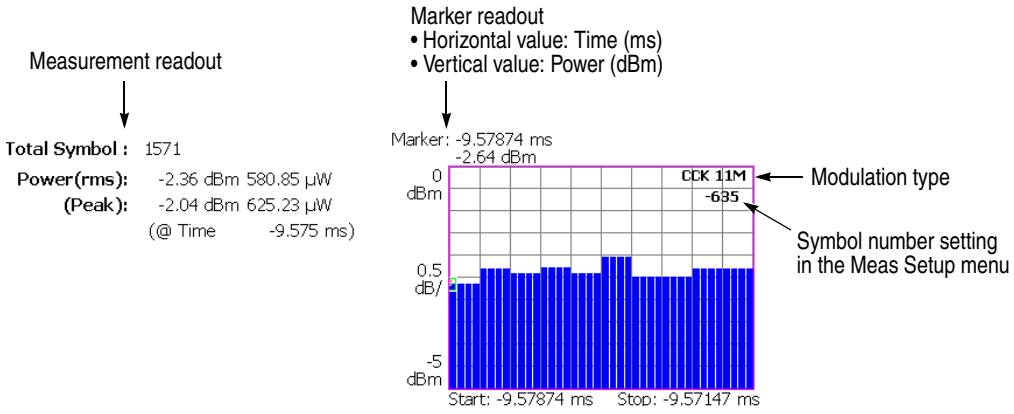

Figure 3-14: Power versus Time (main view)

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)	ms	The peak time relative to the last data point

View Scale Menu. The View Scale menu in Power versus SC for Non-OFDM has the same controls as in Power versus Time. Refer to page 3-11.

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 3-15. The vertical axis represents I and the horizontal axis represents Q.

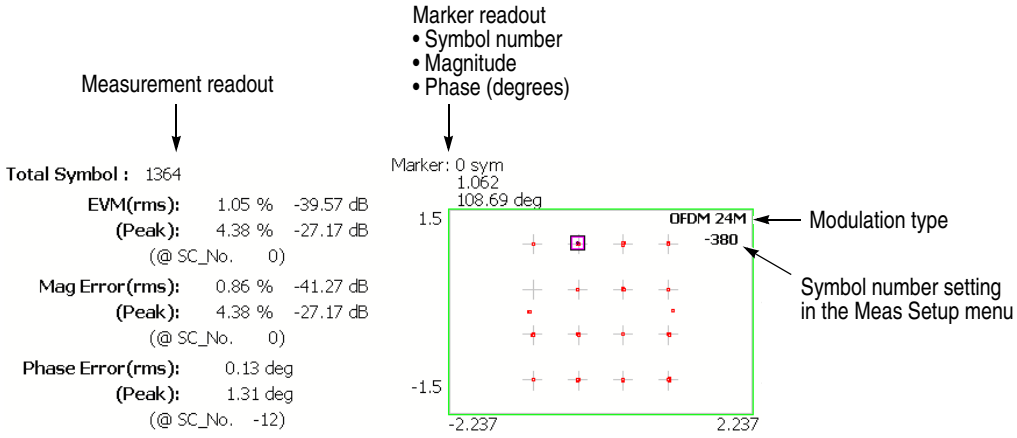

Figure 3-15: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus SC, shown in the table on page 3-13.

View Scale Menu. Same as in Constellation. Refer to page 3-12.

Non-OFDM. The main view displays the constellation of carriers in a rectangular coordinate graph for an analysis symbol, as shown in Figure 3-16. The vertical axis represents I, and the horizontal axis represents Q.

