AE-166/167

SPECTRUM ANALYSER

- 0 MI2134 -

SAFETY NOTES

Read the user's manual before using the equipment, mainly "**SAFETY RULES**" paragraph.

The symbol ⚠ on the equipment means "**SEE USER'S MANUAL**". In this manual may also appear as a Caution or Warning symbol.

WARNING AND CAUTION statements may appear in this manual to avoid injury hazard or damage to this product or other property.

MULTIMEDIA CONTENT

You can access instantly to any chapter by clicking on the title of the chapter in the table of contents.

Click on the arrow ⬅ at the top right of the page to return to the table of contents.

USER'S MANUAL VERSION

Version	Date
2.0	February 2017

SAFETY RULES ⚠

This chapter contains important safety instructions that you must follow during operation and storage. Read the following before any operation to insure your safety and to keep the instrument in the best possible condition.

Safety Guideline

- **General**

    * Do not place any heavy object on the instrument.

    * Avoid severe impact or rough handling that leads to damaging the instrument.

    * Do not discharge static electricity to the instrument.

    * Use only mating connectors, not bare wires, for the terminals.

    * Ensure signals to the RF input do not exceed +30 dBm / ±25 V DC.

    * Do not block the cooling fan opening.

    * Do not disassemble the instrument unless you are qualified.

    * (Measurement categories) EN 61010-1:2010 specifies the measurement categories and their requirements as follows. The instrument falls under category 2.

- **Power Supply**

    * AC Input voltage range: 100 V ~ 240 V.

    * Frequency: 50 / 60 Hz.

    * To avoid electrical shock connect the protective grounding conductor of the AC power cord to an earth ground.

- **Battery**

    * Rating: 10.8 V, 6 cell Li-ion battery

    * Turn off the power and remove the power cord before installing or removing the battery.

- **Cleaning**

    * Disconnect the power cord before cleaning.

    * Use a soft cloth dampened in a solution of mild detergent and water. Do not spray any liquid.

    * Do not use chemicals containing harsh material such as benzene, toluene and acetone.

- **Operation Environment**

  * Location: Indoor, no direct sunlight, dust free, almost non-conductive pollution (Note below).

  * Temperature: 5 °C to 45 °C.

  * Humidity: 90 % to 45 °C.

  * (Pollution Degree) EN 61010-1:2010 specifies the pollution degrees and their requirement as follows. The instrument falls degree 2.

- **Storage environment**

  * Location: Indoor.

  * Temperature: 90 % to 45 °C.

- **Disposal**

  * Do not dispose this instrument as unsorted municipal waste. Please use a separate collection facility or contact the supplier from which this instrument was purchased. Please make sure discarded electrical waste is properly recycled to reduce environmental impact.

- **Symbols related with safety:**

▬▬▬	DIRECT CURRENT	|	ON (Supply)
∿	ALTERNATING CURRENT	◯	OFF (Supply)
≂	DIRECT AND ALTERNATING	▣	DOUBLE INSULATION (Class II protection)
⏚	GROUND TERMINAL	⚡	CAUTION (Risk of electric shock)
⏛	PROTECTIVE CONDUCTOR	⚠	CAUTION REFER TO MANUAL
⏝	FRAME TERMINAL	▭	FUSE
▽	EQUIPOTENTIALITY	♲ 🗑	EQUIPMENT OR COMPONENT TO BE RECYCLED

Descriptive Examples of Over-Voltage Categories

Cat I   Low voltage installations isolated from the mains.

Cat II   Portable domestic installations.

Cat III   Fixed domestic installations.

Cat IV   Industrial installations.

TABLE OF CONTENTS

SPECTRUM ANALYSER
AE-166/167

1 INTRODUCTION

1.1 | Description

The AE-166/167 builds on the strong feature set of the PROMAX spectrum analysers and significantly increases performance in almost every aspect; making this the most comprehensive and feature-rich spectrum analyser Promax has released.

The AE-166/167 features a split window display to view data in spectrum, topographic or spectrographic views. There are also a number of additional test functions such as P1DB. Lastly, the AE-166/167 significantly reduces the sweep time and RBW filter step resolution and complexity.

1.2 | Main Features

► **Performance**
- 9 kHz ~ 3 GHz bandwidth
- 1 Hz resolution
- Nominal RBW accuracy of ±5% < 1 MHz, ±8% = 1 MHz
- Video bandwidth 1 Hz ~ 1 MHz (1-3-10 steps)
- Amplitude measurement range: DANL ~ 30 dBm (frequency dependent)
- Input attenuation: 0 ~ 50 dB, 1 dB steps
- Phase noise: < -88 dBc/Hz@1 GHz, 10 kHz, typical

► **Features**
- 1-3-10 step increments for RBW bandwidth
- Three display modes: Spectrum, Topographic and Spectrographic
- Split window display
- Built-in EMI filter
- Auto Wake-up
- Built-in preamplifier

- Gate sweep
- Marker Frequency counter
- Two operating modes: Spectrum and Power Meter mode
- SEM measurement
- ACPR measurement
- OCBW measurement
- Phase jitter measurement
- Harmonics measurement
- P1dB measurement
- Channel power measurement
- Demodulation analyser
- Diverse marker functions and features with Peak Table
- Sequence function to automatically perform pre-programmed sequential operations
- Optional battery operation

► **Interface**
- 8.4 color LCD (800 × 600)
- On-screen menu icons
- DVI-I video output
- RS-232 with RTS/CTS hardware flow control
- USB 2.0 with support for USB TMC
- LAN TCP/IP
- Optional GPIB/IEEE488 interface
- Optional 3G USB adapter for WLAN
- Optional power meter adapter
- IF output @ 886 MHz
- Headphone output
- REF (reference clock) input/output BNC ports
- Alarm/Open collector output BNC port
- Trigger/Gate input BNC ports
- RF N-type input port
- Tracking generator output
- DC +7 V / 500 Ma output SMB port

2 SETTING UP

2.1 Accessories

Check that your package contains the following elements:
- Power cord
- Quick start guide
- Tracking generator (only for AE-167)
- "N"/ M –BNC/ H adapter

► **Options**
- Battery (11.1 V / 5200 mAH Li-ion battery)

► **Optional accessories**
- Soft Carrying Case
- 6U Rack mount kit

► **Software Downloads**
- PC Software for Windows System (SpectrumShot quick start guide, SpectrumShot software)
- IVI Driver Supports LabView & LabWindows/CVI Programming

2.2 | Appearance

■ **Front Panel**
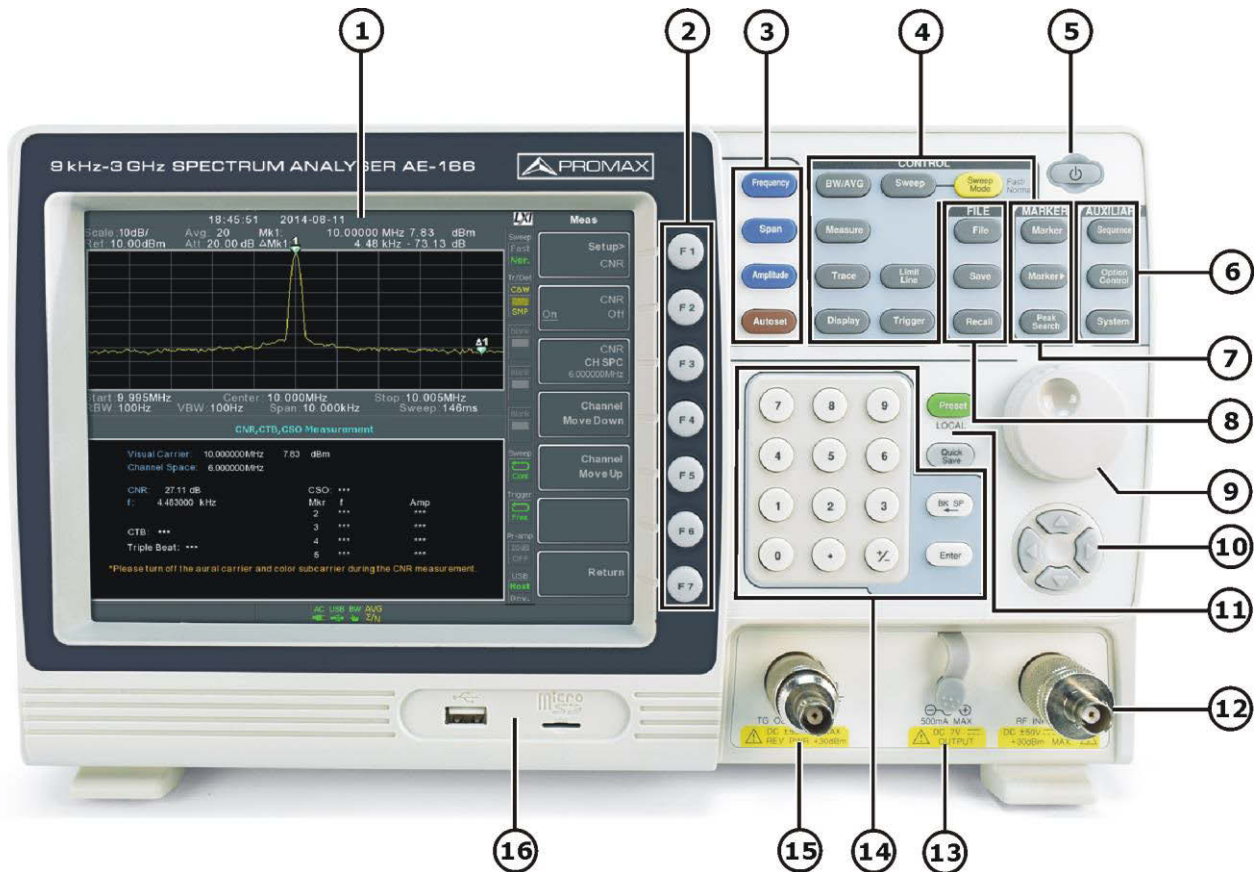
Figure 1.

① **LCD display:** 800 X 600 color LCD display. The display shows the soft keys for the current function, frequency, amplitude and marker information.

② **Function keys:** The F1 to F7 function keys directly correspond to the soft keys on the right-hand side of display.

③ **Main keys:**
■ **Frequency:** Sets the center frequency, start frequency, stop frequency, center frequency step and frequency offset values.
■ **Span:** Sets the span, with options for full span, zero span and last span.
■ **Amplitude:** Sets the amplitude reference level, attenuation, pre-amplifier controls, scale and other options for attenuation and scale.
■ **Autoset:** Automatically searches the peak signal with maximum amplitude and displays it with appropriate horizontal and vertical scales.

4 **Control keys:**

- ■ **BW/Avg:** Sets the resolution bandwidth, video bandwidth, average type and turns the EMI filter on/off.
- ■ **Sweep:** Sets the sweep time and gate time.
- ■ **Sweep Mode:** Toggles the Sweep Control between *Fast* and *Normal* mode.
- ■ **Measure:** Accesses measurement options such as ACPR, OCBW, demodulation measurements, SEM, TOI, phase jitter and other advanced measurements.
- ■ **Trace:** Sets traces and trace related functions.
- ■ **Limit Line:** Sets and tests Pass/Fail limit lines.
- ■ **Display:** The Display key configures the windowing mode and basic display properties.
- ■ **Trigger:** Sets the triggering modes.

5 **Power key:** Turns the instrument on/off. On = yellow, off = blue.

6 **Auxiliary keys:**

- ■ **Sequence:** Access, set and edit program sequences.
- ■ **Option Control:** The *Option Control* key allows you to setup optional accessories such as the Tracking Generator, Power Meter or Demo Kit.
- ■ **System:** The System key shows system information, settings and other system related functions.

7 **Marker keys:**

- ■ **Marker:** Turns the Markers on/off and configures the markers.
- ■ **Marker ▶:** The *Marker* ▶ key positions the markers on the trace.
- ■ **Peak Search:** Finds each maximum and minimum peak. Used with the Marker function.

8 **File keys:**

- ■ **File:** File utilities options.
- ■ **Save:** Save the trace, state etc., and save options.
- ■ **Recall:** Recall the trace, state etc., and recall options.

9 **Scroll wheel:** Edit values, select listed items.

10 **Arrow keys:** Increment/decrement values (in steps), select listed items.

⑪   ▪   **Preset LOCAL:** The *Preset* key will restore the spectrum analyser to the Factory or User Preset settings. The Preset key will also return the instrument back to local control after it has been in remote control mode.

     ▪   **Quick Save:** The Quick Save utility allows you to save either the state, trace, display screen, limit line, correction or sequence with only a single press.

⑫   **RF input terminal:**
- RF input port. Accepts RF inputs.
- Maximum input: + 30 dBm
- Input impedance: 50 Ω
- Maximum DC voltage: ± 50 V
- N-type: female

⑬   **DC power supply:**
- SMB port supplies power for optional accessories.
- DC +7 V
- 500 mA Max

⑭   **Numeric keypad:** The numeric keypad is used to enter values and parameters. It is often used in conjunction with the arrow keys and scroll wheel.

⑮   **TG output port:**
- The Tracking Generator (TG) output source.
- N-type: female
- Input impedance: 50 Ω
- Output power: -50 dBm to 0 dBm
- Maximum reversed power: +30 dBm

⑯   **USB A, Micro SD:** USB A port, Micro SD port for saving/recalling settings/files.

■ **Rear Panel**

Figure 2

① **RS232 port:** 9 pin DSUB port.

② **IF OUT:** SMA IF Out port.

③ **DVI-I port:** DVI video out port. Supports SVGA (800 X 600) @ 60 Hz.

④ **USB B / LAN port:**

  ■ USB B Device port. USB 1.1/2.0.
  ■ LAN RJ-45 10Base-T/100Base-Tx

⑤ **Fan**

⑥ **Power Socket:** 100 ~ 240 V, 50 / 60 Hz.

⑦ **Battery cover / Optional battery pack:** Voltage: 10.8 V Capacity: 5200 mAH

⑧ **REF IN:** BNC female reference input.

⑨ **REF OUT:** BNC female reference output: 10 MHz, 50 Ω impedance

⑩ **ALARM OUT / OPEN COLLECTOR:** BNC female open collector Alarm output.

⑪ **TRIG IN/GATE IN port:** BNC female 3.3 V CMOS trigger input/gated sweep input.

⑫ **Headphone:** 3.5 mm stereo headphone jack (wired for mono operation).

► **Display**
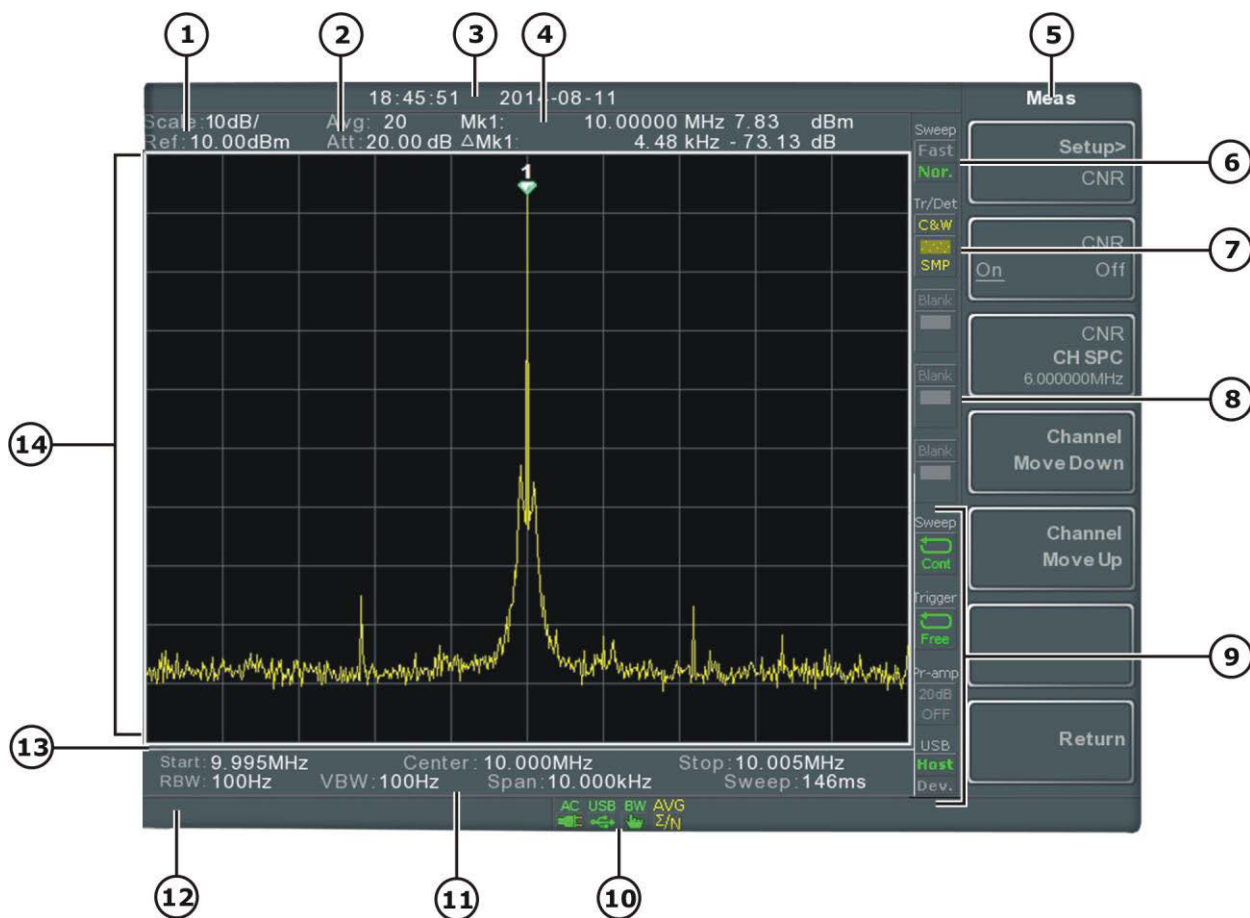
Figure 3.

① **Scale and Reference level:**
- ■ Scale: Displays the vertical scale of the vertical grid.
- ■ Reference level: Displays the reference level.

② **Attenuation level:** Displays the vertical scale (attenuation) of the input signal.

③ **Date/Time:** Displays the date and time.

④ **Marker information:** Displays marker information.

⑤ **Function menu:** Soft menu keys associated with the F1 to F7 function keys to the right of the display.

⑥ **Sweep settings:** This icon displays the sweep mode, as set by the Sweep Mode key.

⑦ **Trace and detection settings:** Trace icon that shows the trace type and the detection mode used for each trace.

8 **Blank:** Unassigned setting icons.

9 **Settings, Trigger, Pre-amp and USB settings:**

Sweep mode icon that shows the sweep status.

Trigger icon that shows the trigger status.

Pre-amplifier icon that shows the Pre-amplifier status.

USB settings icon displays the status of the USB A port.

10 **Status Icons:** Displays the interface status, power source status and alarm status, etc. See the Status Icon Overview for a list of the status icons.

11 **Frequency / Bandwidth settings:** Displays the Start, Center and Stop frequencies, RBW, VBW, Span and Sweep settings.

12 **Entry/Message area:** This area is used to show system messages, errors and input values/parameters.

13 **Sweep progress bar:** The sweep progress bar shows the progress of slow sweeps (greater than 2 seconds).

14 **Trace and waveforms:** Main display showing the input signals, traces, limit lines and marker positions.

■ **Status Icon Overview**

3G Adapter		Indicates that the 3G adapter is installed and turned on.
Demo Kit		Indicates that the demo kit is installed and turned on.
PreAmp		Indicates that the pre amplifier is on.
AC		Shown when running on AC power.
AC Charge		Shown when the AC power is charging the battery.
Alarm Off		Alarm buzzer output is currently off.
Alarm On		Alarm buzzer output is currently on.

Amplitude Offset		Indicates that the amplitude-shift is active. This icon appears when amplitude-related functions are used: Reference level offset Amplitude Correction Input Z = 75 Ω and Input Z cal > 0
Battery indicator		Indicates the battery charge.
Bandwidth Indicator		Indicates that the RBW or VBW settings are in manual mode.
Average		Indicates that the Average function is active.
External Lock		Indicates that the system is now locked and refers to the external reference input signal.
External Trigger		External trigger signal is being used.
Math		Trace math is being used.
Sequence Indicator		Shown when a sequence is running.
Sweep Indicator		Indicates that the sweep time is manually set.
Tracking generator		Indicates that the tracking generator is turned on.
TG Normalization		Indicates that the tracking generator has been normalized.
Wake-up clock		Indicates that the wake-up clock is turned on.
USB		Indicates that a USB flash drive is inserted into the front panel and is recognized.
Micro SD		Indicates that a micro SD card is inserted into the front panel and is recognized.

2.3   First Use Instructions

Use the procedures below when first using the **AE-166/167** to tilt the stand, power up the instrument, set the internal clock, set the wake-up clock, update the firmware and to restore the default settings. Lastly, the Conventions sections will introduce you to the basic operating conventions used throughout the user manual.

2.3.1   Tilting the Stand

► **Description**

The **AE-166/167** has two adjustable rubber feet that can used to position the instrument into two preset orientations.

► **Upright Position**

Tuck the feet under the bottom of the instrument to stand the instrument upright.
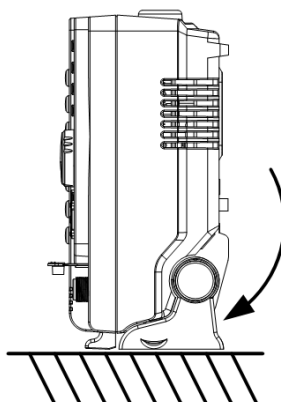
Figure 4.

► **Leaning Position**

Pull the feet back to have the instrument leaning back.
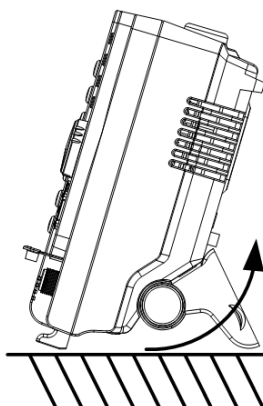
Figure 5.

2.3.2 **Inserting the Battery Pack (optional)**

► **Description**

The **AE-166/167** has an optional battery pack. The battery should be inserted before power is connected to the AC power socket and before the unit is turned on.

► **Steps**

1 Ensure the power is off and the AC power is disconnected.

2 Remove the battery cover.

3 Insert the battery as shown in the diagram below.

4 Replace the battery cover.

► **Display Icon**

The battery icon is displayed when **AE-166/167** is running on battery power.

► **Insertion Diagram**
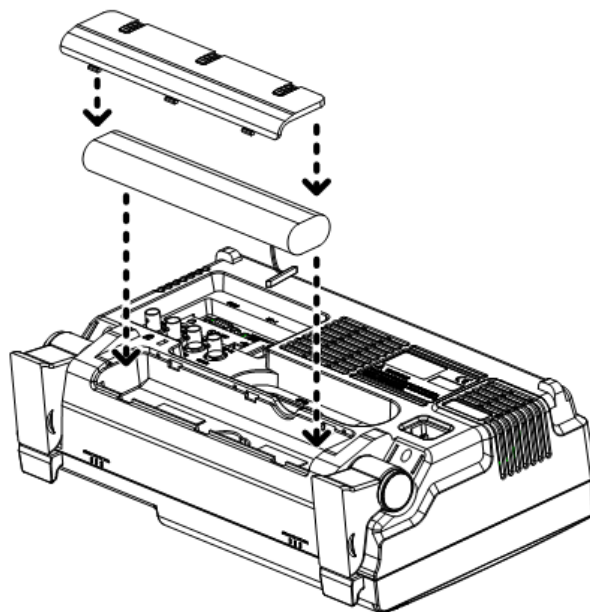
Figure 6.

2.3.3 Power Up

► **Steps**

1 Insert the AC power cord into the power socket.
2 The power button exterior will be lit blue to indicate that the **AE-166/167** is in standby mode.
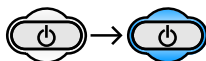
3 Press the power button for a few seconds to turn the **AE-166/167** on.
4 The power button will turn orange and the **AE-166/167** will start to boot up.
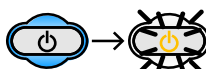
> **NOTE:** It takes a little less than 1 minute for the **AE-166/167** to fully startup.

2.3.4 Power Down

► **Description**

The **AE-166/167** has two methods to power down: Normal and Forced Power Down.

The normal power down method will save the system state and end any running processes. The state is saved for the next time the instrument is turned back on.

The forced power down method only does a minimum state save.

► **Normal Power Down**

Press the power button. The system will automatically handle the power down procedure in the following order:

1 The system state is saved.
2 Outstanding processes are closed in sequence.
3 The LCD backlight is turned off.
4 The system enters standby mode (the power key changes from orange to blue).

> **NOTE:** The process takes ~10 seconds.

► **Forced Power Down**

Press and hold the power button for ~4 seconds until the system turns off and the power button turns blue.

> **NOTE:**
> ⚠️ The forced power down mode might cause the **AE-166/167** to perform a longer system check the next time it is powered up.