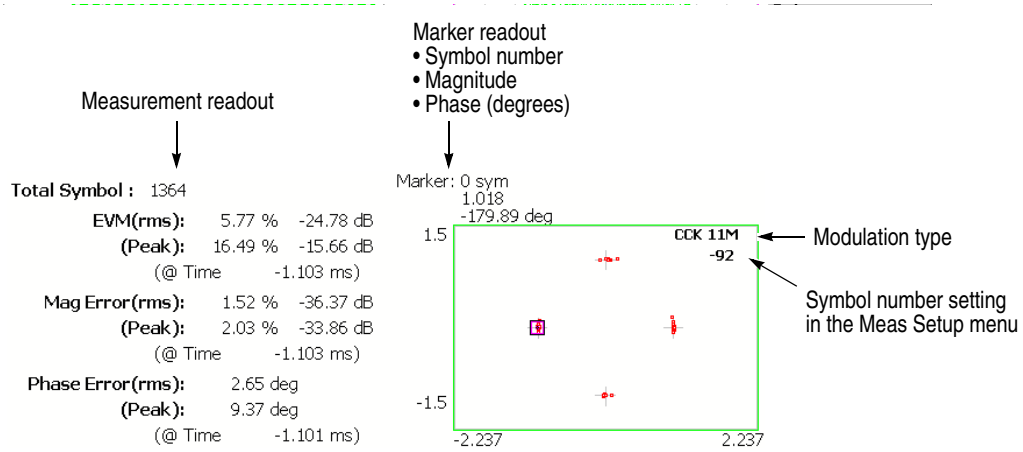

Figure 3-16: Symbol Constellation (main view)

The measurement readout is the same as in EVM versus Time, shown in the table on page 3-6.

View Scale Menu. Same as in Constellation. Refer to page 3-12.

Frequency Error

The main view displays the center frequency deviation over time in a line graph, as shown in Figure 3-17. The vertical axis represents frequency error in kHz, and the horizontal axis represents time in ms.

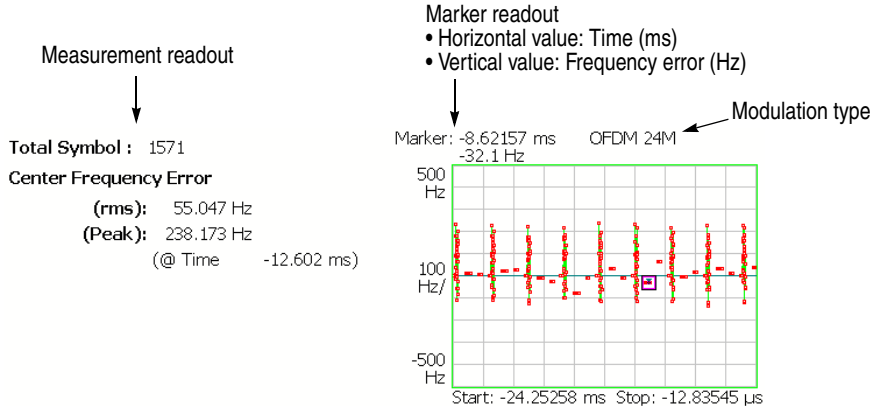

Figure 3-17: Frequency error (main view)

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)	ms	The peak time relative to the last data point

View Scale Menu. The View 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 2-5).*

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 3-18. The vertical axis represents the deviation power of average energy in dB, and the horizontal axis represents subcarrier wave number ranging from –26 to +26.

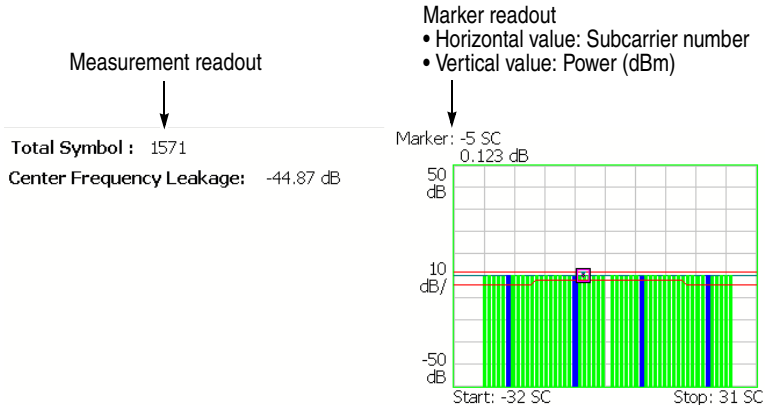

Figure 3-18: OFDM flatness (main view)

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)

View Scale Menu. The View 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: 100µ 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 3-19. The vertical axis represents actual measurement values in mW, and the horizontal axis represents the ideal values in mW.

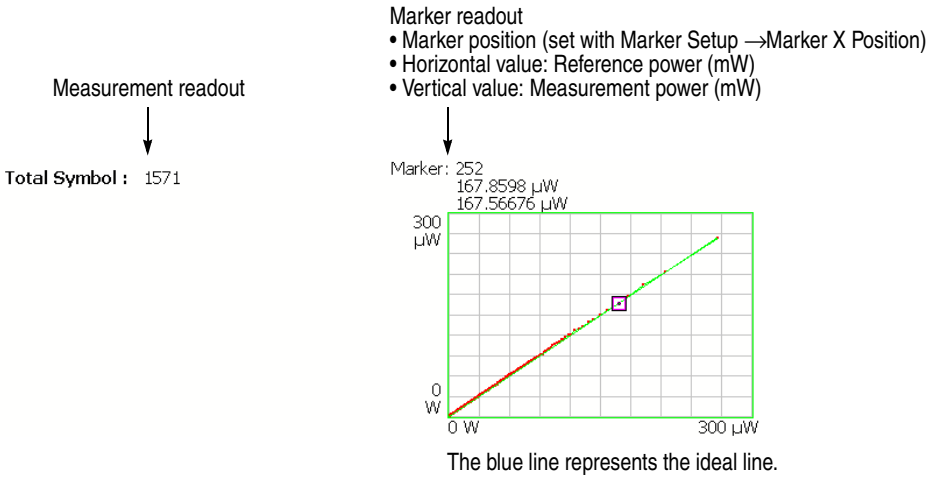

Figure 3-19: OFDM linearity (main view)

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

View Scale Menu. The View 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 3-20. The table can be displayed with binary, octal, or hexadecimal digits.

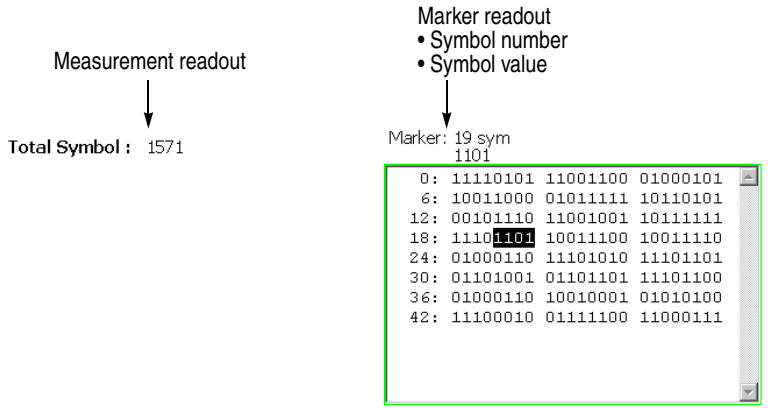

Figure 3-20: Symbol table (main view)

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

View Scale Menu. The View 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

Power Analysis View Formats

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 under PeakHold condition, as shown in Figure 3-21. The vertical axis represents power in dBm and the horizontal axis represents frequency in Hz.

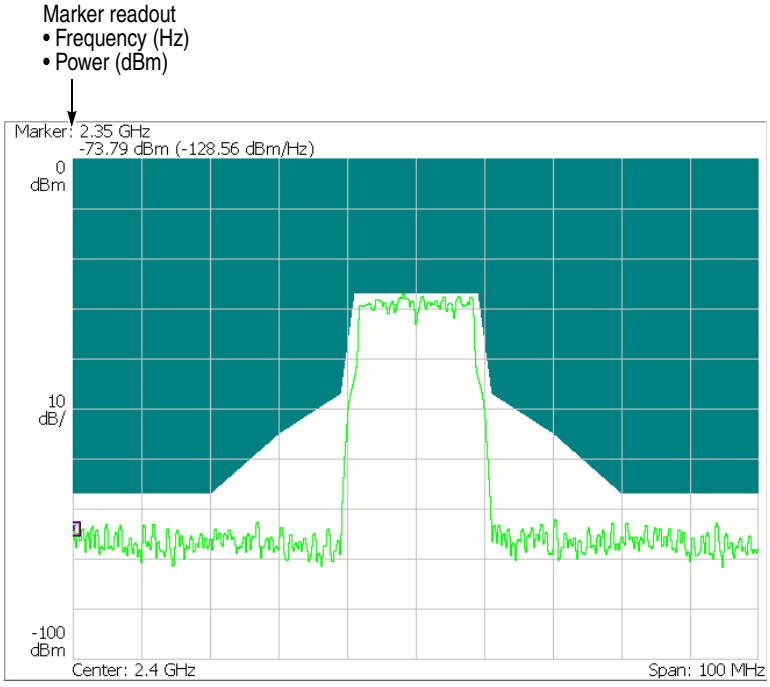

Figure 3-21: Spectrum mask (OFDM)

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

Figure 3-22 shows the IEEE802.11a standard for Spectrum Mask.