2.3.5 | | **Setting the Date, Time and Wake-Up Clock**

► **Description**

The **AE-166/167** can be setup to power-up automatically using the Wakeup Clock function. This feature is useful to wake-up the instrument early and eliminate settling time.

► **System Date**

Example: Set the System Date to July 1, 2016

1 Press (System)> *Date/Time[F4] > Set Date[F1] > Year[F1]*.

2 Press *2016 > Enter[F1]*.

3 Press *Month[F2] > 7 > Enter[F1]*.

4 Press *Day[F3] > 1 > Enter[F1]*.

5 Press *Return[F7]*.

> **NOTE:**
> ⚠️ The System Date will be shown at the top of the display.

► **System Time**

Example: Set the System Time to 9.00 AM

1 Press (System)> *Date/Time[F4] > Set Time[F2] > Hour[F1]*.

2 Press *9 > Enter[F1]*.

3 Press *Minute[F2] > 0 > Enter[F1]*.

4 Press *Second[F3] > 0 > Enter[F1]*.

5 Press *Return[F7]*.

> **NOTE:**
> ⚠️ The System Time will be shown at the top of the display.

► **System Wake-Up Clock**

Example: Set the AE-166/167 to wake up at 9.00 AM

1   Press (System)> *Date/Time[F4] > Wake-Up Clock[F3] > Select Clock[F1]*.

2   Press *Clock 1[F1] ~ Clock 7[F7]* to choose a clock (1 ~ 7).

3   Press *State[F2]* to turn the wake up clock on/off.

4   Press *Hour[F3] > 9 > Enter[F1]*.

5   Press *Minute[F4] > 0 > Enter[F1]*.

6   Press *[F5]* and choose *Rept.* (Repeat) or *Single*.

7   Press *Select Date[F6]* and select a day.

8   Press *Return[F7]* to save the Wake-Up Clock settings.

NOTE: ⚠	The system time is kept with the CR2032 clock battery. If the system time / wake up clock can no longer be set, please replace the clock battery.	

2.3.6   **Firmware Update**

► **Description**

The AE-166/167 allows the firmware to be updated by end-users. Before using the AE-166/167, please check the PROMAX website.

► **System version**

Before updating the firmware, please check the firmware version.

1   Press (System)> *System Information[F1]*.

2   The firmware will be listed on the display.

Figure 7

3   Press any other main/control/file/marker /auxiliary key to exit out of the System Information screen.

4   To upgrade the firmware, insert the new firmware onto a USB flash drive or Micro SD card and put the drive/card into the appropriate front panel port. The firmware files should be located in a local directory.

5   Press > *More 1/2[F7]* > *Upgrade[F2]*.

6   The spectrum analyzer will automatically find the firmware on the USB flash drive and start to update the firmware. When finished, the message "Upgrade is finished" will be shown at the bottom of the screen followed by "Rebooting".
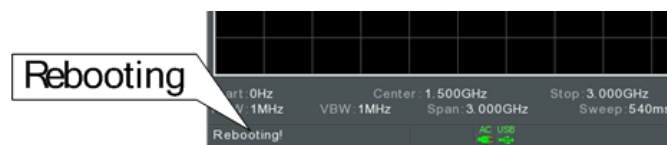
Figure 8

7   The system will automatically restart after the rebooting message.

> **NOTE:**
>
> ⚠️   The upgrade process may take a few minutes.

2.3.7 | Restoring Default Settings

► **Description**

The factory default settings or user presets can be easily restored using the Preset key on the front panel. By default, the factory default settings are restored with the Preset key.

► **Steps**

1   Press (Preset).

2   The spectrum analyser will load the preset settings.

2.3.8 | Conventions

The following conventions are used throughout the user manual. Read the conventions below for a basic grasp of how to operate the **AE-166/167** menu system and front panel keys.

► **Soft Menu keys**

The F1 to F7 function keys on the right side of the display correspond directly to the soft-menu keys on their left.
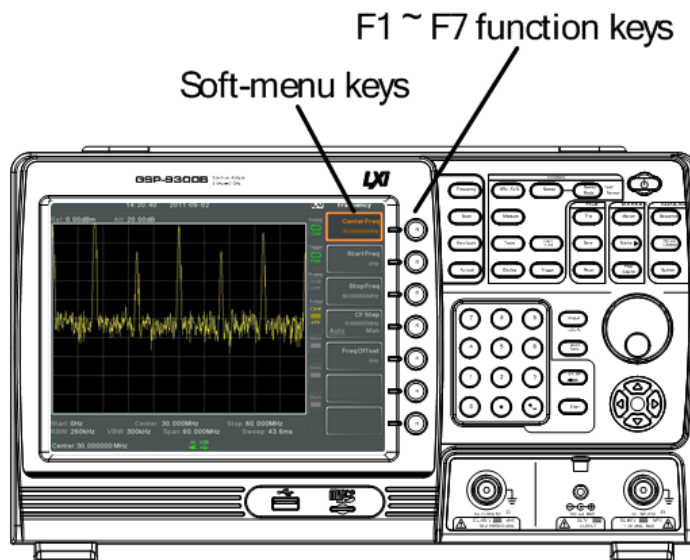
Figure 9.

► **Input Parameter Values**

Selecting this type of menu key will allow you to enter a new value with the numeric keypad or increment / decrement the value using the scroll wheel.
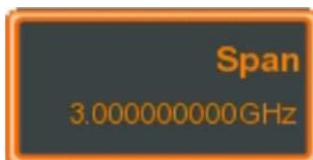
Figure 10.

► **Toggle State**

Pressing this menu key will toggle the state.
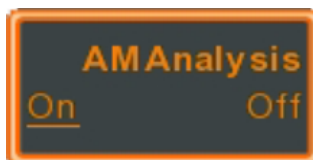
Figure 11.

► **Toggle State & Input Parameter**

Pressing this menu key will allow you to toggle the state of the function between Auto and Man(ual) state. When in the Man state, the parameter value can be manually edited. Use the numeric keypad to enter the new value or use the scroll wheel to increment/decrement the current value.

Figure 12.

► **Sub Menu**

Pressing this menu key will enter a submenu.
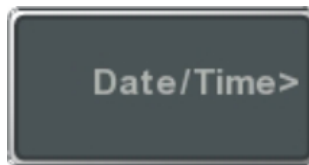
Figure 13.

► **Sub Menu to select parameter**

Pressing this menu key will enter a submenu to select a parameter.

Figure 14.

► **Active Function**

Pressing this type of menu key will activate that function. The menu key will be highlighted to show it is the active function.
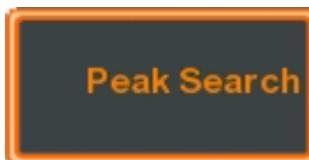
Figure 15.

► **Parameter input**

Parameter values can be entered using the numeric keypad, the scroll wheel and occasionally with the arrow keys.
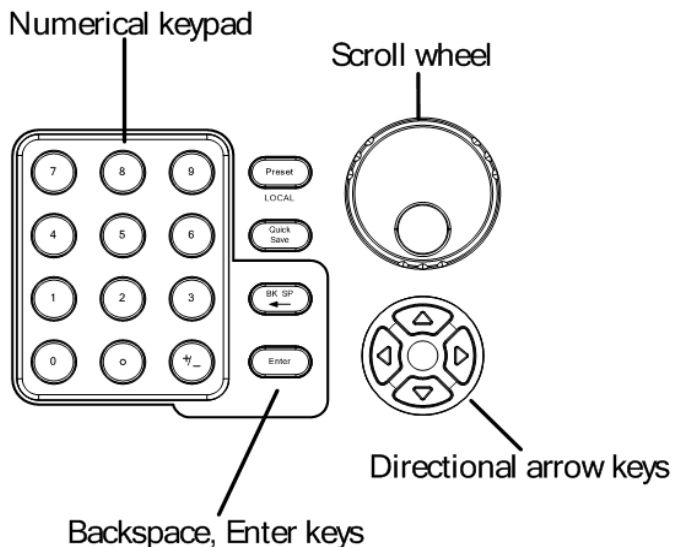
Figure 16.

► **Using the numeric keypad**

When prompted to enter a parameter, use the number keys (0~9), the decimal key (.) and the sign key (+/-) to enter a value. After a value has been entered, the soft-menu keys can be used to select the units.

The value of the parameter is shown at the bottom of the screen as it is edited. Values can include decimal points for non-integer values or for entering dot-decimal notation for IP addresses.
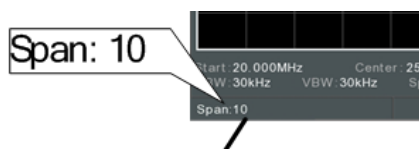
Figure 17.

► **Back Space**

Use the backspace key to delete the last character or number entered.

► **Using the scroll wheel**

Use the scroll wheel to alter the current value. Clockwise increases the value, anti-clockwise decreases the value.

► **Directional arrows**

Use the directional arrows to select discrete parameters or to alter values by a coarser resolution than the scroll wheel. Left decreases the value, right increases the value.

3 BASIC OPERATION

3.1 Frequency Settings

3.1.1 Center Frequency

▶ **Description**

The center frequency function sets the center frequency and centers the display to the center frequency.

▶ **Operation**

Press (Frequency)> *Center[F1]* and enter the frequency and unit.

Range: 0 kHz ~ 3 GHz

Resolution: 1 Hz

Default: 1.5 GHz

▶ **Display**
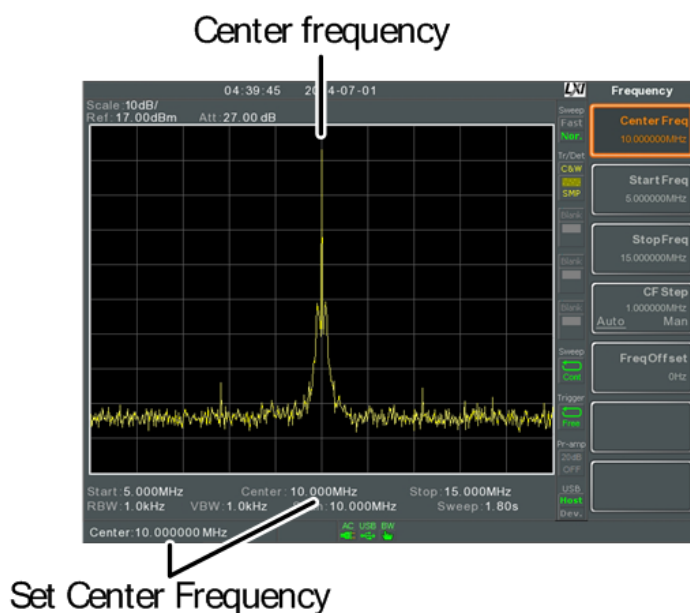
Figure 18.

3.1.2		**Start and Stop Frequency**

► **Description**

The start/stop frequency function will set the start and stop frequency of the span.

► **Operation**

1   To set the start frequency, press ⬭Frequency⬭ > *Start Freq[F2]* and enter the frequency and unit.

2   To set the stop frequency, press ⬭Frequency⬭ > *Stop Freq[F3]* and enter the frequency and unit.

Range: 0 kHz ~ 3 GHz

Resolution: 1 Hz

Default Start frequency: 0 Hz

Default Stop frequency: 3 GHz

► **Display**

Figure 19.

	NOTE:	The start and stop frequency can change when the span settings are used.
⚠		The stop frequency must be set higher than the start frequency (for spans ≠ 0), otherwise the span will be automatically set to 100 Hz.

3.1.3   **Center Frequency Step**

► **Description**

The CF Step function sets the step size of the center frequency when using the arrow keys or scroll wheel.

When the scroll wheel or arrow keys or are used to alter the center frequency, each turn/press will move the center frequency by the step size specified by the CF Step function.

In auto mode, the center frequency step size is equal to 10% (1 division) of the span.

► **Operation**

1   Press (Frequency)> *CF Step[F4]* and set the CF Step to Auto or Man.

2   If Man was selected, set the frequency and unit of the center frequency step size.

Manual Range: 0 Hz ~ 3 GHz

Auto range: 1/10 of span frequency

► **Display**

Figure 20.

3.1.4 Frequency Offset

► **Description**

The Freq Offset function allows you to add an offset to the Center, Start and Stop frequencies as well as the marker frequencies. The offset value does not affect displaying the trace on the display.

► **Operation**

Press (Frequency)> *Freq Offset[F5]* and set the offset value.

The Center, Start, Stop and Marker frequencies are updated accordingly.

Offset Range: 0 Hz ~ 100 GHz

► **Display**
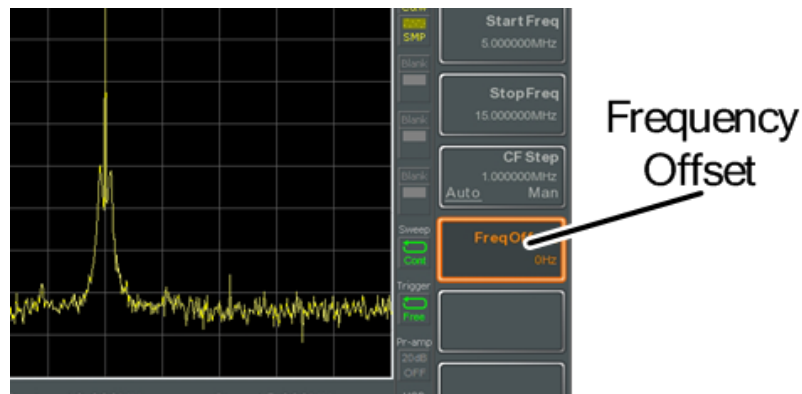
Figure 21.

3.2		Span Settings

3.2.1		Span

► **Description**

The Span function will set the frequency range of the sweep. The sweep will be centered around the center frequency.

Setting the span will alter the start and stop frequencies.

► **Operation**

Press (Span)> *Span[F1]* and enter the span frequency range and unit.

Range: 0 kHz ~ 3 GHz

Resolution: 1 Hz

Default Span: 3 GHz

► **Display**
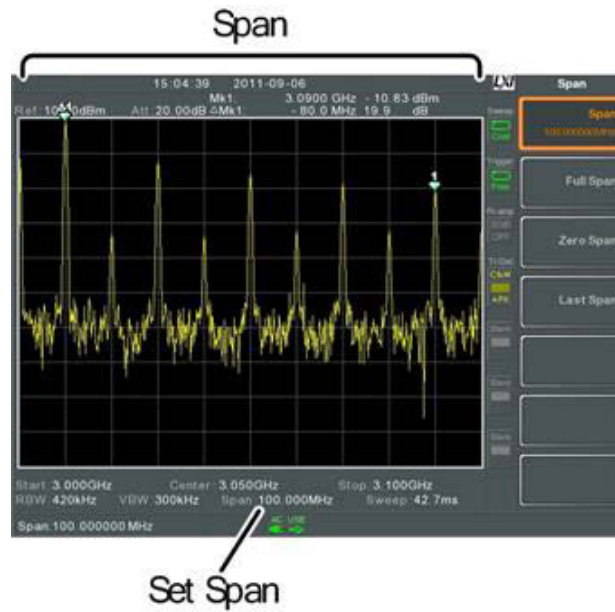
Figure 22.

3.2.2 Full Span

► **Description**

The Full Span function will set the span to the full frequency range.

This function will set the start and stop frequencies to 0 Hz and 3 GHz respectively.

► **Operation**

Press (Span)> *Full Span[F2]*.

3.2.3 Zero Span

► **Description**

The Zero Span function will set the frequency range of the sweep to 0 Hz and fixes the start and stop frequencies to the center frequency. The Zero Span function measures the time domain characteristics of the input signal at the center frequency. The horizontal axis is displayed in the time domain.

► **Operation**

Press (Span)> *Zero Span[F3]*.

The span changes accordingly.

► **Display**
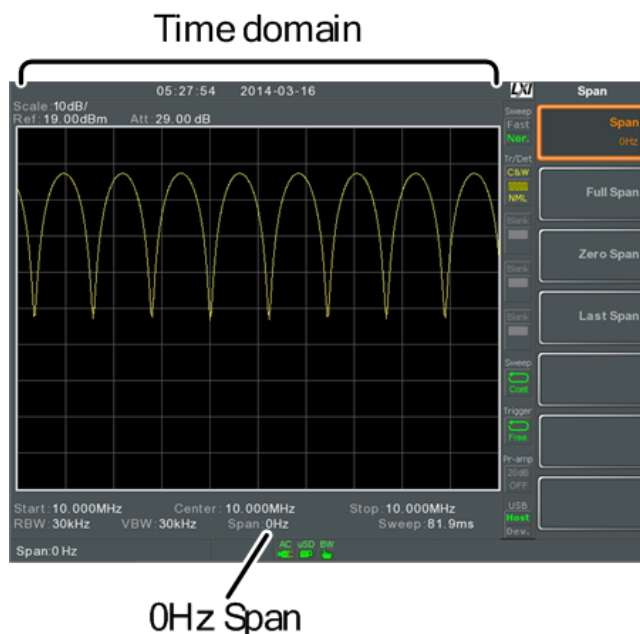
Figure 23. Example: Amplitude modulation

> **NOTE:** The measurement functions such as TOI, SEM, CNR, CTB, CSO, ACPR, OCBW, phase, Jitter, Harmonics, NdB, P1dB and other measurement functions are not available with the zero span setting.

3.2.4 Last Span

► **Description**

The last span function returns the spectrum analyser to the previous span settings.

► **Operation**

Press (Span)> *Last Span[F4]*.

3.3 Amplitude Settings
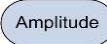
The vertical display scale is defined by the reference level amplitude, attenuation, scale and external gain/loss.

3.3.1 Reference Level

► **Description**

The reference level defines the absolute level of the amplitude on the top graticule in voltage or power.

► **Operation**

Press (Amplitude)> *Ref Level[F1]* and enter the reference level amplitude and unit.

Range: -120 dBm ~ 30 dBm

Units: dBm, -dBm, W, V, dBV

Resolution: 1 dBm

► **Display**
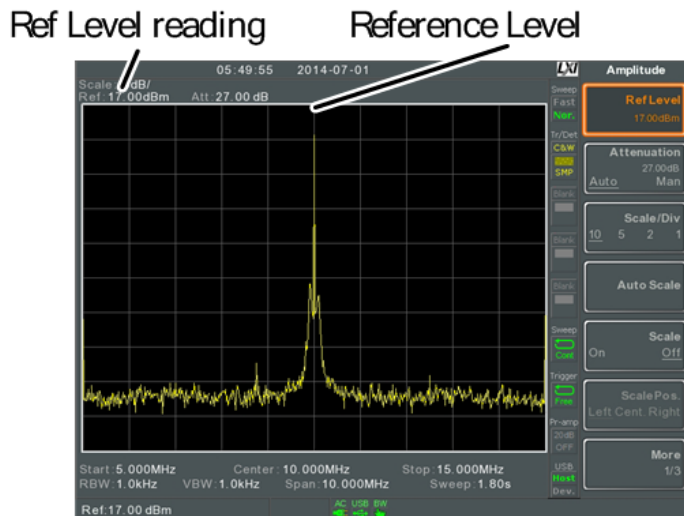
Figure 24.

| 3.3.2 | **Attenuation** |

► **Description**

The attenuation of the input signal level can be set to automatic (Auto) or manual (Man). When the attenuation is set to Man, the input attenuator can be changed manually in 1dB steps.

► **Operation**

1   Press (Amplitude)> *Attenuation[F2]* and select Auto or Man.

2   If Man was selected, enter the attenuation level and unit.

Range: 0 dBm ~ 50 dBm

Units: dBm

Resolution: 1 dB

► **Display**
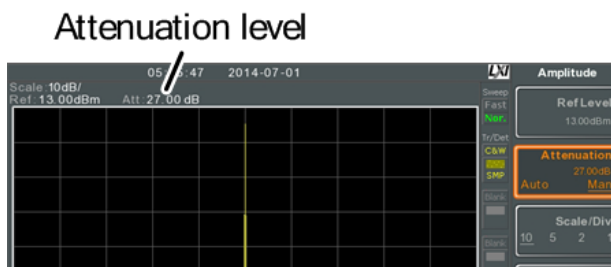
Figure 25.

3.3.3   Scale / Div

► **Description**

Sets the logarithmic units for the vertical divisions when the scale is set to Log.

► **Operation**

Press (Amplitude)> *Scale/Div[F3]* repeatedly to select the vertical division units.

Unit Range: 10, 5, 2, 1

► **Display**

Figure 26.

> **NOTE:** ⚠️   The Scale/Div function is only selectable when the scale is set to Log (logarithmic).

3.3.4   Auto Scale

► **Description**

The Auto Scale function will automatically set the Scale/Div, Reference level and Attenuation (if set to Auto) to best display the spectrum.

► **Operation**

Press (Amplitude)> *Auto Scale[F4]* to turn the Auto Scale function on.

> **NOTE:** ⚠️   This function is applicable to both the linear and logarithmic scales.

3.3.5 | **Scale Type**

► **Description**

Sets the vertical scale in linear or logarithmic units.

By default the linear scale is set to volts and the logarithmic scale is set to dBm.

► **Operation**

Press (Amplitude)> *More[F7] > Scale Type[F2]* and set the vertical scale to Log or Lin.

> **NOTE:** If the unit scale is changed (i.e. dBm → volts), the *displayed* vertical scale type will remain in the set linear or logarithmic setting.

3.3.6 | **View Scale**

► **Description**

The Scale function turns the vertical scale on/off. The value of each graticule division is displayed with the same units that are used for the Ref Level settings.

► **Operation**

1 Press (Amplitude)> *Scale[F5]* to toggle the Scale on or off.

2 Press *Scale Pos.[F6]* to toggle the position of the scale when on.

Scale position: Left, Center, Right

► **Display**
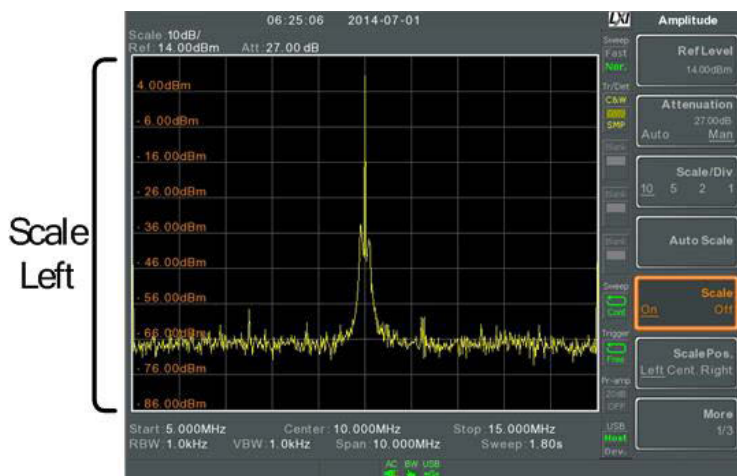
Figure 27. The vertical scale is displayed on the left-hand side by default.

3.3.7 Vertical Scale Units

► **Description**

Change the vertical units for both linear or logarithmic scales.

► **Operation**

1 Press (Amplitude) > *More[F7] > Y Axis[F1]* and then choose the desired units.

2 The units are changed accordingly.

Units: dBm, dBmV, dBuV, Watts, Volts

3.3.8 Reference Level Offset

► **Description**

The Reference Level Offset function sets an offset value to the reference level to compensate for any loss or gain from an external network or device.

The offset value does not affect the input attenuation or the on-screen trace.

This setting will change the reference level readout, the scale readout and the marker readout.

► **Operation**

1 Press (Amplitude) > *More[F7] > RefLvlOffset[F4]* and set the offset level and unit.

2 To remove the offset level, set the reference offset to 0 dB.

Range: 0 dB ~ 50 dB

► **Display Icon**

The AMP icon is displayed at the bottom of the screen.

► **Example**
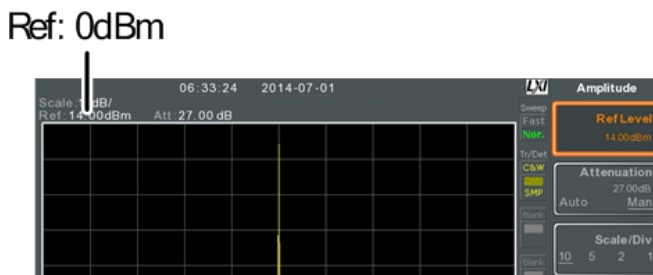
Figure 28. Before reference level offset(offset: 0dB)

Figure 29. After reference level offset (offset: 10dB)

3.3.9 | Amplitude Correction

► **Description**

Amplitude correction adjusts the frequency response of the spectrum analyser by altering the amplitudes at specified frequencies. This allows the spectrum analyser to compensate for loss or gain from an external network or device at certain frequencies.

► **Range**
- ■ **Correction Sets:** 5 sets of 30 points
- ■ **Amplitude:** -40 dB to +40 dB
- ■ **Amplitude Resolution:** 0.1 dB
- ■ **Frequency:** 9 kHz to 3 GHz
- ■ **Frequency Resolution:** 1 Hz

► **Example**
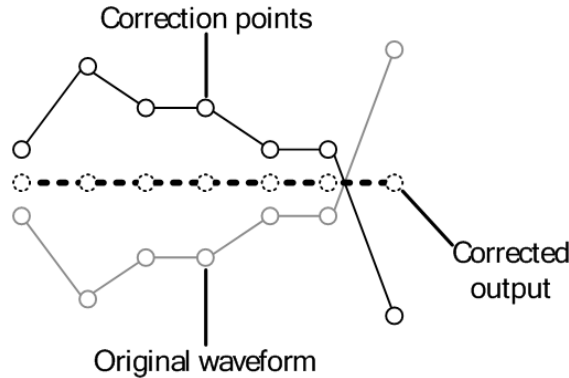
Figure 30. The diagram above shows how amplitude correction is used to compensate for any losses or gains at specific frequencies.

3.3.10		**Create a Correction Set**

► **Description**

The **AE-166/167** can create and edit up to 5 sets of correction points. The correction points and associated values are all tabulated for ease of use.

► **Operation**

1 Press (Amplitude)*> More[F7] > Correction[F3] > Select Correction[F1]* and choose a correction set to edit/create.

Correction set: 1 ~ 5

2 Press *Edit[F3]*.

The **AE-166/167** will split into two screens. The top screen will show the waveform and the bottom screen will provide an overview of the correction points.
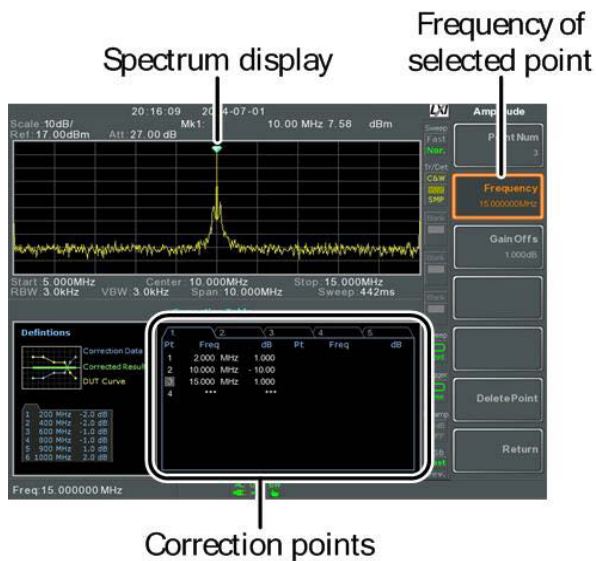
Figure 31.

3 *Press Point Num[F1] and choose a point number to edit. Point numbers can only be created in order. For example Point Num 2 can only be selected after Point Num 1 is created, and point Num 3 can only be selected after Point Num 2 is created and so on.*

Point Num: 1 ~ 20

4 Press *Frequency[F2]* and choose the frequency of the selected point.

5 Press Gain *Offset[F3]* and choose the amplitude of the selected point. The units will be the same as those used for the vertical scale.

The frequency of the point values are displayed in the correction table on the bottom display.
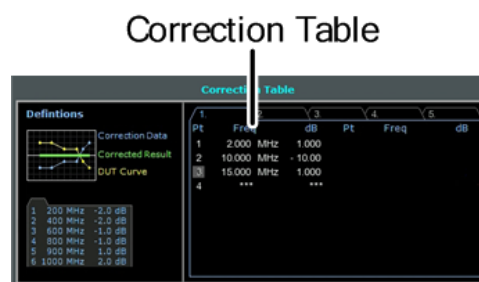
Figure 32.

6 Repeat steps 3 to 5 for any other correction points.

7 To delete the selected point, press *Delete Point[F6]*.

8 Press *Return[F7] > Save Correction[F5]* to save the correction set.

NOTE:	Note that the correction points are automatically sorted by frequency (low → high).
	The correction set must be saved before it can be turned on.
	The frequency values *displayed* in the correction table are rounded down for display purposes only. The actual frequency for each point can be seen in the Frequency soft-key.

3.3.11   Amplitude Correction On/Off

► **Description**

Any one of the 5 correction sets can be turned on.

► **Activate Correction**

1 Press (Amplitude) > *More[F7] > Correction[F3] > Correction Set[F1]* and choose a correction set.

Correction Set: 1 ~ 5

2 Press *Correction[F2]* and toggle correction on.

► **Deactivate Correction**

Press (Amplitude) > *More[F7] > Correction[F3] > Correction[F2]* to turn correction back off.

3.3.12   Delete Correction Set

► **Operation**

1 Press (Amplitude) > *More[F7] > Correction[F3] > Correction Set[F1]* and choose the correction set to delete.

Correction Set: 1 ~ 5

2 Press *Delete Correction[F6]*.

The selected correction set will be deleted.

3.3.13		**Save Correction Set to Memory**

► **Operation**

1 Press > *Save To[F1]* and choose the save location.

Location: Register, Local, USB, SD

2 Press *Type[F2] > Correction[F5]*.

3 Press *Data Source[F3]* and choose a correction.

Correction Set: Correction 1 ~ 5

4 To name the file, press *Name[F5]*. Name the selected file using the F1 ~ F7 keys, as shown below or use the numeric keypad to enter numbers.

Limitations:

∗ *No spaces*

∗ *Only 1 ~ 9, A ~ Z, a ~ z characters allowed*
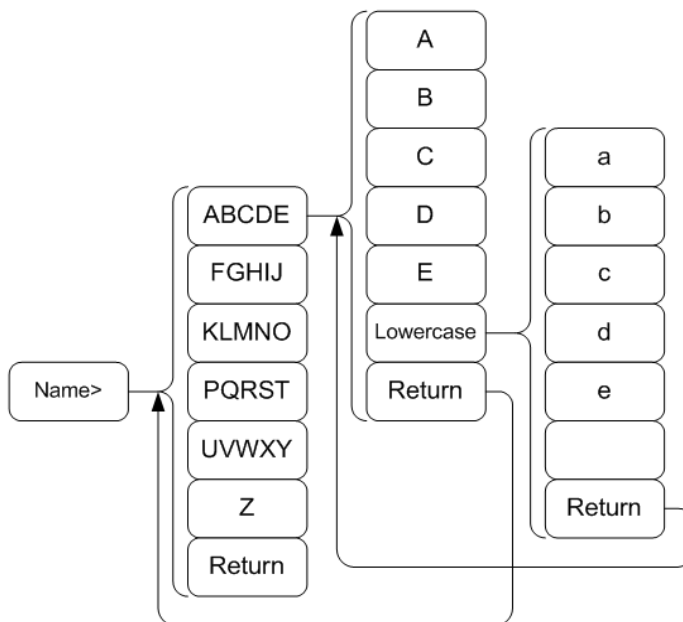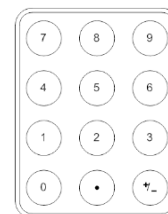
Figure 33.

5 The filename appears on the bottom of the screen as it is created.
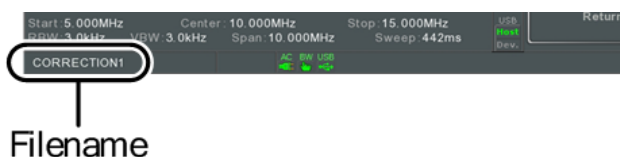
Figure 34.

6   Press (Enter) to confirm the filename.

> **NOTE:**   If the file name is not user-defined, a file name will be automatically created in the following format:
>
> File name: type_data source_file number.file extension:
>
> Example: Correction1_0.cor
>
> The file number parameter is incremented each time the same file type is created.

7   Press *Save Now[F7]*.

8   The correction set will be saved to the selected location.

3.3.14   Recall Correction Set From Memory

▶ **Operation**

1   Press (Recall)> *Recall[F1]* and choose the recall location:

    Location: Register, Local, USB, SD

2   Press *Type[F2] > Correction[F5]*.

3   Use the scroll wheel to select a previously saved correction set from the file directory.

4   Press *Destination[F3]* and choose a correction set.

    Correction Set: Correction 1 ~ 5

5   Press *Recall Now[F4]*.

6   The current correction set will be recalled from the selected location.

3.3.15   Input Impedance

▶ **Description**

Sets the input impedance to 75 Ω or 50 Ω.

▶ **Operation**

Press (Amplitude)> *More[F7] > More[F7] > Input Z[F1]* to toggle the input impedance.

Range: 75 Ω, 50 Ω

3.3.16 | Input Impedance Calibration

► **Description**

When an external impedance converter module is used to convert the impedance of a device from 50 Ω to 75 Ω, some external loss can be induced. The Input Z Cal function can be used to compensate for these losses with an offset value.

> **NOTE:** The Input Z Cal function is only functional when the input impedance is set to 75 Ω.

► **Operation**

Press (Amplitude)> *More[F7] > More[F7] > Input Z Cal[F2]* and set the impedance offset.

Range: 0 dB to +10 dB

Resolution: 1 dB

► **Display Icon**

The AMP icon is displayed at the bottom of the screen when Input Z Cal ≠ 0dB and Input Z is = 75 Ω.

3.3.17 | Using the Built in Pre-Amplifier

► **Description**

The built-in pre-amplifier boosts weak input signals, such as EMI testing signals, to levels that are easy to handle, over the entire frequency range. The built-in pre-amplifier on the **AE-166/167** has a nominal gain of 20 dB.

In the Auto setting, the pre-amplifier will be automatically turned on when the reference level is less than -30 dBm. When the reference level is greater than -30 dBm, the pre-amplifier is turned off. The bypass setting turns the pre-amplifier off.

► **Operation**

Press (Amplitude)> *More[F7] > Preamp[F5] to toggle the Preamp state.*

Range: Auto, Bypass

► **Display Icon**

The Pr-amp icon indicates that the pre amplifier is on.

► **Example**
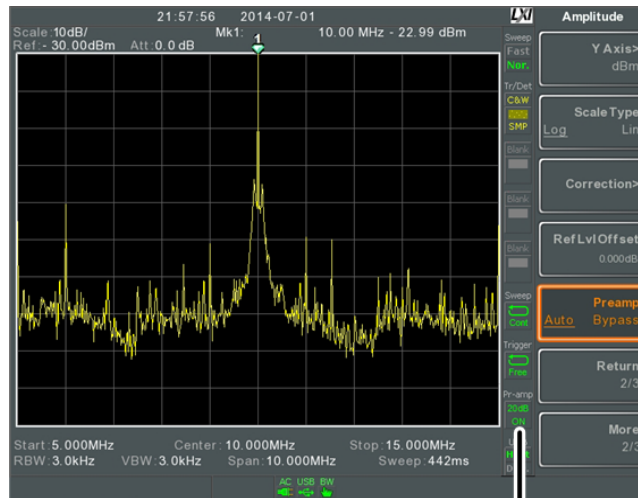
Figure 35.

NOTE: ⚠	When the pre-amplifier is on, the attenuator becomes fixed at 0 dB (i.e. Attenuation = 0 dB).

3.4 Autoset

The Autoset function searches the peak signals in two stages (full span & 0 Hz – 100 MHz limited span), picks the signal peak with the maximum amplitude, and then shows it in the display.

3.4.1 Using Autoset

► **Operation**

Press (Autoset) > *Autoset[F1]*.

► **Autoset Range**

Amplitude: -80 dBm ~ +20 dBm

Span: 0 Hz ~ 3 GHz

► **Example**
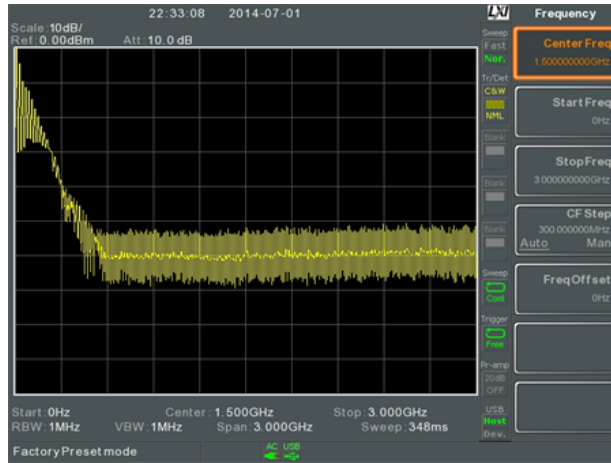
Figure 36. Before Autoset, preset state
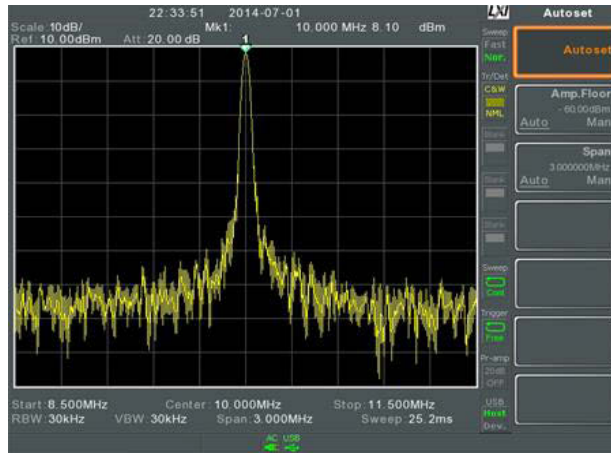
Figure 37. After Autoset

NOTE:	RBW, VBW and sweep settings are reset to Auto when the Autoset function is used.

3.4.2 | **Limiting the Autoset Vertical Search Range**

► **Description**

You can set the amplitude floor so that the signals lower than the setting will be ignored by the Autoset search.

► **Operation**

1 Press (Autoset) > *Amp.Floor[F2]* and switch the range from Auto to Man.

2 Enter the amplitude limit and unit for the Autoset search.

Range: -60 to +20 dBm

3.4.3 | **Limiting the Autoset Horizontal Search Range**

► **Description**

You can change the frequency span limit in the display to get a better view of the Autoset result. By default, the frequency span after Autoset is set at 3 MHz.

► **Operation**

1 Press (Autoset) > *Span[F3]* and switch the range from Auto to Man.

2 Enter the span frequency for the Autoset search.

Manual Range: 100 Hz to 3 GHz

3.5   Bandwidth / Average Settings

BW/AVG key sets the resolution bandwidth (RBW), video bandwidth (VBW) and averaging functions. The resolution, sweep time, and averaging are in a trade-off relationship, so configuration should be done with care.

3.5.1   Resolution Bandwidth Setting (RBW)

► **Description**

RBW (Resolution Bandwidth) defines the width of the IF (intermediate frequency) filter that is used to separate signal peaks from one another. The narrower the RBW, the greater the capability to separate signals at close frequencies. But it also makes the sweep time longer under specific frequency spans (the display is updated less frequently).

► **SPAN-RBW Auto relationship**

When the RBW is set to Auto, the RBW is determined by the frequency span. This is shown in the table below.

► **SPAN-RBW relationship in Auto mode.**

Span (Hz) =	RBW (Hz)	Span (Hz) =	RBW (Hz)
200	1	650 k	3 000
650	3	2 M	10 000
2 k	10	6.5 M	30 000
6.5 k	30	20 M	100 000
20 k	100	65 M	300 000
200 k	1000	200 M	1 000 000

► **Operation**

1. Press (BW/Avg) > *RBW[F1]* and set the RBW to Auto or Man.

2. Set the resolution bandwidth and unit for Man mode.

    Mode: Auto, Man

    Frequency Range (3dB): 1 Hz ~ 1 MHz (1-3-10 step)

    Frequency Range (6dB): 200 Hz, 9 kHz, 120 kHz, 1 MHz

NOTE:	If the setting is in Auto mode, using the scroll wheel or arrow keys will automatically set the RBW to manual mode.

► **Display Icon**

The BW icon is displayed at the bottom of the screen when the RBW is in Man mode.

NOTE:	If the RBW settings have an asterisk (*), it indicates that the -6 dB filters are used.

3.5.2 Video Bandwidth Setting (VBW)

► **Description**

VBW (Video Bandwidth) defines the smoothness of the trace on the display. Combined with RBW, VBW defines the ability to sort out the target signal from surrounding noise or adjacent peaks.

► **Operation**

1. Press (BW/Avg) > *VBW[F2]* and set the VBW to Auto or Man.

2. Set the video bandwidth and unit for Man mode.

   Mode: Auto, Man

   Frequency Range (3 dB): 1 Hz ~ 1 MHz (1-3-10 step)

► **Display Icon**

The BW icon is displayed at the bottom of the screen when the VBW is in Man mode.

3.5.3 VBW / RBW Ratio

► **Description**

The VBW/RBW function is used to view the ratio between the video bandwidth and the resolution bandwidth.

The VBW/RBW ratio is altered by setting the RBW and or VBW settings.

► **View VBW/RBW ratio**

1. Press (BW/Avg).

2. The ratio is displayed on the *VBW/RBW[F3]* soft key.

►**Display**
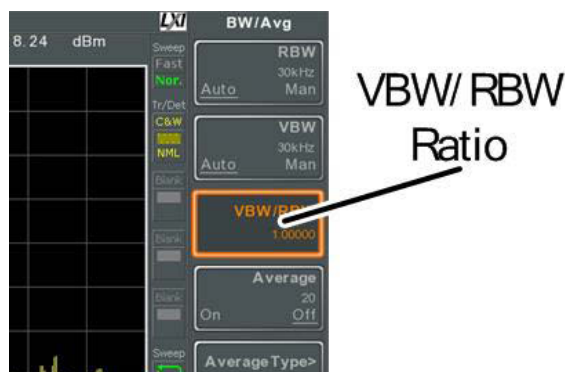
Figure 38.

► **Tip**

Signals that are masked by the noise floor level should have a ratio of less than 1 to smooth the noise out.

Signals with strong frequency components should use a ratio equal to or greater than 1.

3.5.4		**Average Trace**

► **Description**

The Average function averages the trace for a user-defined number of times before it is displayed. This feature smoothes the noise level, but has the drawback of slowing down the display update rate.

► **Operation**

Press (BW/Avg)> *Average[F4]* and toggle Average on or off.

Set the number of averages.

Range: 4 ~ 200

Default: 20

► **Display Icon**

The AVG icon is displayed at the bottom of the screen when the Average function is on.

► **Example**
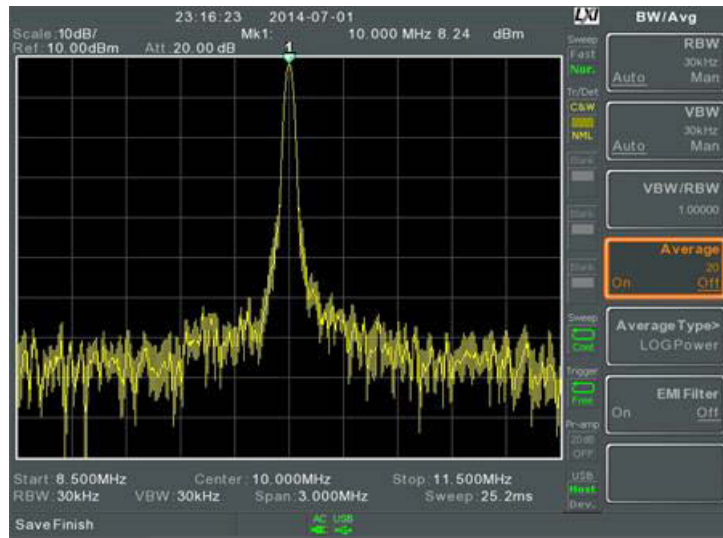
Figure 39. Average:Off
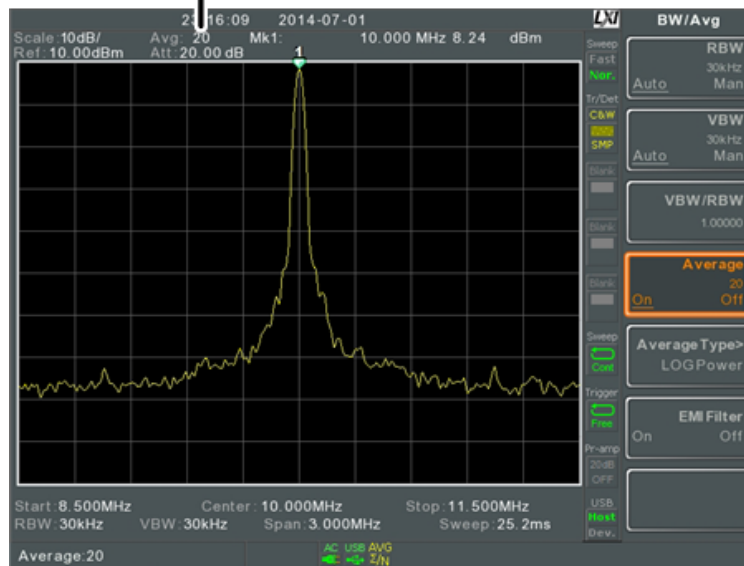
Figure 40. Average: On (20 X)

3.5.5   Average Type

► **Description**

The Average Type function determines how the AE-166/167 determines the average value.

- **LOG Average:** Averages the trace points on a logarithmic scale.
- **Volt Average:** Averages the amplitudes of the trace points on a linear voltage scale.
- **Power Average:** Averages the trace points on a logarithmic scale in watts.

► **Operation**

Press (BW/Avg)> *Average Type[F5]* and choose the average type.

Range: LOG Power, Volt Average, Power Average

Default: LOG Power

3.5.6   EMI Filter

► **Description**

The built-in EMI filter is used for specific measurement situations such as EMI average detection, where a higher level of sensitivity is required compared to the standard configuration. When turned on, the RBW is set to -6 dB, indicated by an asterisk (*).

When any measurement functions are turned on, the EMI filter is automatically disabled. Conversely if the EMI filter is turned on, any measurement functions are turned off.

► **Operation**

Press (BW/Avg)> *EMI Filter[F6]* and toggle EMI filter on or off.

3.6　Sweep

The **AE-166/167** has a number of sweep options including setting the sweep time, the sweep run mode (continuous, single) and sweep mode (fast, slow). The **AE-166/167** also has gated sweep modes.

3.6.1　Sweep Time

► **Description**

Sweep time defines the length of time the system takes to "sweep" the current frequency span. Note, however, that sweep time and RBW/VBW are in a trade-off. Faster sweep times update the display more frequently but make RBW and VBW wider, reducing the capability to separate signals at close frequencies.

► **Operation**

1　Press 〔 Sweep 〕> *Sweep Time[F1]* and toggle the Sweep time to Auto or Man.

2　Set the sweep time for the Man mode.
- **Mode:** Auto, Man
- **Range:** 1.14 ms ~ 1000 s (span = 100 Hz, RBW = 3 kHz)
- **Resolution:** 46.6 us ~ 1000 s (span = 0 Hz, RBW = 1 MHz)

► **Display Icon**

The SWT icon will be displayed at the bottom of the screen when the sweep is in manual mode.

3.6.2 Single Sweep

► **Description**

The single sweep function is used to perform a single sweep. When Sweep Single is pressed the **AE-166/167** will perform a single sweep and then stop.

► **Operation**

1 Press (Sweep)> *Sweep Single[F2]* to put the spectrum analyser into single sweep mode.

2 Press *Sweep Single[F2]* again to perform a single sweep.

When a single sweep has been performed, you can still perform frequency, span, amplitude and other functions on the "frozen" trace.

► **Display Icon**

The Sweep Single icon is displayed on the right-hand side of the screen when the sweep is in single mode.

NOTE:	You must wait for the single sweep to finish before pressing the Single Sweep key again.
⚠	If a setting is changed whilst the spectrum analyser is still sweeping, the single sweep will immediately start over.

3.6.3 Continuous Sweep

► **Description**

The **AE-166/167** has two main sweeping run modes: single and continuous. Use the continuous mode to have the sweep constantly updated.

► **Operation**

Press (Sweep)> *Sweep Cont[F3]* to put the spectrum analyser into continuous sweep mode.

► **Display Icon**

The Sweep Cont icon is displayed on the right-hand side of the screen when the sweep is in continuous mode.

NOTE:	The **AE-166/167** will now continuously sweep unless the mode is changed to single sweep mode or if the system is
⚠	waiting for a trigger condition.

3.6.4		Gated Sweep Overview

► **Description**

The Gated Sweep mode allows a trigger signal to dictate when the spectrum analyser can sweep. This mode is useful for characterizing signals that are pulsed on and off, such as RF burst transmissions or for measuring spurious noise levels between transmission bursts.