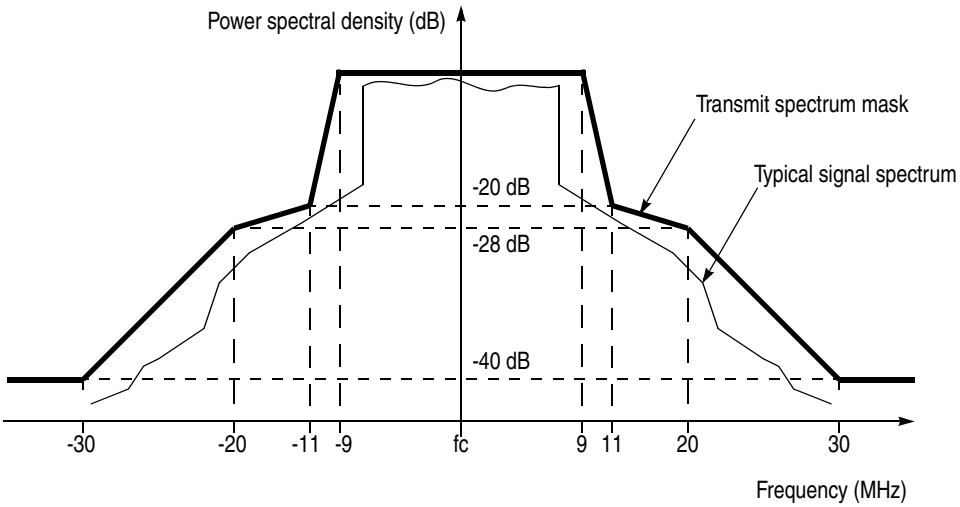

Figure 3-22: IEEE802.11a spectrum mask

View Scale Menu. The View 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: 100µ 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 under PeakHold condition, as shown in Figure 3-23. The vertical axis represents power in dBm and the horizontal axis represents frequency in Hz.

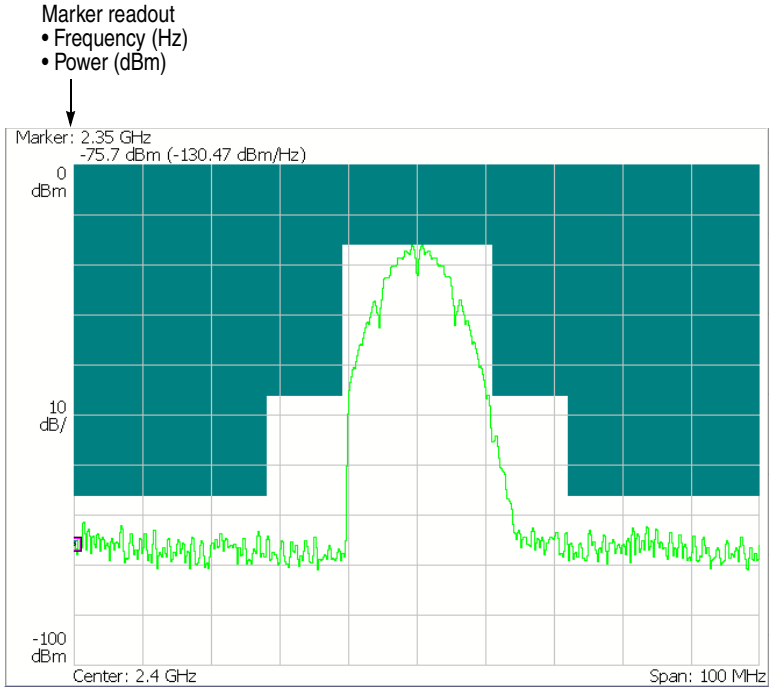

Figure 3-23: Spectrum mask (DSSS)

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

Figure 3-24 shows the IEEE802.11b standard for Spectrum Mask.

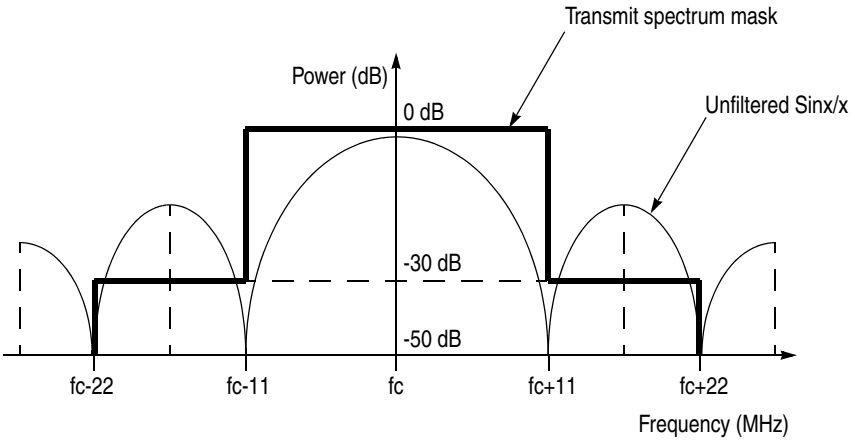

Figure 3-24: IEEE802.11b spectrum mask

View Scale Menu. The View Scale menu in Spectrum Mask for Non-OFDM has the same controls as for OFDM. Refer to page 3-32.

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.

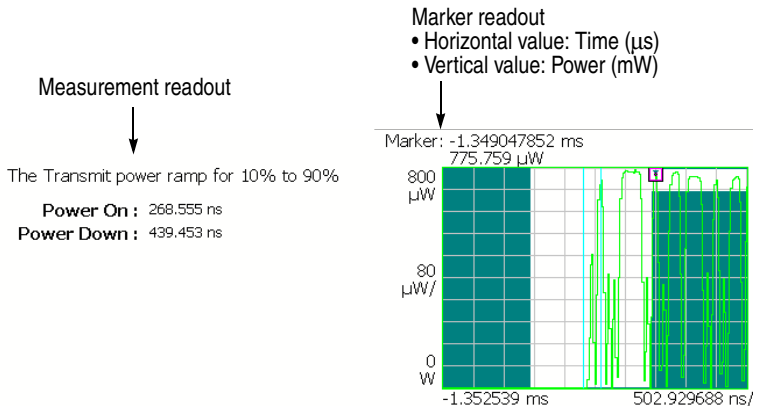

Figure 3-25: Transmit power on (main view)

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 3-26 shows the IEEE802.11b standard for the transmit power-on ramp.

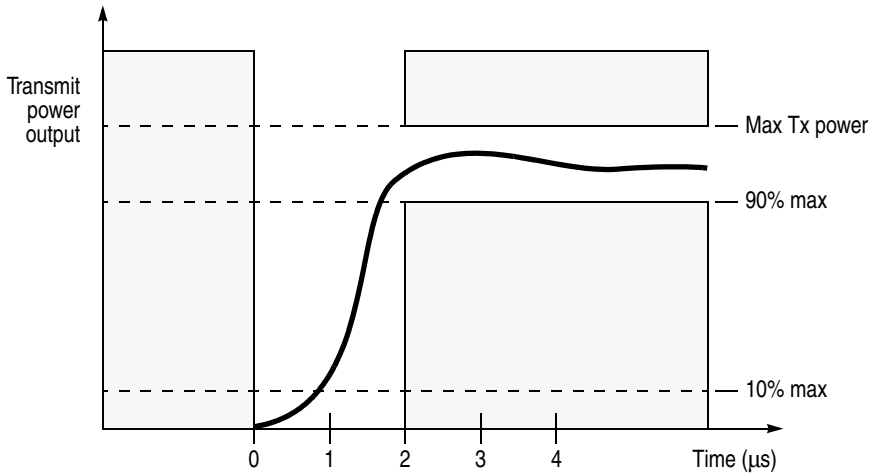

Figure 3-26: IEEE802.11b Transmit power-on ramp

View Scale Menu. The View 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 2-5).*

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.