► **Overview**

1. The trigger signal must be synchronized to the period of the input signal (shown as RF burst below).

2. The start of the gate time is produced from the positive or negative edge of the trigger signal + the delay time.

3. The end of the gate time is determined by the set gate length.

4. The gated sweep should not be positioned at either end of the transmission.
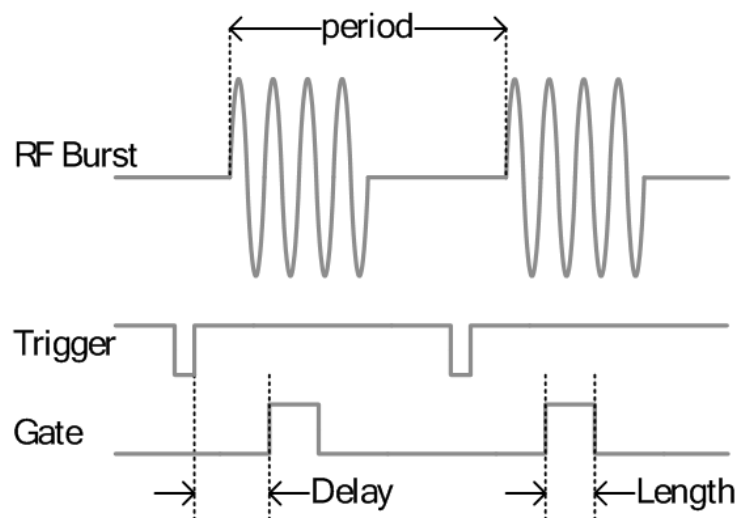
Figure 41. The diagram above demonstrates the relationship between the input trigger, the input signal and the position of the gated sweep relative to the input signal.

NOTE: Please take into consideration RBW settling time. Setting the delay time too short may not leave enough time for the RBW filter to resolve.

3.6.5 | **Using the Gated Sweep Mode**

► **Connection**

Connect a trigger signal (3.3v CMOS) to the GATE IN port on the rear panel.

Figure 42.

NOTE:

⚠️

RBW must be equal to or greater than 10 kHz for the gated sweep mode function to be available.

► **Operation**

1 Press (Sweep)> *GateDelay[F5]* and set the gate delay time.

2 Press (Sweep)> *Gated Length[F6]* and set the gate time length.

3 Press (Sweep)> *Gated Sweep[F4]* and turn the mode on.

Gate Delay: 0 s ~ 1000 s

Gate Length: 58 us ~ 1000 s

► **Display Icon**

The Sweep Gated icon is displayed when Gated Sweep is turned on.

► **Example**

The example below shows the spectrum of an FSK modulated signal when gated sweep mode is off.
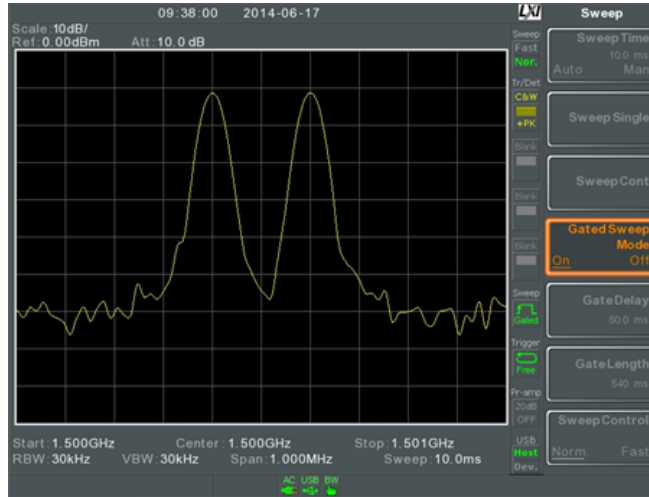
Figure 43.

The example below shows the same signal with the gated sweep timed to sweep when only the desired frequency is output.
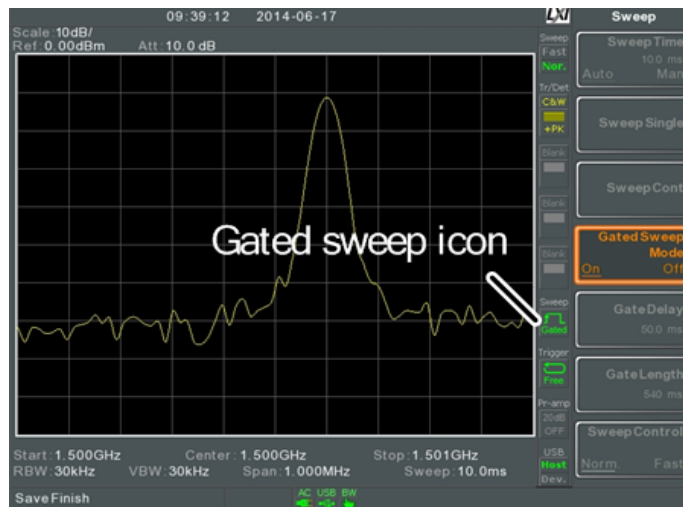
Figure 44.

NOTE: ⚠	Gate Delay and Gate Length must first be set before Gated Sweep is turned on.

3.6.6 | **Sweep Control / Sweep Mode**

► **Description**

The Sweep Control function and the Sweep Mode key (Sweep Mode) toggles the Sweep Mode from Normal to Fast.

The Fast setting speeds up the signal processing and the display update rate to increase the overall sweep time. This mode is especially useful when the span is greater than 1 MHz.

When set to *Normal*, signal processing and update rate is set to normal levels.

► **Operation**

Press (Sweep)> *Sweep Control [F7]* to toggle the Sweep Mode between *Norm.* and *Fast*.

OR

Press (Sweep Mode) and toggle the Sweep Mode between *Norm.* and *Fast*.

► **Display Icon**

The Sweep icon is displayed on the right-hand side of the screen when the sweep is in either Fast or Normal mode.

► **Sweep Times**

Center Frequency = 1.5 GHz		Sweep Mode	
Span (Hz)	RBW (Hz) AUTO	Norm.	Fast.
3 G	1 M	169 ms	84.8 ms
2 G	1 M	104 ms	52.2 ms
1 G	1 M	52 ms	31.1 ms
500 M	1 M	31 ms	16.8 ms
200 M	1 M	13.4 ms	6.72 ms
100 M	1 M	6.7 ms	3.36 ms
50 M	300 k	10.7 ms	716 us
20 M	100 k	23.4 ms	573 us
10 M	100 k	11.7 ms	286 us
5 M	30 k	28.9 ms	655 us
2 M	10 k	101 ms	1.96 ms
1 M	10 k	50.9 ms	1.31 ms
500 k	3 k	6.88 ms	6.88 ms
200 k	1 k	22.9 ms	22.9 ms
100 k	1 k	9.83 ms	9.83 ms
50 k	300	76.4 ms	76.4 ms
20 k	100	219 ms	219 ms
10 k	100	109 ms	109 ms
5 k	30	710 ms	710 ms
2 k	10	1.98 s	1.98 s
1 k	10	994 ms	994 ms
500	3	2.65 s	2.65 s
200	1	2.65 s	2.65 s
100	1	2.65 s	2.65 s

3.7 | Trace

The **AE-166/167** is able to set the parameters of up to 4 different traces on the display at once. Each trace is represented by a different color and is updated with each sweep.

3.7.1 | Selecting a Trace

▶ **Description**

Each trace (1, 2, 3, 4) is represented by a different color. When activated, an icon for each trace color and function is shown to the left of the display. When a trace is selected, parameters can be set / edited from the trace menu.

Trace Color: 1: Yellow

2: Pink

3: Blue

4: Orange

▶ **Trace Type**

The type of trace used determines how the trace data is stored or manipulated before being displayed. The analyser updates each trace according to the type of trace used.

■ **Clear and Write:** The **AE-166/167** continuously updates the display with each sweep.

■ **Hold Max / Hold Min:** The maximum or minimum points are maintained for the selected trace. The trace points are updated each sweep if new maximum or minimum points are found. The Hold Max setting also has a threshold setting. This setting will ensure only those values above the threshold are kept.

■ **View:** View will hold the selected trace and stop updating the trace data for the selected trace. Pressing *View[F5]* will display the trace data that was cleared using the *Blank[F6]* key.

■ **Blank:** Clears the selected trace from the display and stores trace data. The trace can be restored by pressing *View[F5]*.

► **Display Icon Example**
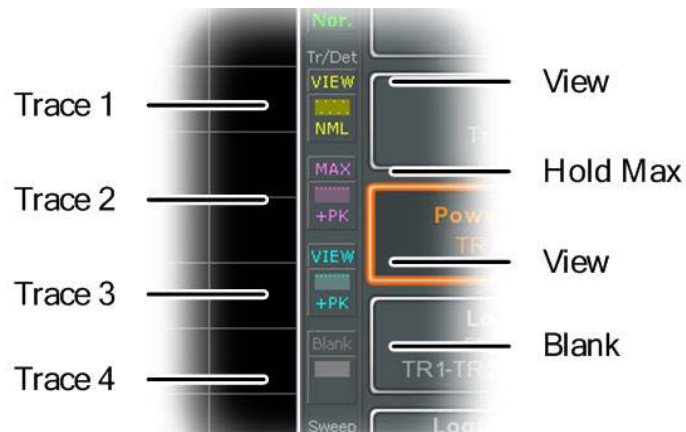
Figure 45.

► **Operation**

1 Press (Trace) > *Trace[F1]* and choose the trace number.

   Trace: 1, 2, 3, 4

2 Select the trace type:
   - Clear & Write[F2]
   - Max Hold[F3]
   - Min Hold[F4]
   - View[F5]
   - Blank[F6]

3 If *Max Hold[F3]* was selected, set the threshold level.

> **NOTE:**
> ⚠️   Traces, 2, 3 and 4 are set to *Blank* by default.

3.7.2		**Trace Math**
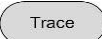
▶ **Description**
Performs trace math from two traces (TR1, TR2) and stores the result in the currently selected trace. It also performs trace shift.

▶ **Math functions**
- **Power Diff:** Subtracts the TR1 amplitude data from the TR2 amplitude data. The TR1 data TR2 data are converted to watts. The result is converted back to dBm.
- **Log Diff:** Subtracts the TR1 amplitude data from the TR2 amplitude data and then adds a logarithmic reference. Both the TR1 and TR2 data is in dBm. The resultant trace of the subtraction is in dB. When the result is added to a logarithmic reference the resulting data is in dBm.
- **LOG Offset:** Adds a reference to the TR1 trace.

▶ **Operation**

1   Press (Trace)> *More[F1] > Trace Math[F1]*.

2   Press *TR1[F1]* and select the first trace source:

TR1:   Trace 1, 2, 3, 4*

3   Press *TR2[F2]* and select the second trace source:

TR2:   Trace 1, 2, 3, 4*

NOTE: ⚠	*You cannot select the current trace as the TR1 or TR2 trace sources. The current trace is designated by pressing (Trace)> Select Trace > [F1].*

4   Select the trace math function:

PowerDiff[F3]

LogDiff[F4]

LogOffset[F5]

5   If LogDiff was selected, set the reference level and unit.

LogDiff ref range: -120 dBm ~ 30 dBm

LogDiff ref units: dBm, W

6   If LogOffset was selected, set the offset level and unit.

LogOffset range: -50 dB ~ +50 dB

7   To turn trace math off, press the *OFF[F6]*.

► **Display Icon**

The Math icon is displayed when trace math is turned on.

3.7.3		**Trace Detection Mode**

► **Description**

Each time the spectrum analyser samples data for each point on the trace, a number of samples are usually taken for each point, known as a sample bucket. The actual value of each point is determined by the detector from the samples in each bucket.

Each selected trace, (1, 2, 3, 4), can use a different detection mode.

► **Detection modes**

- ▪ **Auto:** Automatically chooses an appropriate mode based on the values of all the samples.
- ▪ **Normal:** While the signal level is constantly increasing or decreasing, the positive peaks are detected. Otherwise, the detection mode switches between positive peak and negative peaks. Useful for picking up burst phenomenon while avoiding excessive noise.
- ▪ **Peak+:** Detects positive peak signals by selecting the maximum peak value for each point from each bucket. This mode is useful for sinusoidal signals.
- ▪ **Peak-:** Detects negative peak signals by selecting the lowest peak value for each point from each bucket. This mode is not recommended for amplitude measurement.
- ▪ **Sample:** Randomly selects a value from the bucket sample. Useful for noise signals.
- ▪ **RMS Average:** Calculates the RMS average power of all the samples in the sample bucket.

► **Auto Detector Selection Method**

Below is a flow chart diagram showing the Detector selection for the Auto mode.
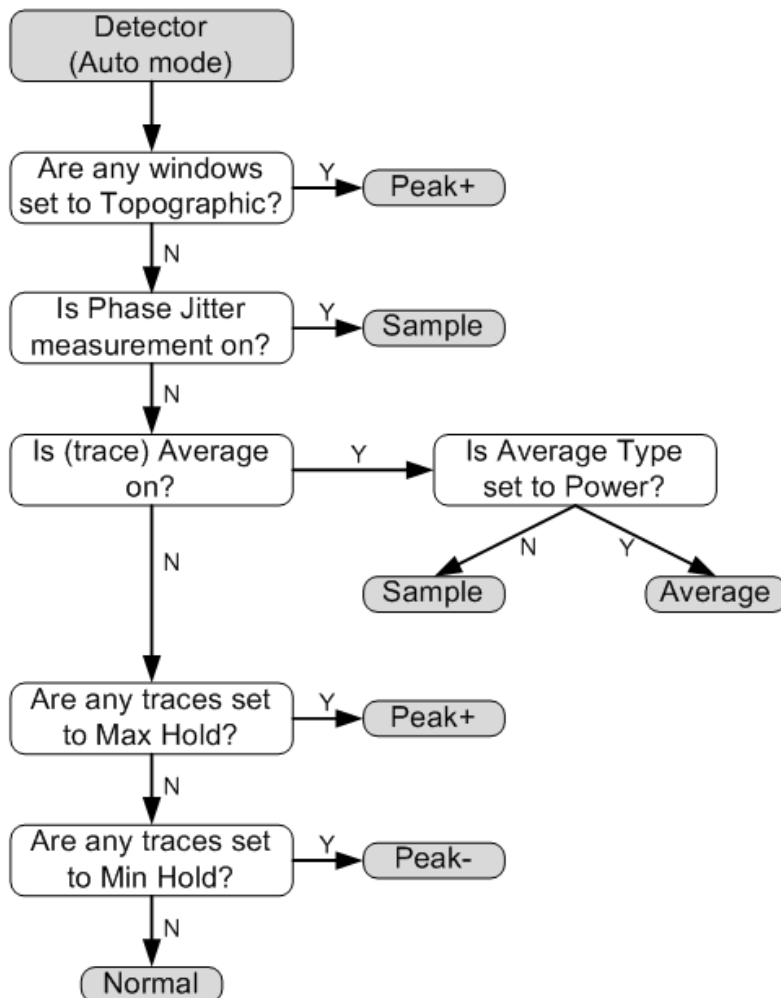
Figure 46.

► **Operation**

1 Press > *More[F7] > Detection[F2]*.

2 Select the trace detection mode for the selected trace:
- Auto[F1]
- Normal[F2]
- Peak+[F3]
- Peak-[F4]
- Sample[F5]
- RMS Average[F6]

3 The display will return to the Trace menu.

▶ **Display Icon**
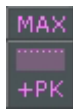
	Normal		Peak+ icon

	Peak- icon		Sample icon

	RMS Average icon

3.8   Trigger

The Trigger function sets the signal conditions upon which the spectrum analyser triggers captured waveforms, including frequency, amplitude, and delay. An external trigger signal, instead of the default internal signal, may be used as required for special conditions.

The sections below can be used to skip to the relevant section:
- Free Run Mode
- Activate Video Trigger
- Activate External Trigger
- Selecting Trigger Mode
- Set the Trigger Delay Time

3.8.1   Free Run Mode

► **Description**

In free run mode all signals are captured and the trigger conditions are not used.

► **Free Run Mode**

Press ⬭ Trigger ⬭ > *Free Run[F1]* to run in free mode.

3.8.2   Activate Video Trigger

► **Description**

Sets the video trigger level for video signals. When the video signal voltage level exceeds* the video trigger level, a trigger signal will be generated.

► **Parameters**
- **Video Edge:** Determines the polarity of the video trigger.
  Positive: The signal voltage exceeds the video level at the trigger frequency.

  Negative: The signal voltage is lower than the video level at the trigger frequency.

- **Video Level:** The trigger voltage level.
- **Trigger Frequency:** Sets the frequency to start triggering.

---

*for positive video edge

► **Operation**

1. Press (Trigger)> *Trigger Condition[F2] > Video[F1]*

2. Press *Video Edge[F1]* and choose the edge.

   Range: Positive, Negative

3. Press *Video Level[F2]* and set the video voltage trigger level.

   Trigger level: (-120 dBm to +30 dBm) +Ref Level Offset

4. Press *Trigger Freq[F3]* and choose the frequency at which the spectrum analyser will check the triggering conditions.

   Frequency: 0 ~ 3 GHz + frequency offset

► **Display Icon**

The Video Level trigger icon is displayed when the Video trigger is activated.

NOTE:	Set the trigger back to Free Run to disable the video trigger.

3.8.3 Activate External Trigger

► **Description**

The external trigger is used when an external trigger signal is input into the rear panel TRIG IN port. The external trigger signal can be configured as positive or negative edge.

Trigger: 3.3 V, CMOS

► **Operation**

1. Press (Trigger)> *Trigger Condition[F2] > Ext.Edge[F2]* and select the trigger edge:

   Pos: Positive edge

   Neg: Negative edge

2. Connect the external trigger signal to the rear panel TRIG IN port.

Figure 47.

3 Press *Action Now[F5]* to activate the external trigger.

4 The system will now wait for the trigger conditions to be matched before starting a sweep.

► **Display Icon**

The EXT Trigger icon is displayed when the external trigger is activated.

NOTE: ⚠	The trigger will revert back to the Free Run mode if any parameter settings are changed, such as the span or amplitude settings.

3.8.4   Selecting the Trigger Mode

► **Description**

In free run mode all signals are captured and the trigger conditions are not used.

► **Modes**
- **Normal:** The spectrum analyser captures every signal that meets the trigger conditions.
- **Single:** The spectrum analyser captures the first signal that meets the trigger conditions.
- **Continuous:** The spectrum analyser captures the first signal that meets the trigger conditions then switches to free run mode thereafter.

► **Operation**

1 Press (Trigger)> *Trigger Mode[F3]* to toggle the trigger mode:
- **Nor.:** Normal
- **Sgl.:** Single
- **Cont.:** Continuous

2 Press *Action Now[F5]* to manually start triggering.

► **Display Icons**
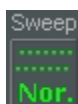
Normal:	**Single:**	**Continuous:**

3.8.5 | **Set the Trigger Delay Time**

► **Description**

Sets the delay time between when the analyser triggers and when the analyser begins to capture the signal.

Delay time range: 1ns to 1ks

► **Operation**

Press (Trigger)> *Trigger Delay[F4]* and set the trigger delay time.

Delay range: 0 ~ 1000 s

3.9   Marker

A Marker shows the frequency and amplitude of a waveform point. The **AE-166/167** can activate up to 6 markers or marker pairs simultaneously as well as up to 10 peak markers in the marker table.

The marker table helps editing and viewing multiple markers in a single display.

A delta marker shows the frequency and amplitude difference from a reference marker.

The **AE-166/167** can automatically move a marker to various locations including the peak signal, center frequency, and start/stop frequency. Other marker operations regarding signal peaks are available in the Peak Search function.

- Activating a Marker
- Move Marker Manually
- Move Marker to Preset Locations
- Activate Delta Marker
- Move Delta Marker(s)Manually
- Marker Functions
- Move Marker to Trace
- Show Markers in Table
- Peak Search
- Peak Configuration
- Peak Table

Activating a Marker

There are two basic marker types, normal markers and delta markers. Normal markers are used to measure the frequency/time or amplitude of a point on the trace. Delta markers are used to measure the difference between a reference point and a selected point on the trace.

3.9.1 | **Activate a Normal Marker**

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

Marker: 1 ~ 6

2 Press *[F2]* to turn the selected marker on.

3 Press *Normal[F3]* to set the selected marker to the Normal type.

4 The display will show the marker on the trace (centered by default) with the marker measurement at the top of the display.
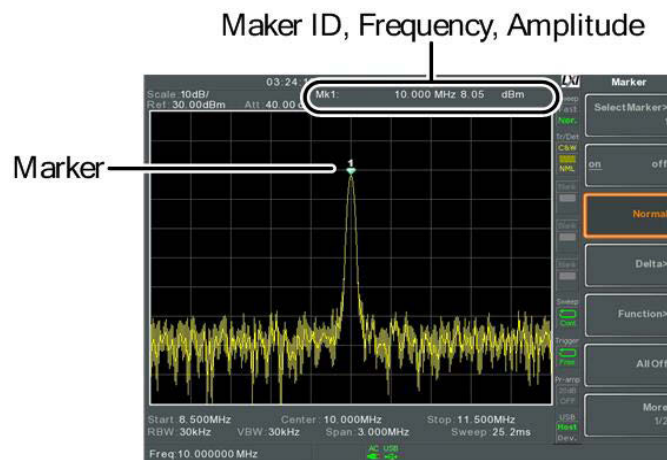
Figure 48.

3.9.2 | **Move Marker Manually**

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Use the left/right arrow keys to move the marker one grid division.

3 Use the scroll wheel to move the marker in fine increments.

4 Alternatively, the numeric keypad in combination with the F1 ~ F7 keys can be used to directly enter the frequency of the marker position
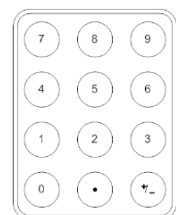
3.9.3   Move Marker to Preset Locations

► **Description**

The (Marker ▶) key is used to move the selected marker to a number of preset positions.

► **Functions**
- ▪ **Mkr>Center:** Move to center frequency.
- ▪ **Mkr>Start:** Move to start frequency.
- ▪ **Mkr>Stop:** Move to stop frequency.
- ▪ **Mkr>CF Step:** Move to step frequency.
- ▪ **Mkr>Ref Lvl:** Move to reference level amplitude.

> **NOTE:** When the (Marker ▶) key is used, the span and other settings may be automatically changed.

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Press (Marker ▶) and select a marker position:
- ▪ Mkr>Center[F1]
- ▪ Mkr>Start [F2]
- ▪ Mkr>Stop[F3]
- ▪ Mkr>CF Step[F4]
- ▪ Mkr>Ref Lvl[F5]

3.9.4   Activate Delta Marker

► **Description**

Delta markers are marker pairs that measure the difference in frequency/time and amplitude between a reference marker and a delta marker.

When delta markers are activated, the reference and delta marker appear at the position of the selected marker, or in the center of the display if the selected marker has not yet be activated.

The marker measurement is located at the top of the display, under the "normal marker" measurement.

► **Delta Markers**

Ref: Reference marker, designated as $\overset{1}{\diamond}$.

Delta: Delta marker, designated as $\overset{\Delta 1}{\diamond}$.

► **Operation**

1   Press (Marker)> *Select Marker[F1]* and select a marker number.

2   Press *[F2]* to turn the selected marker on.

3   Press *Delta[F4] > Delta[F1]* to set the selected marker to the Delta type.

3.9.5		**Move Delta Marker(s) Manually**

► **Move Delta or Reference Marker**

1   Press (Marker)> *Delta[F4] > MoveRef[F2]* to move the reference marker.

2   Press (Marker)> *Delta[F4] > MoveDelta[F3]* to move the Delta marker.

3   Move the selected marker in the same fashion as a normal marker.

► **Move Both reference and delta marker**

1   Press either *Move Pair Span[F4]* or *Move Pair Center[F5]* to move both markers at the same time.

    ■ **Move Pair Span:** Sets the frequency span between both markers. The span can be positive or negative:

       $\overset{1}{\diamond}$←+span→$\overset{\Delta 1}{\diamond}$

       $\overset{\Delta 1}{\diamond}$←-span→$\overset{1}{\diamond}$

    ■ **Move Pair Center:** Moves both markers at the same time, keeping the span between both markers even throughout.

2   Move both markers in the same fashion as a normal marker.

3.9.6		Marker Noise

► **Description**

The noise marker function calculates the average noise level over a bandwidth of 1 Hz, referenced from the marker position.

► **Operation**

1. Press (Marker)> *Select Marker[F1]* and select a marker number.

2. Press *[F2]* to turn the selected marker on.

3. Press *Normal[F3]* and then position the marker to the desired location.

4. Press *Function[F5] > Marker Noise* and turn Marker Noise on.

5. The display will show the noise level measurement at the top of the screen in dBm/Hz.
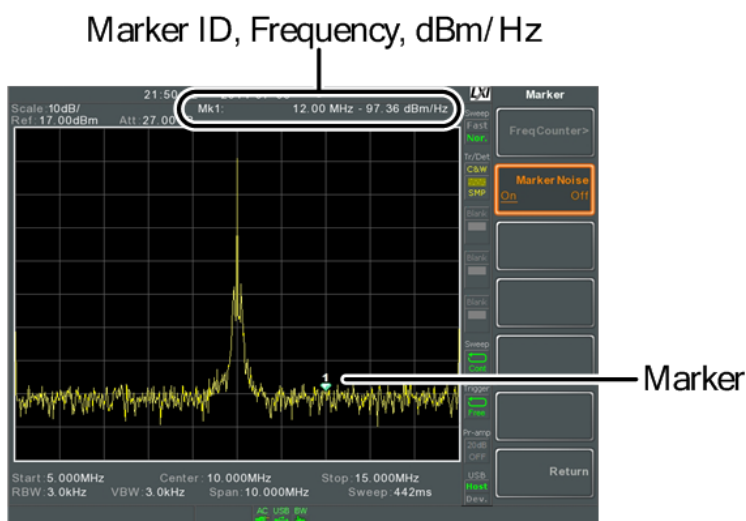
Figure 49.

| 3.9.7 | | Frequency Counter |

▶ **Description**

The frequency counter function is used to make accurate frequency measurements.

▶ **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Press *[F2]* to turn the selected marker on.

3 Press *Normal[F3]* and then position the marker to the desired location.

4 Press *Function[F5] > Frequency Counter[F1]* and turn the counter function on.

5 Press *Resolution[F2]* and set the resolution:
   ■ **Auto:** Automatically chooses the best resolution.
   ■ **Man:** Allows the resolution to be manually set.
   ■ **Man Range:** 1 Hz, 10 Hz, 100 Hz, 1 kHz

6 The display will show the frequency measurement at the top of the screen at the selected resolution.
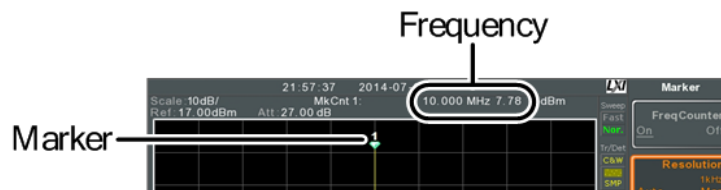
Figure 50.

3.9.8		VSWR

► **Description**

The Voltage Standing Wave Ratio is the voltage ratio between transmitted and reflected waves, usually measured in RF electrical transmission systems. The VSWR function will use the Tracking Generator of the **AE-166/167** as reference signal.

► **Operation**

1   Before starting a VSWR measurement, the tracking generator must be turned on and normalized. If the TG has not been turned on and normalized, the VSWR function will not be available.

2   Connect the TG output directly to the RF input.

3   Press ⬭Option Control⬭ > *Tracking Generator[F1] > TG[F1]* to toggle the tracking generator to on.

4   Press *Normalize[F6] > Exe. Norm[F1]* to perform a normalization.

5   Using a Return Loss Bridge, connect the DUT to the TG output and the RF input of the **AE-166/167** as shown in the below diagram.
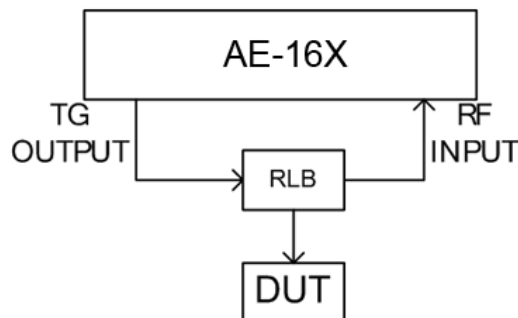
Figure 51.

6   Press ⬭Marker⬭ > *Select Marker[F1]* and select a marker number.

7   Press *[F2]* to turn the selected marker on.

8   Press *Function[F5] > VSWR[F3]* to turn the VSWR measurement on.

9   The display will show the VSWR measurement at the top of the screen.

Marker ID, Frequency, VSWR measurement
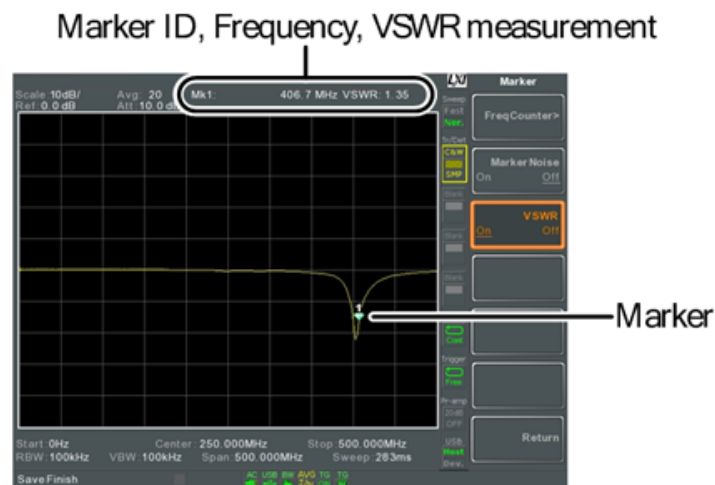
Figure 52.

| 3.9.9 | **Move Marker to Trace** |

► **Description**

The Marker Trace function moves the selected marker to any of the currently active traces.

► **Operation**

1   Press (Marker)> *Select Marker[F1]* and select a marker number.

2   Press *[F2]* to turn the selected marker on.

3   Press *More[F7] > Marker Trace[F1]* and choose a trace to move the current marker to. Only active traces can be selected.

Auto[F1]

Trace1[F2]

Trace2[F3]

Trace3[F4]

Trace4[F5]

4 In the example below, marker 1 is set to Trace1 and marker 2 is set to Trace2.
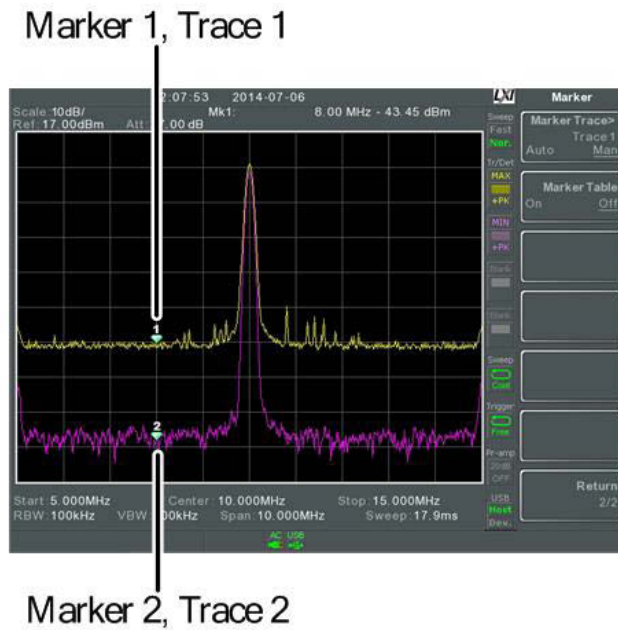
Figure 53.

3.9.10 Show Markers in Table

► **Description**

The AE-166/167 has a Marker Table function to show all the active markers and measurements at once.

► **Operation**

1 Press (Marker)> *More[F7] > Marker Table[F2]* and turn the marker table on.

2 The display will split into two screens. The bottom half will show the Marker Table with the marker ID (normal, reference or delta), trace, x-axis position (frequency/time) and the amplitude of the marker.

Marker Table

Figure 54.

| 3.9.11 | | **Move Marker to Peak** |

► **Description**

The (Peak Search) key is used to find trace peaks.

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Press (Peak Search)> *Peak Search[F1]*. The marker will move to the highest signal peak.

3 To continually search for the peak on each sweep, press, (Peak Search)> *More [F7] > Peak Track[F1]* and set *Peak Track* to on.

3.9.12		Move Marker to Peak to Center

► **Description**

The Center function moves the marker to the highest signal peak and moves the center frequency to that peak. This function can be used with the *Next Peak*, *Next Peak Right*, *Next Peak Left* and *Min Search* peak functions.

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Press (Peak Search)> *Mkr > Center[F2]*.

NOTE:

⚠️ The span will not be changed.

3.9.13		Search for Peaks

► **Description**

The (Peak Search) key can be used to search for a number of different peaks.

► **Peak Search**
- **Next Peak:** Searches for next highest peak visible on the display.
- **Next Peak Right:** Searches for the next peak to the right of the marker.
- **Next Peak Left:** Searches for the next peak to the left of the marker.
- **Min Search:** Searches for the lowest peak.

► **Operation**

1 Press (Marker)> *Select Marker[F1]* and select a marker number.

2 Press (Peak Search) and select the type of peak you wish to find.

► **Example**
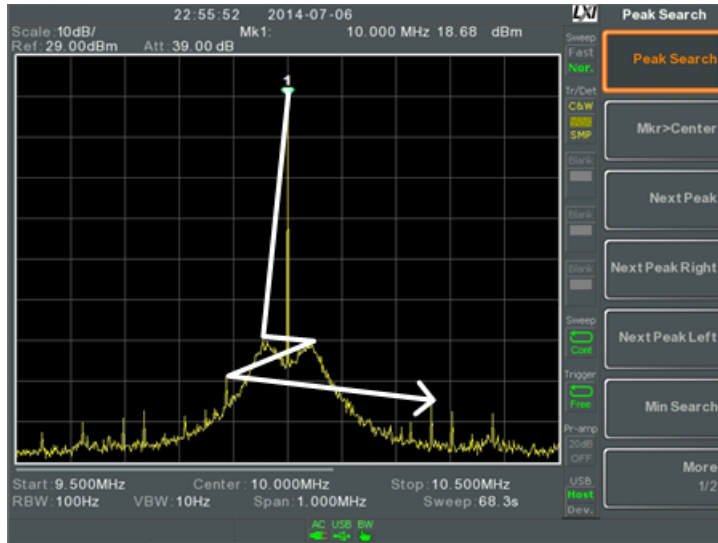
Figure 55. Next Peak
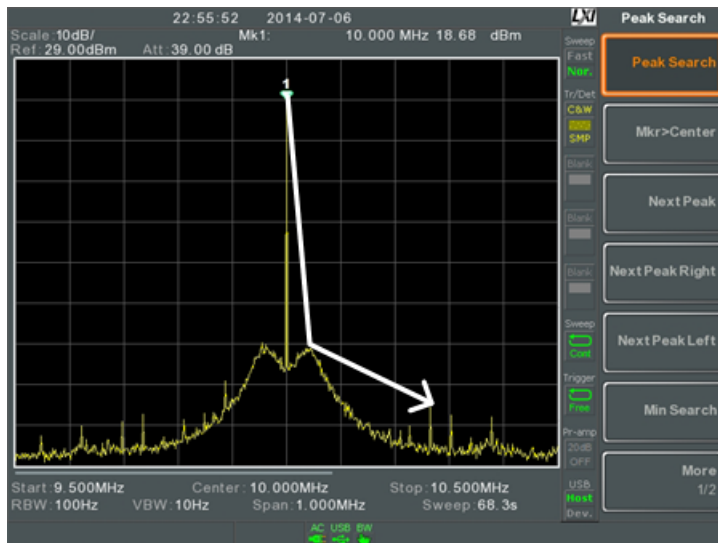
Figure 56. Next Peak Right
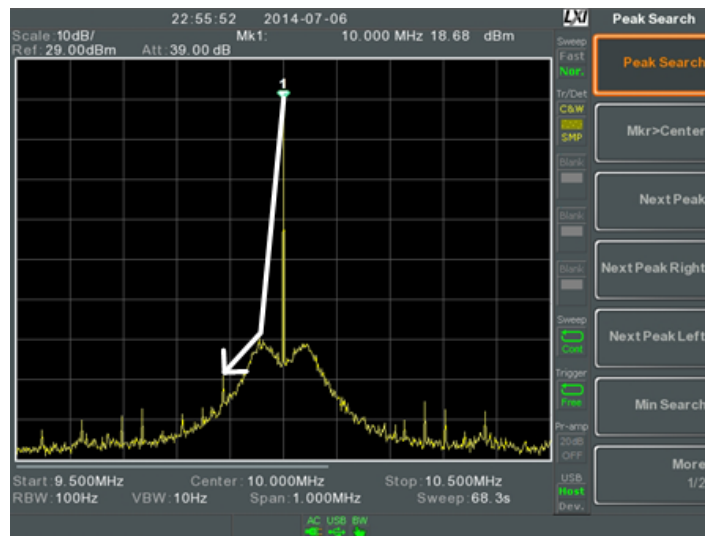
Figure 57. Next Peak Left

3.9.14		**Peak Configuration**

► **Description**

There are two peak search configuration options: Peak Excursion and Peak Threshold.

Peak Excursion: Peak Excursion sets the minimum value above the peak threshold for which peaks will be detected.

Peak Threshold: Peak threshold sets the minimum threshold level for the analyser to detect peaks. Any value above the Peak Threshold + Peak Excursion will be detected as a peak.
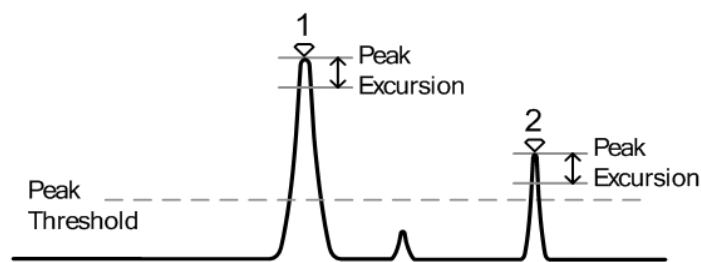
Figure 58.

► **Operation**

1. Press (Peak Search) > *More [F7]*.

2. Press *Peak Excursion[F2]* to set the excursion level.

3. Press *Peak Threshold[F3]* to set the peak threshold.

Peak Excursion: 0 ~ 100 dB

Peak Threshold: -120 dB ~ +30 dB

3.9.15 **Peak Table**

► **Description**

The Peak Table function will display all peaks (up to 10) that meet the peak configuration settings. The amplitude and frequency for each peak is listed.

► **Operation**

1 Press (Peak Search) > *More[F7] > Peak Table[F5]*.

2 Press *Peak Sort[F2]* and set the sorting type:

Freq: Sort by frequency in ascending order

Amp: Sort by amplitude in ascending order.

3 Press *Peak Table[F1]* to turn the peak table on.

4 The display splits in two. The bottom screen shows the peak table with the peak marker ID, X-axis position and amplitude.
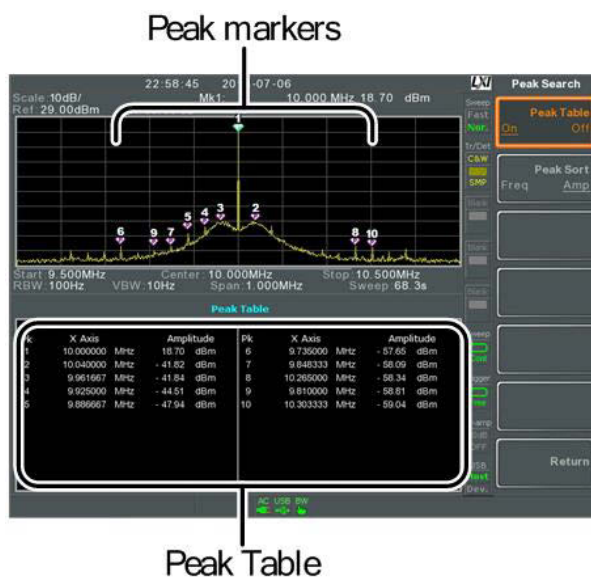
Figure 59.

NOTE:	Note all that the markers for the Peak Table function are all marked with "P" and are colored purple so they can be distinguished from the other markers.

3.10   Display

The Display key configures the basic display settings as well as setting up the display mode (spectrum, spectrographic, topographic) and the split screen modes.

3.10.1   Adjusting the LCD Brightness

► **Description**

The LCD brightness levels can be adjusted to three pre-set levels.

► **Operation**

Press (Display)> *LCD Brightness[F2]* to toggle the display brightness:

Hi: High brightness

Mid: Medium brightness

Lo: Low brightness

3.10.2   Turning the LCD Backlight Off

► **Description**

The LCD backlight can be turned off to preserve power or to prolong the lifetime of the LCD display when not in use.

► **Operation**

1. Press (Display)> *LCD Backlight[F3]* and turn the LCD backlight off.

2. When the backlight is off, press any function key to turn the LCD backlight back on.

3.10.3   Setting a Display Line (Reference Level Line)

► **Description**

The Display Line function is used to super-impose a reference level line over the traces.

► **Operation**

1. Press (Display)> *Display Line[F4]* to turn the display line on.

2. Set the display line level and unit.

► **Example**
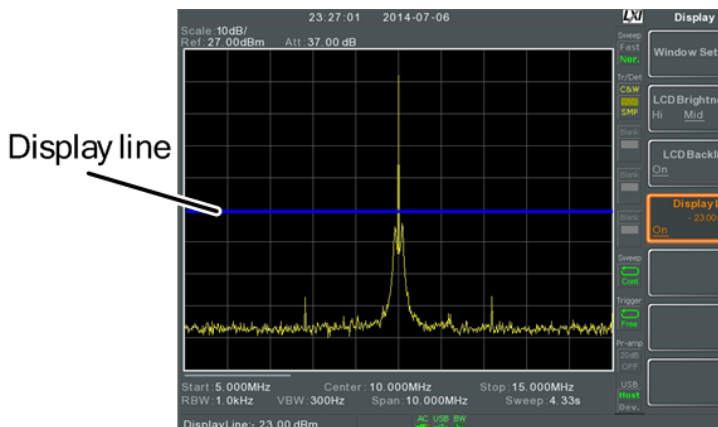
Figure 60. Display line set at -50 dBm

3.10.4 Using the Video Out Port

► **Description**

The **AE-166/167** has a dedicated DVI terminal to output the display to an external monitor. The video output is always on.

Output resolution: 800 x 600 (fixed)

► **Operation**

Connect an external monitor to the rear panel DVI terminal.
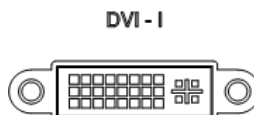
Figure 61.

3.10.5 Setting the Display Mode

► **Description**

The **AE-166/167** has three different display modes for viewing: spectrum, spectrograph and topographic. It is also possible to view the spectrum with the spectrographic or topographic views using a split screen.

- **Spectrum:** Default display mode.
- **Spectrogram:** Useful for viewing frequency or power in the time domain.
- **Topographic:** Useful for observing the frequency of events with a trace.

► **Operation**

Press (Display)> *Window Setup[F1]* and select the display mode:

Spectrum[F1]:

Spectrogram[F3]:

Topographic[F4]:

Spectrogram+Spectrum[F5]:

Topographic+Spectrum[F6]:

NOTE: ⚠	The same trace is used on the top and bottom for the Spectrogram+Spectrum and Topographic+Spectrum modes.

► **Example: Spectrogram**

Figure 62.

The Spectrogram view shows signals in both the frequency and time domain. The X-axis represents frequency, the Y-axis represents time and the color of each point represents the amplitude at a particular frequency & time

(Red = high → dark blue = low).

Each new trace is shown at the bottom of the display and older traces are pushed up toward the top of the display until they are removed.

► **Topographic**
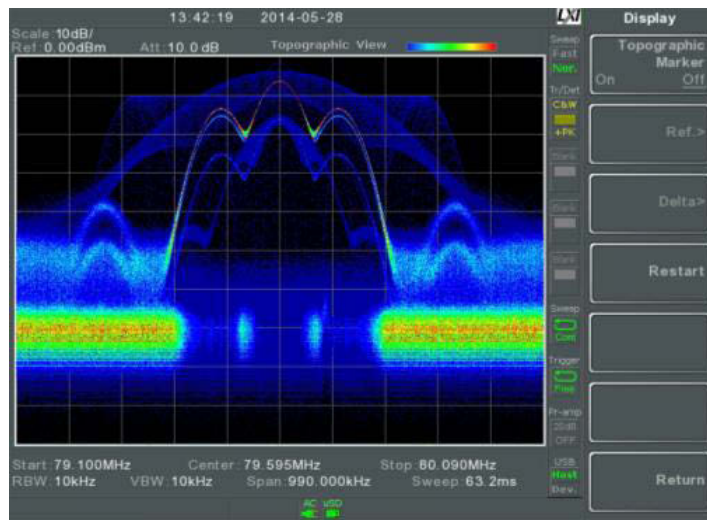
Figure 63.

The topographic view shows the frequency of events. The topographic view is useful for observing smaller signals that have been overpowered by stronger signals or to easily observe intermittent events. Color is used to represent the frequency of an event. Red represents a high frequency of occurrence, while blue represents events that occur rarely.

► **Spectrogram + Spectrum**
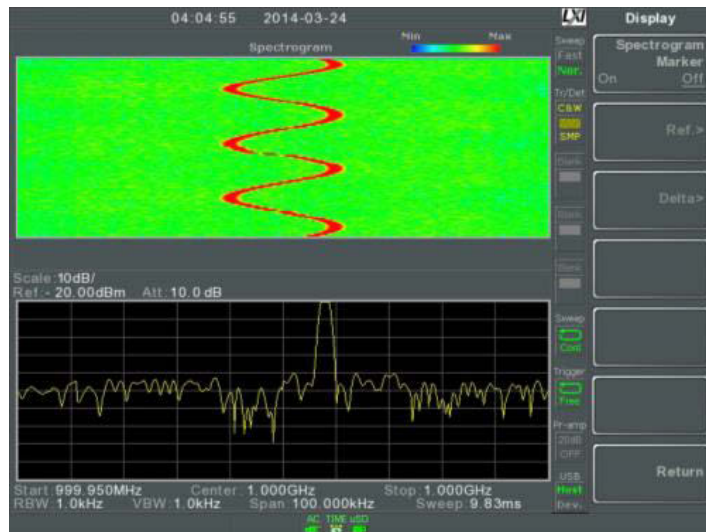
Figure 64. Displays both spectrographic and spectrum views of the signal.

► **Topographic + Spectrum**
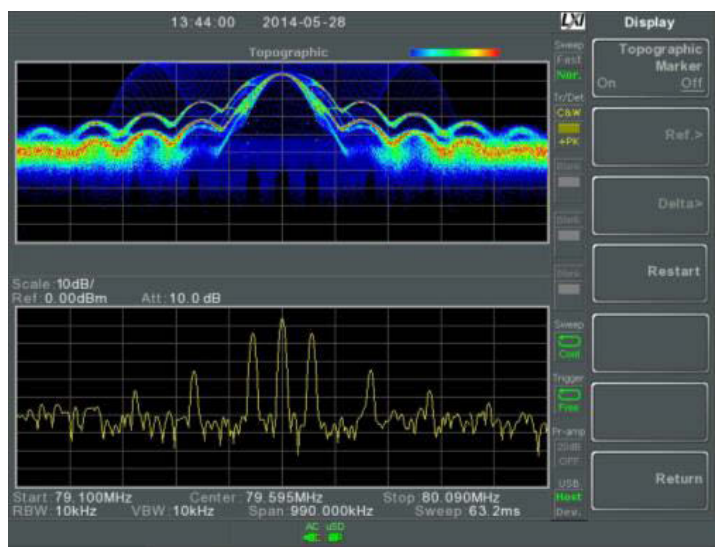
Figure 65. Displays both topographic and spectrum views of the signal.

3.10.6		**Spectrogram and Topographic Markers**

► **Description**

The Spectrogram and Topographic display view can also use markers and delta markers to mark the frequency and amplitude of points of interest. This function is particularly useful as it allows you to make delta measurements both in the frequency and time domain.

► **Operation**

1 When in the Topographic view (single or split screen), press *Topographic Marker* and turn on.

2 When in the Spectrographic view (single or split screen), press *Spectrogram Marker* and turn on.

3 To set the reference marker, press *Ref.[F2] > X Axis[F1]* and set x-axis position (frequency).

4 Press *Y Axis[F2]* and the set the y-axis position (amplitude).
■ The frequency and amplitude information will be displayed on the remaining function keys:

Frequency[F3]: Marker frequency.

Amplitude[F4]: Marker Amplitude.

Time[F4]: Time relative to the start of the sweep.

5   To set the delta marker, press *Return[F7] > Delta[F3] > X Axis[F1]* and set the x-axis position of the delta marker (frequency).

6   Press *Y Axis[F2]* to set the y-axis position of the delta marker (amplitude).

■   The frequency and amplitude delta will be displayed on the remaining function keys:

ΔFrequency[F3]: Position of the delta marker.

ΔAmplitude[F4]: Amplitude of the delta marker.

ΔTime[F4]: Time delta.

1/ΔTime[F5]: Frequency delta.

► **Example**
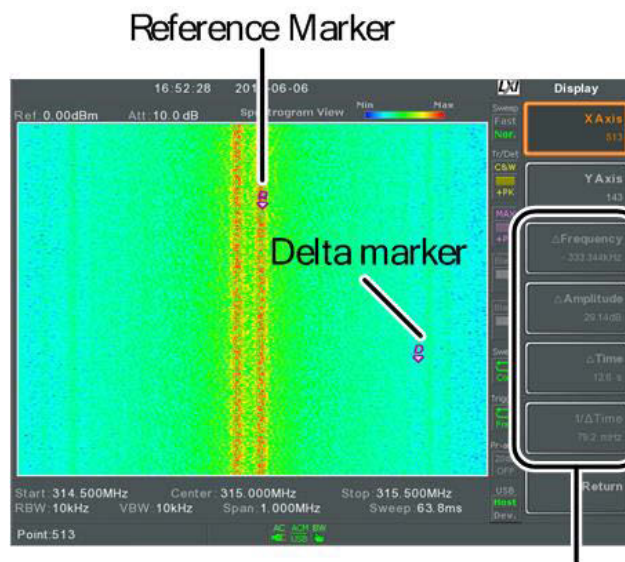
Figure 66. Spectrogram view is shown as an example.

| 3.10.7 | | **Split Spectrum View** |

► **Description**

The split spectrum view is able to view two different sweep ranges on the display at the same time using a split screen view. The top and bottom view can have independent sweep ranges, amplitudes, spans and other settings. However only one split screen (top or bottom) can be swept each time.