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.

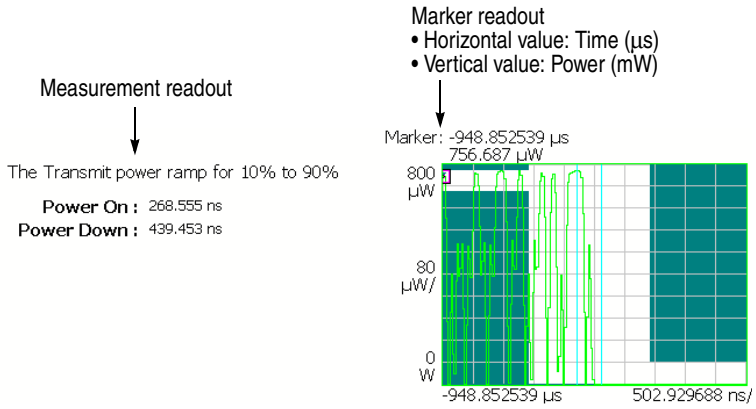

Figure 3-27: Transmit power down (main view)

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

The readout is the same as Transmit Power-On. Refer to page 3-35.

Figure 3-28 shows the IEEE802.11b standard for the transmit power-down ramp.

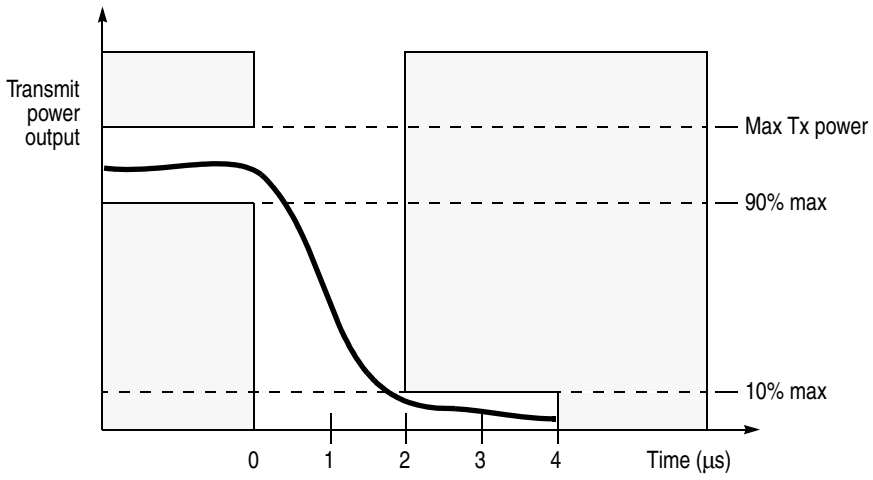

Figure 3-28: IEEE802.11b Transmit power-down ramp

View Scale Menu. The View Scale menu for Transmit Power Down has the same controls as for Transmit Power On. Refer to page 3-36.

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
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 degrees
Power versus Time	All	–100 to 0 ms [1]	–100 to 50 dBm
Constellation	All	Fixed	Fixed
EVM versus SC	OFDM	Subcarrier # –32 to 31	–100 to 200%
	Non-OFDM	–100 to 0 ms [1]	
MagErr versus SC	OFDM	Subcarrier # –32 to 31	–300 to 300%
	Non-OFDM	–100 to 0 ms [1]	
PhaseErr versus SC	OFDM	Subcarrier # –32 to 31	–675 to 675 degrees
	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	–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.

Glossary and Index

Glossary

Acronyms

BPSK
Binary Phase Shift Keying

CCK
Complementary Code Keying

DSSS
Direct Sequence Spread Spectrum

EVM
Error Vector Magnitude

IEEE
Institute of Electrical and Electronic Engineers

LAN
Local Area Network

OFDM
Orthogonal Frequency Division Multiplexing

PBCC
Packet Binary Convolutional Coding

PLCP
Physical Layer Convergence Protocol

PSK
Phase Shift Keying

QAM
Quardrature Amplitude Modulation

QPSK
Quardrature Phase Shift Keying

SC
Subcarrier

WLAN
Wireless Local Area Network

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