► **Operation**

1 Press (Display)>*Window Setup[F1] > Split Spectrum[F2] > Active Win[F1]* to activate the upper split screen.

2 Pressing *Active Win.[F1]* will toggle the sweep between the upper and lower screen.

3 Press *Alternate Sweep[F2]* for the analyser to alternate the sweep between the upper and lower screen at the end of each sweep.

NOTE: ⚠️	No operations can be performed in alternate sweep mode.
	After exiting the split spectrum view, the analyser will use the settings from the active window. The settings for the inactive screen will be retained for the next time that split spectrum view is used.

► **Example**
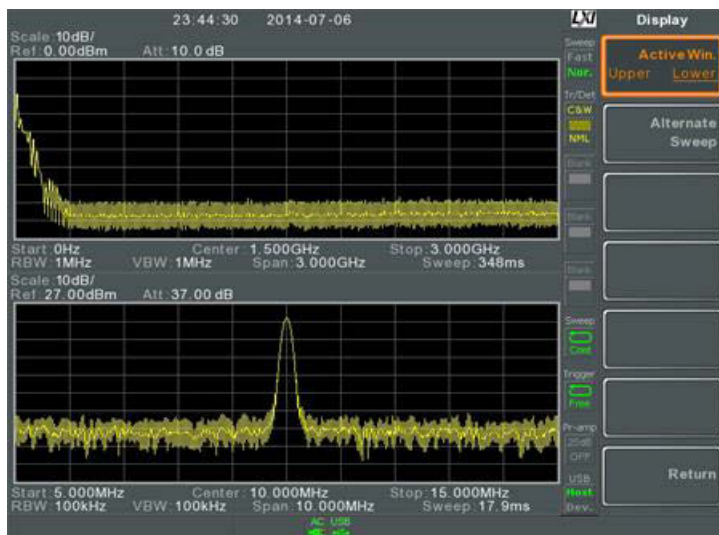
Figure 67.

3.11   System Settings

3.11.1   System Information

► **Description**

The System Information displays the following.

Serial Number	**Installed Options**
Version:	**Calibration Date:**
Software	**LOI**
Firmware	**RF**
File sys	**TG**
RF	**DNS Hostname**
TG	**MAC Address**
DSP	
Wordlist	
Core	

► **Operation**

Press (System)> *System Information[F1]* to bring up a list of the system information.

3.11.2   Error Messages

► **Description**

You can view error messages that are in the error queue by message number, description and time. All errors from the system error queue are logged when operating the analyser. For a list of the error messages, please see the programming manual.

► **Operation**

1 Press (System)> *Error message[F2]* to bring up the error message table.

2 Press *Prev Page[F2]* and *Next Page[F3]* to navigate through each page of the error list.

3 Press *Clear Error Queue[F6]* to clear the error messages from the list.

3.11.3 | **Set the System Language**

► **Description**

The **AE-166/167** supports a number of languages. The system language sets the soft menu keys to the selected language.

► **Operation**

Press (System)> *Language[F3]* and choose the system language.

3.11.4 | **Set the Date and Time**

► **Operation**

1 Press (System)> Date/Time[F4].

2 Press *Set Date[F1]* to set the date:

Year[F1]: Sets the year.

Month[F2]: Sets the month.

Day[F3]: Sets the day.

3 Press *Set Time[F2]* to set the system time:

Hour[F1]: Sets the hour (24hr).

Minute[F2]: Sets the minute.

Second[F3]: Sets the second.

4 The system time and date will be shown at the top of the display.
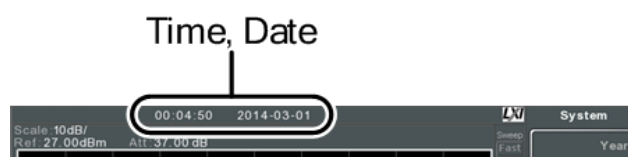
Figure 68.

3.11.5 | **Display the Date and Time on the Screen**

► **Description**

Enables or disables the date and time on the screen.

► **Operation**

Press (System)> *Date/Time[F4] > Clock[F4]* and turn the clock display on or off.

3.11.6   Using the Wake Up Clock

► **Description**

The **AE-166/167** has a wake-up clock to allow the spectrum analyser to automatically turn on at a set time.

► **Operation**

Press (System)> *Date/Time[F4] > Wake-Up Clock[F3]* and set the following parameters.

Select Clock[F1]: Choose a wake-up clock (1~7).

State[F2]: Turns the selected clock on/off.

Hour[F3]: Set the wake-up hour.

Minute[F4]: Set the wake-up minute.

Repeat Single[F5]: Set the wake-up clock to repeat or single.

> **NOTE:**
> Only single days can be configured for the wake-up clock.

3.11.7   Alarm Output

► **Description**

Allows the pass/fail output to be output via the ALARM OUT port.

Output: Open collector
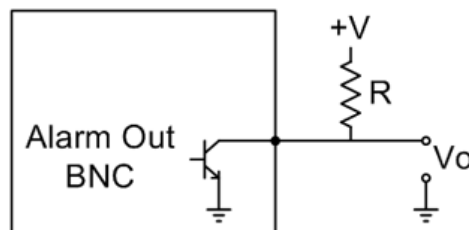
Figure 69.

► **Operation**

Press (System)> *Alarm Output[F6]* and toggle the ALARM OUT port on or off.

3.12   Preset

The Preset function loads either factory default states or the user-defined states – depending on the Preset configuration settings.

- ■ Using the Preset Key
- ■ Save the User Preset Settings
- ■ Preset Type Settings
- ■ Power on Preset Settings

3.12.1   Using the Preset Key

► **Description**

The (Preset) key loads the factory default state or user-defined preset settings.

► **Operation**

Press (Preset) to load the preset settings.

3.12.2   Save the User Preset Settings

► **Description**

The user-defined preset settings can be created by saving the current state as the user-defined preset settings.

► **Operation**

Press (System)>*Pwr On/Preset[F5] > Save User Preset[F3]* to save the current state as the *User Preset* settings.

3.12.3   Preset Type Settings

► **Description**

Each time the (Preset) key is pressed, a set of preset configuration settings are loaded. The preset configuration settings can be either the factory default settings or the user-defined settings.

► **Operation**

Press (System)>*Pwr On/Preset[F5] > Preset Type[2]* and choose the preset type:

User Preset[F1]

Factory Preset[F2]

3.12.4 | | **Power on Preset Settings**

► **Description**

When the spectrum analyser is turned on, either the preset configuration settings are loaded (default) or the configuration settings that were used before the instrument was turned off.

► **Operation**

Press (System)> *Pwr On/Preset[F5] > Power On[F1]* and choose the power on settings:

Power On: Last, Preset.

| NOTE: ⚠ | The last preset conditions cannot be loaded if the instrument was not powered down correctly the last time it was used. |

4 ADVANCED OPERATION

4.1   Measurement

This section describes how to use the automatic measurement modes. The **AE-166/167** includes the following measurements:
- ACPR
- OCBW
- AM Analysis
- FM Analysis
- AM/FM Demodulation
- Phase Jitter
- SEM measurement
- TOI measurement
- CNR/CSO/CTB measurement
- Harmonic Measurement
- N dB measurement
- P1dB Measurement

4.1.1   Channel Analysis Overview

► **Description**

Channel analysis measurement includes ACPR (adjacent channel power) and OCBW (occupied bandwidth) measurements.

► **Parameters**

- **Channel bandwidth:** The frequency bandwidth the target channel occupies.

   Range: Between 0 Hz ~ 3 GHz (0 Hz excepted)

- **Channel Space:** The frequency distance between each main channel.

   Range: Between 0 Hz ~ 3 GHz

- **Adjacent channel bandwidth 1 & 2:** The frequency bandwidth the adjacent channels occupy.

   Range: Between 0 Hz ~ 3 GHz (0 Hz excepted)

■ **Adjacent channel offset 1 ~ 3:** The frequency distance between the adjacent channels and main channel.

Range: 1 Between 0 Hz ~ 3 GHz (0 Hz excepted)

■ **OCBW%:** The ratio of occupied bandwidth to the amount of power consumed.

Range: 0 % to 100 %, 0.1 % resolution.

4.1.2 ⬜ **ACPR**

► **Description**

Adjacent channel power refers to the amount of power leaked to the adjacent channel from the main channel. This measurement is a ratio of the main channel power to power in the adjacent channel.

► **Example**
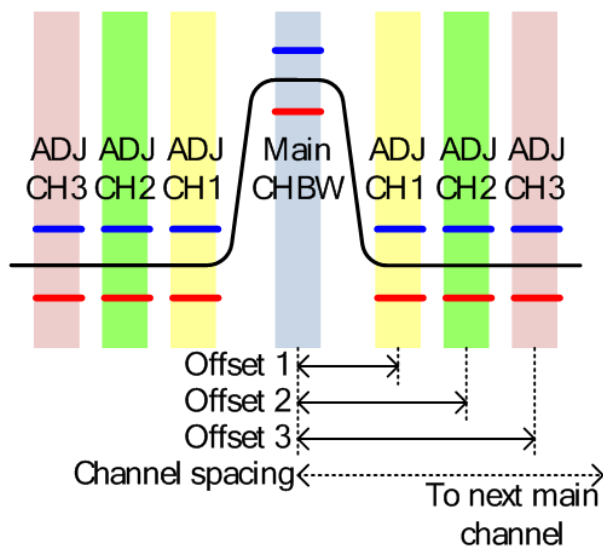
Figure 70.

► **Operation: Setting up the main channel**

1 Press (Measure)> *Channel Analysis[F1] > ACPR[F2]* and turn ACPR on.
  ■ Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top screen shows the main channel, adjacent channels and their corresponding limits. The bottom screen shows the ACPR measurement results in real time.
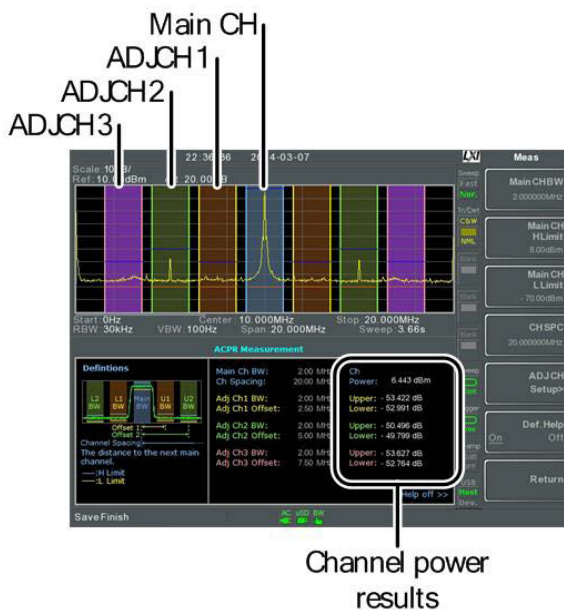
Figure 71.

3 Press (Measure)> *Channel Analysis[F1] > ACPR Setup[F1] >* and set the following:
  ■ *Main CHBW[F1]:* Set the bandwidth of the main channel.
  ■ *Main CH H Limit[F2]:* Set the low limit for the main channel.
  ■ *Main CH Limit[F3]:* Set the high limit for the main channel.
  ■ *CH SPC[F4]:* Specify the channel spacing

► **Operation: Setting up the adjacent channel(s)**

1 Press *ADJCH Setup[F5]* to setup the adjacent channels:
  ■ *Select AdjCh[F1]:* Choose an adjacent channel number: 1, 2, 3
  ■ *[F2]:* Toggle the selected channel on/off.
  ■ *ADJCHBW[F3]:* Choose the bandwidth of the selected channel.
  ■ *ADJCH Offset[F4]:* Set the adjacent channel offset.
  ■ *ADJCH HLimit[F5]:* Set the adjacent channel high limit.
  ■ *ADJCH LLimit[F5]:* Set the adjacent channel low limit.

2 Repeat the above steps for the other adjacent channels, if needed.

► **Move Channels Up/Down**

Press (Measure) > *Channel Analysis[F1]* and press the following to move to another channel:

- ■ Channel Move Up[F5]: Next main channel.
- ■ *Channel Move Down[F6]* Previous main channel.

NOTE: ⚠️	The channel space (CH SPC) parameter determines where the next main channel is located.

► **Remove Definitions Help**

Press (Measure) > *Channel Analysis[F1]>ACPR Setup[F1]>Def. Help* to toggle the *Definitions Help* on or off.

4.1.3	OCBW

► **Description**

Occupied bandwidth measurements are used to measure the power of the occupied channel as a percentage to the power of the channel.

► **Example**
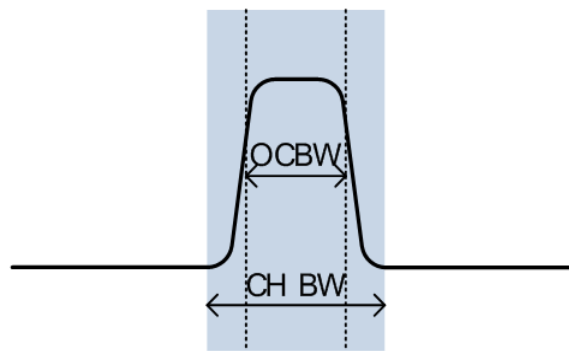
Figure 72.

► **Operation: Setting up the main channel**

1 Press (Measure)> *Channel Analysis[F1] > OCBW[F4]* and turn OCBW on.

■ Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top shows the channel bandwidth. The bottom screen shows the OCBW measurement results in real time.
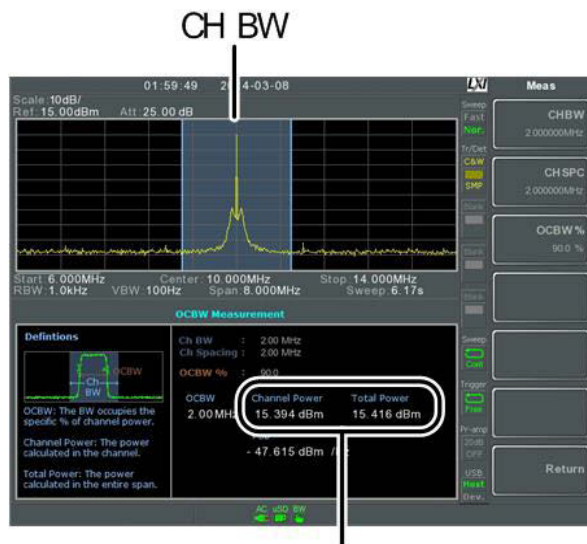
Figure 73.

3 Press *OCBW Setup[F3]* to enter the OCBW setup:

■ *CHBW[F1]*: Set the channel bandwidth.
■ *CH SPC[F2]*: Set the channel space between main channels.
■ *OCBW%[F3]:* Set the % of the OCBW to CHBW.

► **Move Channels Up/Down**

Press (Measure)> *Channel Analysis[F1]* and select*:*

■ *Channel Move Up[F5]*   Next main channel.
■ *Channel Move Down[F6]*   Previous main channel.

NOTE: ⚠	The channel space (CH SPC) parameter determines where the next main channel is located.
	The CH SPC parameters from the ACPR and OCBW setups are independent.

4.1.4		AM Analysis

► **Description**

When amplitude modulation is turned on, the input signal is centered on the center frequency and the span is automatically set to zero-span.

► **Measurement items**
  ▪ **AM Depth:** Current, Min, Cent, Max
  ▪ **Mod. Rate:** Current, Min, Cent, Max
  ▪ **Carrier Pwr:** Current, Min, Cent, Max
  ▪ **Carrier Freq Offset:** Current, Min, Cent, Max
  ▪ **SINAD:** Current, Min, Cent, Max

► **Operation: configuration**

  1 Set the center frequency to the carrier frequency).

  2 Press (Measure)> *Demod[F2] > AM Analysis[F1] > AM Analysis[F1]* and turn AM analysis on.
    ▪ Any other measurement mode will automatically be disabled.

  3 The display splits into two screens. The top shows the AM waveform in the time domain. The bottom screen shows the AM measurement.

AM waveform

AM modulation measurements
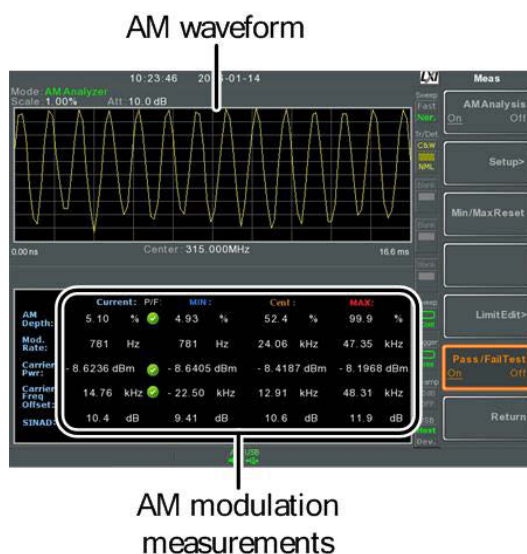
Figure 74.

4 Press *Setup[F2] > IF Bandwidth[F1]* and set the Intermediate frequency bandwidth.

- Set with adequate bandwidth to accommodate spectrum contained in the carrier.

5 Press *LPF[F2]* to set the low pass filter frequency, alternatively the frequency can be set to bypass:

AM Signal Frequency (Hz)

	Selectable bandwidth of LPF (Hz)				
=78,125	156,250	78,125	52,083	39,063	31,250
=39,063	78,125	39,063	26,042	19,531	15,625
=19,531	39,063	19,531	13,021	9,766	7,813
=7,813	15,625	7,813	5,208	3,906	3,125
=3,906	7,813	3,906	2,604	1,953	1,563
=1,953	3,906	1,953	1,302	977	781
=781	1,563	781	521	391	313
=391	781	391	260	195	156
=195	391	195	130	98	78
=78	156	78	52	39	31
=39	78	39	26	20	16
=20	39	20	13	10	8
=8	16	8	5	4	3

6 Press *Time Axis [F3]* to set horizontal axis parameters:

- *Ref. Value[F1]*: Sets the starting time on the time axis.
- *Ref. Pos[F2]*: Shifts the waveform X number of grid subdivisions.
- *Scale/Div[F3]*: Sets the grid division scale when Auto Scale is Off.
- *Auto Scale[F4]*: Toggles auto-scaling on/off.

7 Press *Depth Axis[F4]* to set depth (vertical) parameters:
- *Ref.Value[F1]*: Offsets the reference position as a percentage of the vertical scale/div.
- Ref.Pos[F2]: Sets the reference position of the waveform on a vertical grid subdivision (1:10).
- *Scale/Div[F3]*: Sets the vertical grid division scale when Auto Scale is Off.
- *Auto Scale[F4]*: Toggles auto-scaling execution.

8 Press *Squelch[F6]* to set carrier squelch level. The squelch setting will suppress unwanted noise of a certain level.

► **Operation: trigger configuration**

1 Press *AF Trigger[F5]> Trigger Setup[F2]* to set the triggering conditions:
- *Edge Slope[F1]:* Sets the trigger to rising or falling edge.
- *Trigger Mode[F2]:* Sets the triggering mode:

  - *Nor.:* Normal trigger

  - *Sgl.:* Single trigger

  - *Cont.:* Continuously trigger
- *Trigger Level[F3]:* Sets the trigger level as a percentage of the depth. (The displayed level will only remain for a few moments).
- *Trigger Delay[F4]:* Sets the trigger delay time: 0 to 1 ks

2 Press *Return[F7]* to return to the AF Trigger menu and to set the remaining trigger options:
- *FreeRun[F1]:* Disables the trigger, this is the default setting.
- *Start Time[F3]:* Sets the start time for the x-axis for the AM waveform in the top-half of the screen.
- *Stop Time[F4]:* Sets the stop time for the x-axis for the AM waveform in the top-half of the screen.
- *Action Now[F5]:* Turns FreeRun mode off and uses the user-defined trigger settings.

NOTE: ⚠️	The MAX and MIN measurements are held until higher or lower values are found. To reset the MAX and MIN measurements, press (Measure)> *Demod[F2] > AM Analysis[F1] > Min/Max Reset[F3].*

4.1.5		AM Pass Fail Testing

▶ **Description**

The Limit Edit function puts a pass limit on the AM depth, carrier offset and carrier power.

▶ **Measurement Range**

AM Depth: 5 % ~ 95 %

Carr. Offset: 1 Hz ~ 400 kHz

Carrier Power: -120 dBm ~ 30 dBm

▶ **Operation: configuration**

1 Press (Measure) *> Demod[F2] > AM Analysis[F1] > Limit Edit[F5]* and set the limits.
   ▪ *AM Depth[F1]:* If the measured depth is above this limit, it will be judged as Fail.
   ▪ *Carr. Offset[F2]:* If the measured carrier offset is above this limit, it will be judged as Fail.
   ▪ *Carr. Power[F3]:* If the measured carrier power is above this limit, it will be judged as Fail.

2 Press *Pass/Fail* Test and turn Pass/Fail on.

3 The AM Measurement area in the bottom half of the screen will now include Pass/Fail indicators for the AM depth, carrier offset and carrier power.

Pass: ✅   **Fail:** ❌

▶ **Example**

Pass/Fail judgments
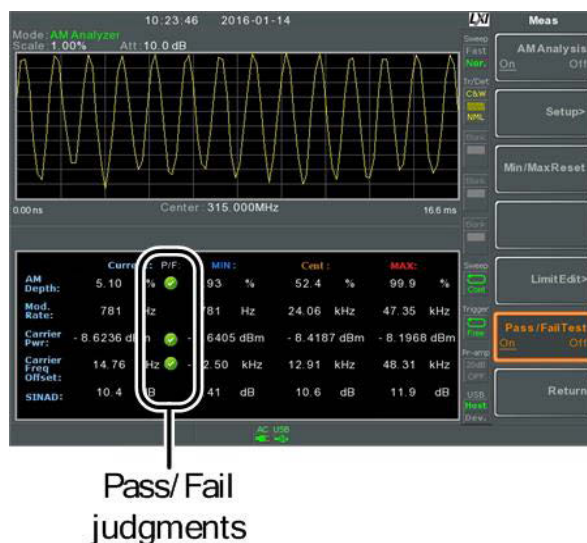
Figure 75.

4.1.6		FM Analysis

► **Description**

When frequency modulation is turned on, the input signal is centered on the carrier frequency and the span is automatically set to zero-span.

► **Measurement ítems**
- **Freq. Deviation:** Current, Min, Cent, Max
- **Mod. Rate:** Current, Min, Cent, Max
- **Carrier Pwr:** Current, Min, Cent, Max
- **Carrier Freq Offset:** Current, Min, Cent, Max
- **SINAD:** Current, Min, Cent, Max

► **Operation: configuration**

1   Set the center frequency to the carrier frequency.

2   Press (Measure)> Demod[F2] > FM Analysis[F2] > FM Analysis[F1] and turn FM analysis on.
- Any other measurement mode will automatically be disabled.

3   The display splits into two screens. The top shows the FM waveform in the time domain. The bottom screen shows the FM measurement.
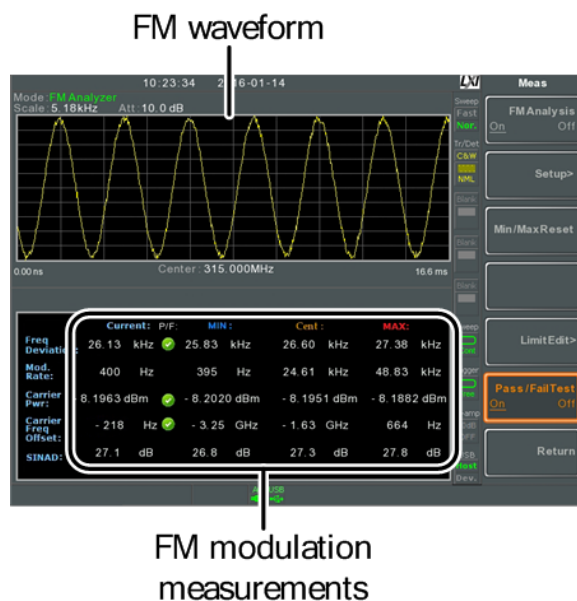
Figure 76.

4   Press *Setup[F2] > IF Bandwidth[F1]* and set the Intermediate frequency bandwidth. (10 kHz, 30 kHz, 100 kHz, 300 kHz, 1 MHz,)
- Set with adequate bandwidth to accommodate spectrum contained in the carrier.

5 Press *LPF[F2]* to set the low pass filter frequency, alternatively the frequency can be set to bypass:

FM Signal Frequency (Hz)

	Selectable bandwidth of LPF (Hz)				
=78,125	156,250	78,125	52,083	39,063	31,250
=39,063	78,125	39,063	26,042	19,531	15,625
=19,531	39,063	19,531	13,021	9,766	7,813
=7,813	15,625	7,813	5,208	3,906	3,125
=3,906	7,813	3,906	2,604	1,953	1,563
=1,953	3,906	1,953	1,302	977	781
=781	1,563	781	521	391	313
=391	781	391	260	195	156
=195	391	195	130	98	78
=78	156	78	52	39	31
=39	78	39	26	20	16
=20	39	20	13	10	8
=8	16	8	5	4	3

6 Press *Time Axis[F3]* to set horizontal axis parameters:
- *Ref. Value[F1]:* Sets the starting time on the time axis.
- *Ref. Pos[F2]:* Shifts the waveform X number of grid subdivisions.
- *Scale/Div[F3]:* Sets the grid division scale when Auto Scale is Off.
- *Auto Scale[F4]:* Toggles auto-scaling on/off.

7 Press *Deviation Axis[F4]* to set deviation (vertical) parameters:
- *Ref.Value[F1]:* Offsets the reference position (in frequency).
- *Ref.Pos[F2]:* Sets the reference position of the waveform on a vertical grid subdivision (1:10).
- *Scale/Div[F3]:* Sets the vertical grid division scale.
- *Auto Scale[F4]:* Toggles auto-scaling execution.

► **Operation: trigger configuration**

8 Press *AF Trigger[F5] > Trigger Setup[F2]* to set the triggering conditions:
   ▪ *Edge Slope[F1]:* Sets the trigger to rising or falling edge.
   ▪ *Trigger Mode[F2]:* Sets the triggering mode:

   Norm.: Normal trigger

   Sgl.: Single trigger

   Cont.: Continuously trigger

   ▪ *Trigger Level[F3]:* Sets the trigger level as a frequency. (The displayed level will only remain for a few moments).
   ▪ *Trigger Delay[F4]:* Sets the trigger delay time: 0 to 1 ks

9 Press *Return[F7]* to return to the AF Trigger menu and set the remaining triggering options:
   ▪ *FreeRun[F1]:* Disables the trigger, this is the default setting.
   ▪ *Start Time[F3]:* Sets the start time for the x-axis for the FM waveform in the top-half of the screen.
   ▪ *Stop Time[F4]:* Sets the stop time for the x-axis for the FM waveform in the top-half of the screen.
   ▪ *Action Now[F5]:* Turns FreeRun mode off and uses the user-defined trigger settings.

NOTE: The MAX and MIN measurements are held until higher or lower values are found. To reset the MAX and MIN measurements, press ⟨Measure⟩ *> Demod[F2] > AM Analysis[F1] > Min/Max Reset[F3].*

4.1.7 **FM Pass Fail Testing**

► **Description**

The Limit Edit function puts a pass limit on the FM deviation, carrier offset and carrier power.

► **Measurement Range**

Frequency Deviation: 40 Hz ~ 400 kHz, 1 Hz measurable

Carr. Offset: 1 Hz ~ 400 kHz

Carrier Power: -120 dBm ~ 30 dBm

► **Operation: configuration**

1. Press (Measure)*> Demod[F2] > FM Analysis[F2] > Limit Edit[F5]* and set the limits.

   - *FM Deviation [F1]:* If the measured deviation is above this limit, it will be judged as Fail.
   - *Carr. Offset[F2]:* If the measured carrier offset is above this limit, it will be judged as Fail.
   - *Carr. Power[F3]:* If the measured carrier power is above this limit, it will be judged as Fail.

2. Press *Pass/Fail Test* and turn Pass/Fail on.

3. The FM Measurement area in the bottom half of the screen will now include Pass/Fail indicators for the FM deviaton, carrier offset and carrier power.

<div align="center">

Pass: ✅   Fail: ❌

</div>

► **Example**
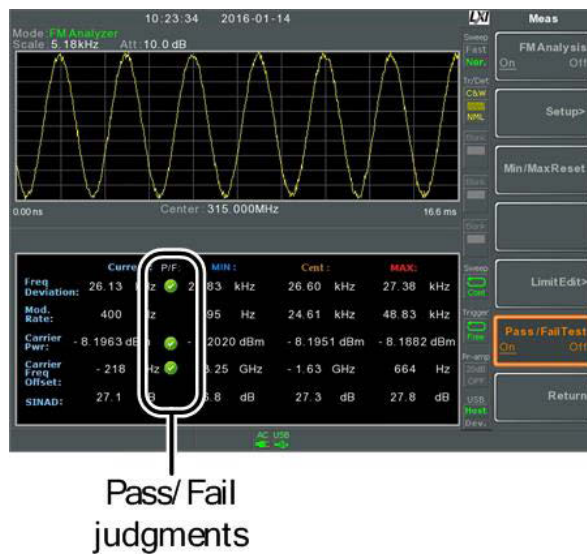
Figure 77.

| 4.1.8 | | **AM/FM Demodulation** |

► **Description**

The **AE-166/167** has a convenient AM/FM demodulation function to tune into AM or FM broadcast signals and listen to the demodulated baseband signals using the ear phone out socket.

► **Operation: Setup**

1 Set the center frequency to the desired FM/AM carrier frequency.

2 Set the span to zero.

3 Set the Preamp to Auto.

4 Connect an antenna to the RF input.

► **Connection**

Connect headphones or a speaker to the phone output port.

► **Operation**

1 Press (Measure)> *Demod[F2] > Sound[F3] > Ear Phone Out[F1]* and turn the ear phone out on.

2 Press *Volume[F2]* to set the volume output:

   Volume: 0 ~ 15, default 7

3 Press *Digital Gain Control[F3]* to change the gain:

   Gain: 0 ~ 18 dB, 6 dB step

4 Press *Demod Type[F4]* to choose AM or FM demodulation.

4.1.9		**Phase Jitter Measurement**

► **Description**

Phase Jitter refers to the amount of phase fluctuation and can be used to evaluate stability of a signal in the time domain.

► **Parameters**

- **Start Offset:** The start frequency with respect to the center frequency.
- **Stop Offset:** The stop frequency with respect to the center frequency.

► **Measurement ítems**

- Carrier Power: dBm
- Jitter in phase: rad
- Jitter in time: ns

► **Example**
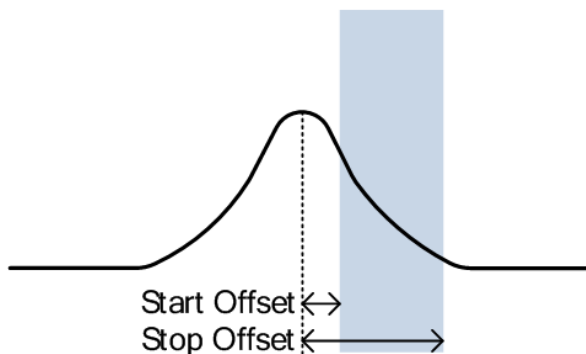
Figure 78.

► **Operation: Setting up the main channel**

1. Press (Measure)> *Phase Jitter[F4]>Phase Jitter[F1]* and turn Phase Jitter on.
   - Any other measurement mode will automatically be disabled.

2. The display splits into two screens. The top shows the trace with the start and stop offsets. The bottom screen shows the phase jitter measurements.

Figure 79.

3. Press *Start Offset[F2]* to set the start offset:

   Offset: (0 Hz ~ ½ span freq)

4. Press *Stop Offset[F3]* to set the stop offset:

   Offset: (0 Hz ~ ½ span freq)

> **NOTE:** The phase jitter measurements are strongly tied to the RBW and VBW.

4.1.10 Spectrum Emission Mask Overview

▶ **Description**

SEM measurements are used to measure the out-of-channel emissions relative to the in-channel power. SEM measurements are usually calculated for specified power bands at a number of different offsets to the carrier frequency. SEM measurements are often carried out for a number of different wireless standards.

For 3GPP, the **AE-166/167** supports BS (base station) and UE (user equipment) testing standards for both FDD (frequency-division duplexing) and TDD (time-division duplexing) modes.

The **AE-166/167** also supports SEM testing for 802.11b, 802.11g, 802.11n and 802.16 as well as user defined emission mask testing.

▶ **Example**
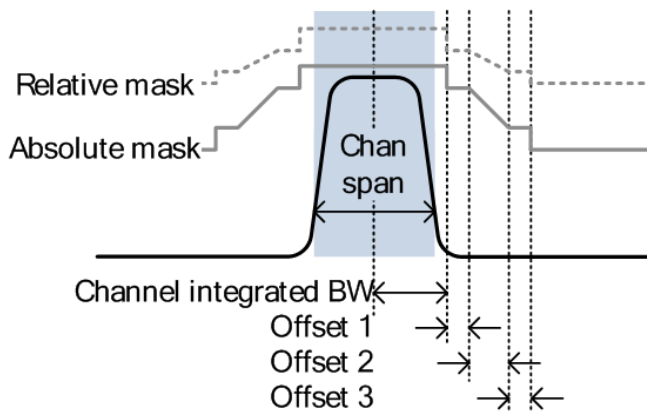
Figure 80.

▶ **Parameters**

- **ChanIntegBW:** Channel Integration Bandwidth. The ChanIntegBW is used to measure the in-channel power.
- **Chan Span:** Used to define the span of the main channel when measuring the channel power.
- **RBW:** Sets the resolution bandwidth for the main channel when measuring the in-channel power.
- **Total Pwr Ref:** The total power of the carrier that is used as the reference for calculating the offset power.
- **PSD Ref:** The mean power spectral density of the carrier that is used as the reference for calculating the offset power.

- ■ **Select Offset:** Selects the offset pairs (1 ~ 5) used for configuration.
- ■ **Start Freq:** Sets the start frequency offset for the selected offset number.
- ■ **Stop Freq:** Sets the stop frequency offset for the selected offset number.
- ■ **RBW:** Sets the resolution bandwidth of the selected offset number.
- ■ **Abs Start:** Sets the absolute level limit at the Start Freq for selected offset number.
- ■ **Abs Stop:** Sets the absolute level limit at the Stop Freq for the selected offset number. The Abs Stop level limit can be set to Couple or Man. Man allows Abs Stop to be user-defined, while Couple will lock Abs Stop to the Abs Start level limit.
- ■ **Rel Start:** Sets the relative level limit at the Start Freq for the selected offset number.
- ■ **Rel Stop:** Sets the relative level limit at the Stop Freq for the selected offset number. Rel Stop can be set to Couple or Man. Man allows Rel Stop to be user-defined, while Couple will lock Rel Stop to the Rel Start level limit.
- ■ **Fail Mask:** Sets the fail conditions for measurement with regards to the level limits: Absolute, Relative, Absolute & Relative, Absolute or Relative.

► **Measurement items**
- ■ **Main Channel Bandwidth:** Unit: Hz
- ■ **Total Power:** Unit: dBm
- ■ **PSD (Power Spectral Density):** Unit: dBm/Hz
- ■ **Offset 1 ~ 5:** Lower dBm, Upper dBm

3GPP Operating Bands*

Operating Band	UL Frequencies UE transmit, Node B receive	DL Frequencies UE receive, Node B transmit
I	1920 ~ 1980 MHz	2110 ~ 2170 MHz
II	1850 ~ 1910 MHz	1930 ~ 1990 MHz
III	1710 ~ 1785 MHz	1805 ~ 1880 MHz
IV	1710 ~ 1755 MHz	2110 ~ 2155 MHz
V	824 ~ 849 MHz	869 ~ 894 MHz
VI	830 ~ 840 MHz	875 ~ 885 MHz
VII	2500 ~ 2570 MHz	2620 ~ 2690 MHz
VIII	880 ~ 915 MHz	925 ~ 960 MHz
IX	1749.9 ~ 1784.9 MHz	1844.9 ~ 1879.9 MHz
X	1710 ~ 1770 MHz	2110 ~ 2170 MHz
XI	1427.9 ~ 1452.9 MHz	1475.9 ~ 1500.9 MHz
XII	698 ~ 716 MHz	728 ~ 746 MHz
XIII	777 ~ 787 MHz	746 ~ 756 MHz
XIV	788 ~ 796 MHz	758 ~ 768 MHz
XV	Reserved	Reserved
XVI	Reserved	Reserved
XVII	Reserved	Reserved
XVIII	Reserved	Reserved
XIX	830 ~ 845 MHz	875 ~ 890 MHz
XX	832 ~ 862 MHz	791 ~ 821 MHz
XXI	1447.9 ~ 1462.9 MHz	1495.9 ~ 1510.9 MHz
XXV	1850 ~ 1915 MHz	1930 ~ 1995 MHz

*for FDD, referenced from ETSI:

3GPP TS 25.101 version 10.2.0 Release 10

3GPP TS 25.104 version 10.2.0 Release 10

► **3GPP-FDD BS**

For the FDD configuration, different limits can by chosen based on the total channel power, P.

The default value for Δfmax is 12.5 MHz. Δfmax can be user-defined.

The channel span is set to 5 MHz.

Note: A, B, C, D, E denote offsets 1 to 5, respectively.

P ≥ 43

Unit: MHz	Abs[1]	RBW
2.5 ≤ A < 2.7	-14 dBm	30 kHz
2.7 ≤ B < 3.5	-14 ~ -26 dBm	30 kHz
3.5 ≤ C < Δfmax	-13 dBm	1 MHz

39 ≤ P < 43

Unit: MHz	Abs[1]	RBW
2.5 ≤ A < 2.7	-15 dBm	30 kHz
2.7 ≤ B < 3.5	-14 ~ -26 dBm	30 kHz
3.5 ≤ C < 7.5	-13 dBm	1 MHz
7.5 ≤ D < Δfmax	P-56 dB	1 MHz

31 ≤ P < 39

Unit: MHz	Abs[1]	RBW
2.5 ≤ A < 2.7	P-53 dB	30 kHz
2.7 ≤ B < 3.5	P-53 dB ~ P-56 dB	30 kHz
3.5 ≤ C < 7.5	P-52 dB	1 MHz
7.5 ≤ D < Δfmax	P-56 dB	1 MHz

P < 31

Unit: MHz	Abs[1]	RBW
2.5 ≤ A < 2.7	-22 dBm	30 kHz
2.7 ≤ B < 3.5	-22 ~ -34 dBm	30 kHz
3.5 ≤ C < 7.5	-21 dBM	1 MHz
7.5 ≤ D < Δfmax	-25 dBm	1 MHz

For P < 31, two additional power limits (shown below) can be selected via the *Additional Max Out. Pwr* option for Home BS applications:

(The default value for Δfmax is 14.5 MHz. Δfmax can be user-defined).

	Unit: MHz	Abs[1]	RBW
6 ≤ P ≤ 20	12.5 ≤ E < Δfmax	P- 56dB	1 MHz
P < 6	Unit: MHz	Abs[1]	RBW
	12.5 ≤ E < Δfmax	-50dBm	1 MHz

▶ **3GPP-FDD BS Additional Requirements**

For operation in bands II, IV, V, X, XII, XIII, XIV and XXV, additional requirements (listed below) apply in addition to the minimum requirements listed above.

	Unit: MHz	Additional[3]	RBW
Bands: II, IV, X	2.5 ≤ A <3.5	-15 dBM	30 kHz
	3.5 ≤ B < Δfmax	-13 dBM	1 MHz
Bands: V	Unit: MHz	Additional[3]	RBW
	2.5 ≤ A < 3.5	-15 dBM	30 kHz
	3.5 ≤ B < Δfmax	-13 dBM	100 kHz
Bands: XII, XIII, XIV	Unit: MHz	Additional[3]	RBW
	2.5 ≤ A < 3.5	-13 dBM	30 kHz
	3.5 ≤ B < Δfmax	-13 dBM	100 kHz

▶ **3GPP-FDD UE**

The channel span is set to 5 MHz.

Note: A, B, C, D, E denote offsets 1 to 5, respectively.

Unit: MHz	Rel	Abs[1]	RBW
2.5 ≤ A < 3.5	-35 ~ -50 dBc	-71.1 dBm	30 kHz
3.5 ≤ B < 7.5	-35 ~ -39 dBc	-55.8 dBm	1 MHz
7.5 ≤ C < 8.5	-39 ~ -49 dBc	-55.8 dBm	1 MHz
8.5 ≤ D < 12.5	-49 ~ -49 dBc	-55.8 dBm	1 MHz

▶ **3GPP-FDD UE Additional Requirements**

Additional requirements for 3GPP-FDD UE.

Bands II, IV, X	Unit: MHz	Additional[3]	RBW
	2.5 ≤ A < 3.5	-15 dBm	30 kHz
	3.5 ≤ B < 12.5	-15 dBm	1 MHz
Band V	Unit: MHz	Additional[3]	RBW
	2.5 ≤ A < 3.5	-15 dBm	30 kHz
	3.5 ≤ B < 12.5	-13 dBm	100 kHz
Bands XII, XIII, XIV	Unit: MHz	Additional[3]	RBW
	2.5 ≤ A < 3.5	-13 dBm	30 kHz
	3.5 ≤ B < 12.5	-13 dBm	100 kHz

▶ **3GPP-TDD BS 3.84 Mcps***

For the TDD configuration, different limits can by chosen based on the total channel power,

The channel span: 3.84 Mcps: 5 MHz.

Note: A, B, C, D, E denote offsets 1 to 5, respectively.

P≥43	Unit: MHz	Abs[1]	RBW
	2.5 ≤ A<2.7	-14 dBm	30 kHz
	2.7 ≤ B<3.5	-14 ~ -26 dBm	30 kHz
	3.5 ≤ C<12	-13 dBm	1 MHz
39≤P<43	Unit: MHz	Abs[1]	RBW
	2.5 ≤ A < 2.7	-14 dBm	30 kHz
	2.7 ≤ B < 3.5	-14 ~ -26 dBm	30 kHz
	3.5 ≤ C < 7.5	-13 dBm	1 MHz
	7.5 ≤ D < 12	P-56 dB	1 MHz

---

*referenced from ETSI:

3GPP TS 25.102 version 10.2.0 Release 10

3GPP TS 25.105 version 10.3.0 Release 10

31≤P<39	Unit: MHz	Abs[1]	RBW
	2.5 ≤ A < 2.7	P-53 dBm	30 kHz
	2.7 ≤ B < 3.5	P-53 ~ P-65 dBm	30 kHz
	3.5 ≤ C < 7.5	P-52 dBm	1 MHz
	7.5 ≤ C < 12	P-56 dBm	1 MHz
P≤31	Unit: MHz	Abs[1]	RBW
	2.5 ≤ A < 2.7	-22 dBm	30 kHz
	2.7 ≤ B < 3.5	-22 ~ -34 dBm	30 kHz
	3.5 ≤ C < 7.5	-21 dBm	1 MHz
	7.5 ≤ D < 12	-25 dBm	1 MHz

▶ **3GPP-TDD BS 1.28 Mcps**

The channel span:1.28 Mcps: 1.6 MHz.

P ≤ 34	Unit: MHz	Abs[1]	RBW
	0.8 ≤ A < 1	-20 dBm	30 kHz
	1 ≤ B < 1.8	-20 ~ -28 dBm	30 kHz
	1.8 ≤ C < 3.5	-13 dBm	1 MHz
26 ≤ P < 34	Unit: MHz	Abs[1]	RBW
	0.8 ≤ A < 1	P-54 dB	30 kHz
	1 ≤ B < 1.8	P-54 ~ P-62dB	30 kHz
	1.8 ≤C < 3.5	P-47 dB	1 MHz
P < 26	Unit: MHz	Abs[1]	RBW
	0.8 ≤ A < 1	-28 dBm	30 kHz
	1 ≤ B < 1.8	-28 ~ -36dBm	30 kHz
	1.8 ≤ C < 3.5	-21 dBm	1 MHz

► **3GPP-TDD BS 7.68 Mcps**

The channel span: 7.68 Mcps: 10 MHz.

P ≥ 43

Unit: MHz	Abs[1]	RBW
5 ≤ A < 5.2	-17 dBm	30 kHz
5.2 ≤ B < 6	-17 ~ -29 dBm	30 kHz
6 ≤ C < 24.5	-16 dBm	1 MHz

39 ≤ P < 43

Unit: MHz	Abs[1]	RBW
5 ≤ A < 5.2	-17 dBm	30 kHz
5.2 ≤ B < 6	-17 ~ -29 dBm	30 kHz
6 ≤ C < 15	-16 dBm	1 MHz
15 ≤ D = 4.5	P-59 dB	1 MHz

31 ≤ P < 39

Unit: MHz	Abs[1]	RBW
5 ≤ A < 5.2	P-56 dB	30 kHz
5.2 ≤ B < 6	P-56 ~ P-68 dB	30 kHz
6 ≤ C < 15	P-55 dB	1 MHz
15 ≤ D = 24.5	P-59 dB	1 MHz

P < 31

Unit: MHz	Abs[1]	RBW
5 ≤ A < 5.2	-25 dBm	30 kHz
5.2 ≤ B < 6	-25 ~ -37 dBm	30 kHz
6 ≤ C < 15	-24 dBm	1 MHz
15 ≤ D = 24.5	-28 dBm	1 MHz

► **3GPP-TDD UE**

The channel span:

3.84 Mcps: 5 MHz.

1.28 Mcps: 1.6 MHz.

7.68 Mcps: 10 MHz.

Note: A, B, C, D, E denote offsets 1 to 5, respectively.

3.84 Mcps

Unit: MHz	Rel[2]	RBW
2.5 ≤ A < 3.5	-35 ~ -50 dBc	30 kHz
3.5 ≤ B < 7.5	-35 ~ -39 dBc	1 MHz
7.5 ≤ C < 8.5	-39 ~ -49 dBc	1 MHz
8.5 ≤ D < 12.5	-49 dBc	1 MHz

1.28 Mcps

Unit: MHz	Rel[2]	RBW
0.8 ≤ A < 1.8	-35 ~ -49 dBc	30 kHz
1.8 ≤ B < 2.4	-49 ~ -59.2 dBc	30 kHz
2.4 ≤ C < 4	-44 dBc	1 MHz

68 Mcps

Unit: MHz	Rel[2]	RBW
5 ≤ A < 5.75	-38 ~ -46 dBc	30 kHz
5.75 ≤ B < 7	-46 ~ -53 dBc	30 kHz
7 ≤ C < 15	-38 ~ -42 dBc	1 MHz
15 ≤ D < 17	-42 ~ -52 dBc	1 MHz
17 ≤ E < 25	-53 dBc	1 MHz

► **802.11b***

The channel span: 22 MHz

Note: A, B denotes offsets 1 and offset 2.

Here the default value of "f" is 24 MHz. This can be user-defined.

Unit: MHz	Rel[2]	RBW
11 ≤ A < 22	-30 dBc	100 kHz
22 ≤ B < f	-50 dBc	100 kHz

---

*reference: IEEE Std 802.11b-1999

▶ **802.11g***

The channel span:

ERP-OFDM/DSSS-OFDM: 18 MHz

ERP-DSSS/ERP-PBCC/ERP-CCK: 22 MHz

Note: A, B, C, D denote offsets 1 to 4, respectively. Here the default value of "f" is 40 MHz (ERP-OFDM/ DSSS-OFDM) or 25 MHz (ERP-DSSS/ ERP-PBCC/ ERP-CCK). This can be user-defined.

ERP-OFDM/ DSSS-OFDM	Unit: MHz	Rel[2]	RBW
	9 ≤ A < 11	-0 ~ -20 dBc	100 kHz
	11 ≤ B < 20	-20 ~ -28 dBc	100 kHz
	20 ≤ C < 30	-28 ~ -40 dBc	100 kHz
	30 ≤ D < f	-40 dBc	100 kHz
ERP-DSSS/ ERP-PBCC/ ERP-CCK	Unit: MHz	Rel[2]	RBW
	11 ≤ A < 22	-30 dBc	100 kHz
	22 ≤ B < f	-50 dBc	100 kHz

▶ **802.11n****

The channel span:

CH BW 20 MHz: 18 MHz

CH BW 40 MHz: 38 MHz

Note: A, B, C, D denote offsets 1 to 4, respectively. Here the default value of "f" is 40 MHz (CHBW 20 MHz) or 70 MHz (CHBW 40 MHz). This can be user-defined.

CH BW 20 MHz	Unit: MHz	Rel[2]	RBW
	9 ≤ A < 11	-0 ~ -20 dBc	100 kHz
	11 ≤ B < 20	-20 ~ -28 dBc	100 kHz
	20 ≤ C < 30	-28 ~ -45 dBc	100 kHz
	30 ≤ D < f	-45 dBc	100 kHz
CH BW 40 MHz	Unit: MHz	Rel[2]	RBW
	19 ≤ A < 21	0 ~ -20 dBc	100 kHz
	21 ≤ B < 40	-20 ~ -28 dBc	100 kHz
	40 ≤= C < 60	-28 ~ -45 dBc	100 kHz
	60 ≤ D < f	-45 dBc	100 kHz

---

*reference: IEEE Std 802.11a-1999
**reference: IEEE Std 802.1n-2009

► **802.16***

The channel span:

CH BW 20 MHz: 19 MHz

CH BW 10 MHz: 9.5 MHz

Note: A, B, C, D denote offsets 1 to 4, respectively. Here the default value of "f" is 16.75 MHz (CHBW 20 MHz) or 31.5 MHz (CHBW 10 MHz). This can be user-defined.

CH BW 20 MHz	Unit: MHz	Rel[2]	RBW
	9.5 ≤ A < 10.9	0 ~ -25 dBc	100 kHz
	10.9 ≤ B < 19.5	-25 ~ -32 dBc	100 kHz
	19.5 ≤ C < 29.5	-32 ~ -50 dBc	100 kHz
	29.5 ≤ D < f	-50 dBc	100 kHz
CH BW 10 MHz	Unit: MHz	Rel[2]	RBW
	4.75 ≤ A < 5.45	0 ~ -25 dBc	100 kHz
	5.45 ≤ B < 9.75	-25 ~ -32 dBc	100 kHz
	9.75 ≤ C < 14.75	-32 ~ -50 dBc	100 kHz
	14.75 ≤ D < f	-50 dBc	100 kHz

NOTE:

⚠️

[1] Abs: Absolute limit.

[2] Rel: Relative limit (to the total power or the power spectral density, depending on the compliance of the main channel).

[3] Additional: Additional absolute limit.

Pass Fail Criteria:

Case 1: When both Abs and Rel are used, the highest value (Abs or Rel) is used as the Pass/Fail judgment. The trace points under the limit indicate a pass.

Case2: If the additional limit is used, the higher value from case1 is compared to the additional limit. The lowest one is used as the pass/fail judgment.

---

*reference: IEEE Std 802.16-2009

| 4.1.11 | | **Spectrum Emission Mask Testing** |

► **Description**

For spectrum emission mask testing, the **AE-166/167** has pre-defined testing parameters for 3GPP, 802.11x and 802.16. The **AE-166/167** also allows you to perform user-defined SEM testing.

► **Operation**

1 Press (Measure) *> SEM[F5] > SEM[F2]* and turn SEM on.

■ Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top shows the trace with the absolute and or relative masks. The bottom screen shows the SEM measurement results.
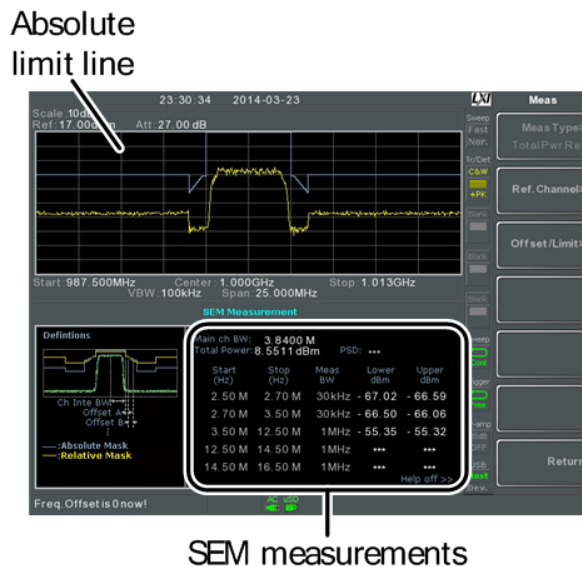
Figure 81.

► **User Defined Parameters**

1 Press *Setup[F1] > User Define[F6]* to set SEM measurement to user defined parameters.

2 Press *Meas Type[F1]* choose between *TotalPwrRef[F1]* or *PSDRef[F2]*.

3 Press *Ref. Channel[F2]* and set the following:
■ *ChanIntegBW[F1]:* Sets the channel integration bandwidth.
■ *Chan Span[F2]:* Sets the channel span.
■ *RBW[F3]:* Sets the resolution bandwidth.
■ *TotalPwrRef[F4]/PSDRef[F4]:* Sets the total power/PSD reference level.

4 Press *Return[F7]* to return to the previous menu.

5   Press *Offset/Limit[F3]* to set the offset parameters:
- *SelectOffset[F1]:* Select which offset to edit.
- *[F2]:* Toggles the selected offset on/off.
- *StartFreq[F3]:* Sets the start frequency of the selected offset.
- *StopFreq[F4]:* Sets the Stop Frequency of the selected offset.
- *RBW[F5]:* Sets the RBW of the selected offset.

6   Press *More 1/2[F6]* to set absolute and relative level limits and conditions:
- *Abs Start[F2]:* Sets the absolute start level limit for the selected offset.
- *Abs Stop[F3]:* Sets the absolute stop level limit for the selected offset
- Man: Allows a user-defined Abs Stop level
- Couple: Sets the Abs Stop level to the Abs Start level.
- *Rel Start[F4]:* Sets the relative start level limit for the selected offset.
- *Rel Stop[F5]:* Sets the relative stop level for the selected offset.
- Man: Allows a user-defined Abs Stop level.
- Couple: Sets the Rel Stop level to the Rel Start level.

7   Press *Fail Mask[F6]* to set the Fail Mask conditions:
- *Absolute[F1]:* Sets the fail condition to the Absolute level limit.
- *Relative[F2]:* Sets the fail condition to the relative level limit.
- *Abs AND Rel[F3]:* Sets the fail condition as both the absolute and relative level limits.
- *Abs OR Rel[F4]:* Sets the fail condition to either the absolute or relative level limits.

8   Press *Select Offset[F1]* and repeat the above steps for any other offsets.
- Offset: 1 ~ 5

► **Pre-Set Test Parameters: 3GPP**

For details on 3GPP SEM test parameters.

1 Press *Setup[F1] > 3GPP[F1]* to choose 3GPP measurement.

2 Press *Ref. Channel[F2]* and set the following:

   RBW[F3]: Sets the resolution bandwidth.

3 All other reference channel settings are pre-defined.

4 Press *Return[F7]* to return the previous menu.

5 Press *Offset/Limit[F3]>Duplexing Mode[F1]* and choose FDD or TDD duplexing:

6 For FDD, press FDD *Setup[F2]* set the FDD parameters, for TDD, press TDD *Setup[F3]*:

   ■ *Transmission[F1]:* Toggles between BS and UE testing

   ■ *Chip Rate[F2]:* Selects the bandwidth of the RRC filter that is used to measure the in-channel power for TDD duplexing:
     3.84 MHz, 1.28 MHz, 7.68 MHz

   ■ Max Out Pwr[F2/F3]:
     Sets the maximum output power for BS tests:
     P > = 43
     39 < = P < = 43
     31 < = P < = 39
     P < 31

   ■ Add.limits[F4]
     Selects the operating bands for FDD duplexing: None
     BandII
     BandIV
     BandV
     BandX
     BandX11
     BandXIII
     BandXIV

   ■ *MinOffset/Limit Value[F5]:* Allows you to view the parameters of each of the offsets, including Stara / stop frequency, RBW, Abs Start / Stop and Rel Start / Stop.

► **Pre-Set Test Parameters: 802.XX**

For details on 802.11x and 802.16 SEM test parameters, please see the SEM overview.

1 Press *Setup[F1]>* and choose a 802.XX test:
802.11b[F2]
802.11g[F3]
802.11n[F4]
802.16[F5]

2 Press *Ref. Channel[F2]* to view the predefined settings for channel integrated bandwidth, channel span, RBW and PSD ref.

3 Press *Offset/Limit[F3]* to view the parameter values of each of the offsets, including Start and Stop Frequency, RBW, Rel Start and Stop.

4.1.12	Third Order Intermodulation Distortion (TOI)

► **Description**

Third order intermodulation distortion measurement is used to calculate the TOI products caused by two signals that are close together in frequency in a non-linear system. Both the upper and lower third order intercept points (IP3) are calculated. Markers are placed at the frequencies of the TOI products and their respective base signals.

Limits can be placed on the upper and lower TOI products for limit testing.

► **Parameters**
- **Reference Lower:** Sets the reference level to lowest base signal.
- **Reference Upper:** Set the reference level to the highest base signal.
- **Limit:** Sets the limit in dBm for pass/fail testing.
- **Pass/Fail Test:** Enables/disables pass/fail testing.

► **Measurement items**
- **Base Upper:** Frequency, dBm, dBc
- **Base Lower:** Frequency, dBm, dBc
- **3rd Order Lower:** Frequency, dBm, dBc, limit, Intercept point
- **3rd Order Upper:** Frequency, dBm, dBc, limit, Intercept point
- **Δf:** Frequency

► **Example**
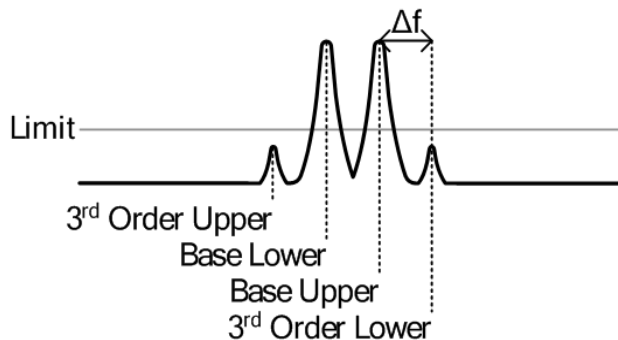
Figure 82.

► **Operation**

1 Press (Measure) *> TOI[F6] > TOI[F1] and turn TOI on*.

   ■ Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top shows the trace with markers in the upper and lower base frequencies and the upper and lower 3rd order intermodulation products. The bottom screen shows the TOI measurements and pass/fail results.

Figure 83.

3 Press *Reference[F2]* to set the reference to the upper or lower base frequencies.

The (R) icon will be displayed next to the selected upper or lower reference.

4 Press *Limit[F3]* and set the limit for the upper and lower 3rd order intermodulation product amplitude.

5 Press *Pass/Fail Test[F4]* to toggle pass/fail testing on/off.

6 The ✓ pass or ✗ fail icon will be displayed depending on the limit set above.

4.1.13   Carrier to Noise Ratio (CNR)

► **Description**

Carrier to noise ratio calculates the difference in amplitude between the carrier signal and the noise level present in the transmission. CNR measurements are used for both analog and digital CATV.

► **Parameters**

- **Noise Parking:** Sets the position of the delta marker (Δ1) using two options:
- **MIN:** The delta marker will search for the minimum between the carrier frequency and the carrier frequency + 4 MHz.
- **ΔMarker:** User defined delta marker position.

► **Measurement items**

- **Visual Carrier:** frequency, amplitude
- **CNR:** amplitude difference
- **Δf:** frequency difference between visual carrier and noise marker.

► **Example**
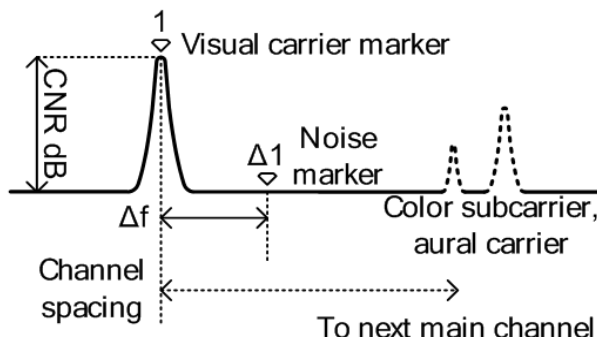
Figure 84.

► **Operation**

1 Press (Measure) > *More[F7] > CNR/CSO/CTB[F1] > Setup[F1] > CNR[F1]* to choose CNR measurement.

2 Press *Noise Marking[F1]* and toggle the noise marker type between Min and ΔMarker.

3 If Min was selected, press *Return[F7]* to return to the previous menu.

4 If ΔMarker was selected, press (Marker) > *Delta[F4] > Delta[F1]* and set the delta marker position.

5 Press (Measure) > *CNR/CSO/CTB[F7]* to return to the previous menu.

6 Press *CNR[F2]* and turn CNR on.

   ▪ Any other measurement mode will automatically be disabled.
   ▪ Ensure the aural and color subcarriers are disabled before CNR is turned on.

7 The display splits into two screens. The top shows the trace with the visual carrier marker and the noise marker. The bottom screen shows the CNR measurements.
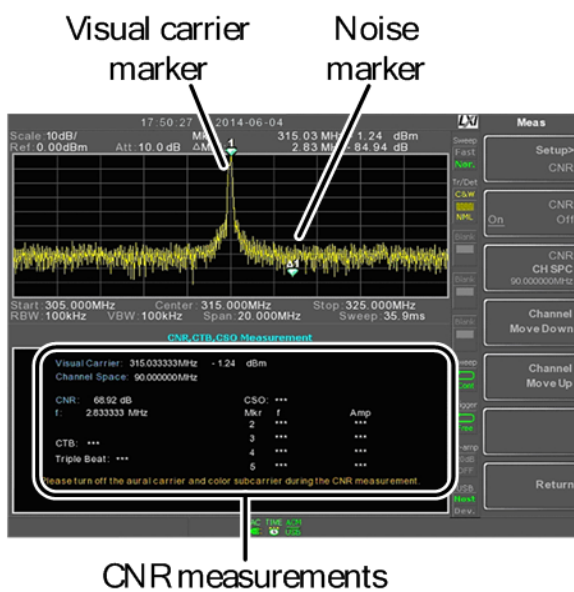
Figure 85.

8 Press *CNR CH SP[F2]* to set the channel space.

   Range: 0 ~ 3 GHz

9 Press *Channel Move Down[F4]* or *Channel Move Up [F5]* to move to the next or previous channel.

> **NOTE:** Ensure the aural and color subcarriers are turned off when making CNR measurements.

4.1.14 Composite Second Order (CSO)

► **Description**

Composite Second Order measurement calculates the difference in amplitude between the carrier signal and the composite second order beat.

► **Parameters**
- CSO CH SP: The channel space.

► **Measurement items**
- Visual Carrier: frequency, amplitude
- Channel Space: frequency
- CSO: amplitude difference

► **Example**
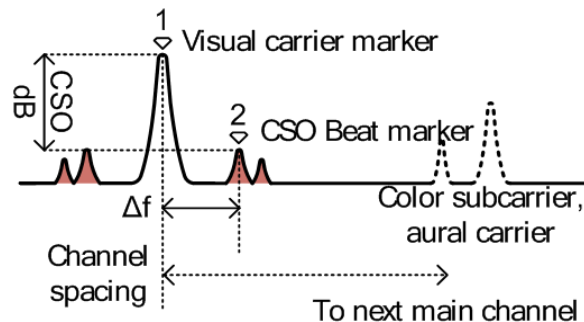
Figure 86.

► **Operation**

1 Press (Measure) > *More[F7] > CNR/CSO/CTB[F1] > Setup[F1] > CSO[F2]* and choose CSO.

2 Press *CSO[F2]* and toggle CSO on.
- Any other measurement mode will automatically be disabled.

3 The display splits into two screens. The top shows the trace with the visual carrier marker and the CSO beat marker. The bottom screen shows the CSO measurements.
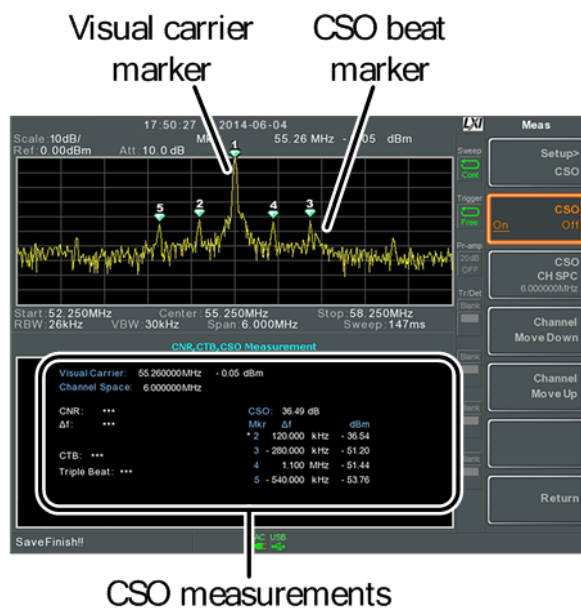
Figure 87.

4 Press *CSO CH SPC[F3]* to set the channel space.

Range: 0 ~ 3 GHz

5 Press *Channel Move Down[F4]* or *Channel Move Up [F5]* to move to next or previous channel.

4.1.15		**Composite Triple Beat (CTB)**

► **Description**

Composite triple beat measurement calculates the difference in amplitude between the visual carrier and the composite triple beat amplitude.

► **Measurement items**

■ Visual Carrier: frequency, amplitude
■ CTB: amplitude difference from the visual carrier and the triple beat
■ Triple Beat: amplitude

► **Example**
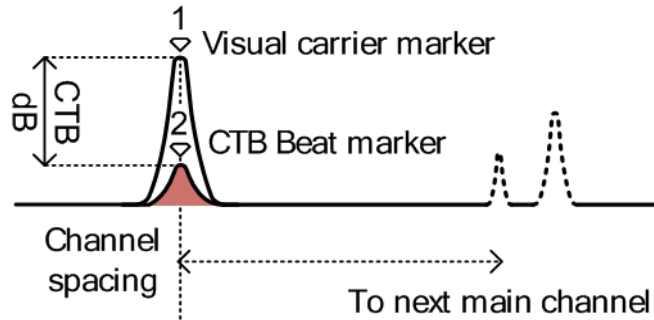
Figure 88.

► **Operation**

1 Press (Measure)*> More[F7] > CNR/CSO/CTB[F1] > Setup[F1] > CTB[F3] > Return[F7]* to choose CTB measurement and return to the previous menu.

2 Press *CTB[F2]* and turn CTB on.
- Any other measurement mode will automatically be disabled.

3 The display splits into two screens. The top shows the trace with the visual carrier marker. The bottom screen shows the CTB measurements.
- This will place a marker ($\overset{1}{\triangledown}$) on the visual carrier and record the amplitude.
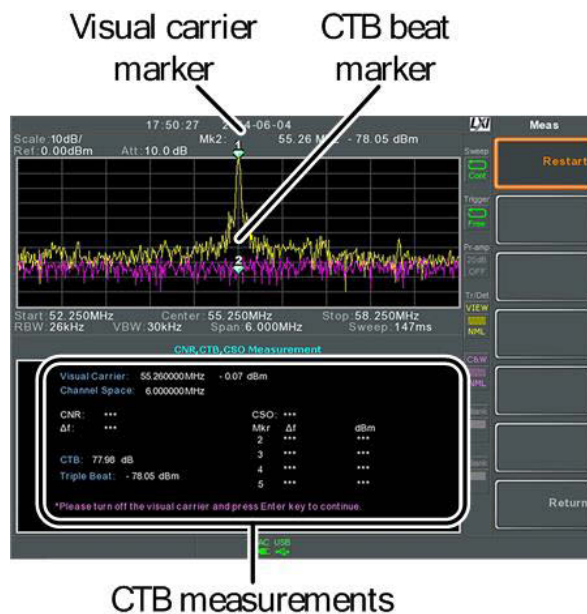
Figure 89.

4 Turn off the visual carrier signal from the input and press the (Enter) key on the front panel.

5 A second trace will appear to mark the CTB amplitude.

- This will place a marker ($\overset{2}{\diamond}$) on the second trace and calculate the difference ($\overset{1}{\diamond}$-$\overset{2}{\diamond}$).

6 Press CTB CH SP[F2] to set the channel space.

Range: 0 ~ 3 GHz

7 Press *Channel Move Down[F4]* or *Channel Move Up [F5]* to move to next or previous channel.

> **NOTE:** To perform the CTB measurement again, press *Setup[F1] > CTB[F3] > Restart[F1]*.

4.1.16 Harmonic Measurements

▶ **Description**

The Harmonic function can be used to easily measure the amplitude of the fundamental frequency and its harmonic frequencies up to the 10th harmonic. The function can also measure the amplitude relative to the fundamental (dBc) and the total harmonic distortion (THD).

▶ **Measurement ítems**

- **Amplitude:** Amplitude of each harmonic (dBm).
- **dBc:** Amplitude of each harmonic relative to the fundamental.
- **THD:** The square root of the sum of the amplitude of each harmonic frequency squared, divided by the amplitude of the fundamental frequency.

$$THD = \frac{\sqrt{V_2^2 + V_3^2 \ldots + V_3^2}}{V_1}$$

Figure 90.

▶ **Example**
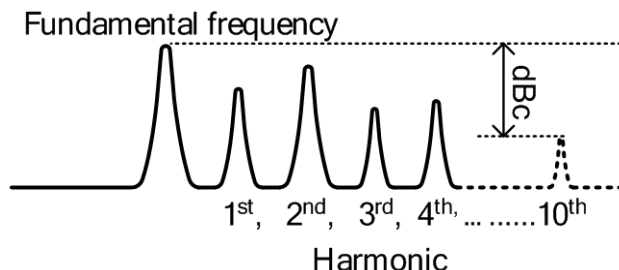
Figure 91.

► **Operation**

1 Press (Measure)> *More[F7] > Harmonic[F2] > Harmonic[F1] and turn Harmonic on*.

- Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top shows a bar graph with fundamental measurement (1) and the each of the harmonic frequencies (2 ~ 10). The bottom screen shows the amplitude, dBc and THD results.
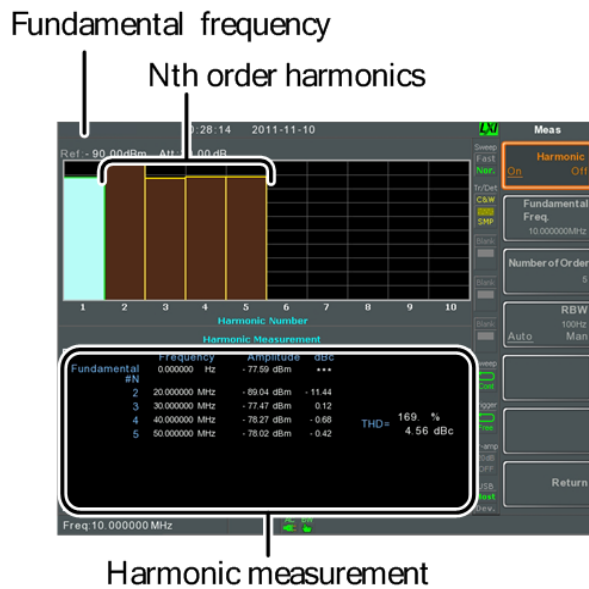
Figure 92.

3 Press *Fundamental Freq.[F2]* to set the fundamental frequency.

4 Press *Number of Order[F3]* to set the number of harmonic frequencies to measure.

- The number of harmonic frequencies set will affect the THD measurement.

5 Press *RBW[F4]* and set the RBW to Auto or Man. Set the resolution bandwidth and unit for RBW Man mode.

- The RBW setting will affect the THD measurement.

  Mode: Auto, Man

  Frequency Range(3dB): 10 kHz ~ 1 MHz (1-3-10 step)

4.1.17		N dB Bandwidth

► **Description**

N dB bandwidth measurements are used to measure the frequency bandwidth that covers a specified amplitude (N dB) from the top of the peak.

► **Example**
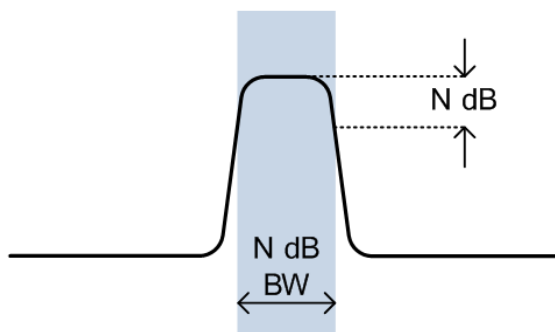
Figure 93.

► **Operation**

1 Press (Measure)*> More[F7] > NdB Bandwidth[F3] > NdB BW[F1]* and turn N dB BW on.
  ■ Any other measurement mode will automatically be disabled.

2 The display splits into two screens. The top shows the trace with markers for NdB and NdB BW. The bottom screen shows the N dB measurement results in real time.
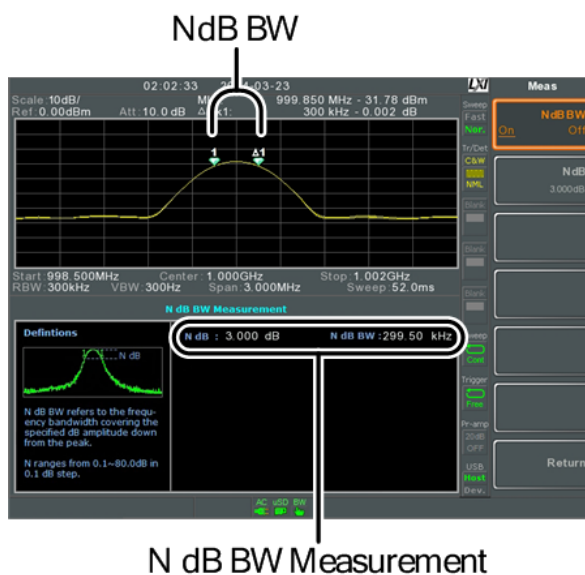
Figure 94.

3 Press *NdB[F2]* to set the NdB amplitude:

Amplitude: 0.1 dB ~ 80.0 dB

> **NOTE:** The NdB bandwidth measurements are strongly tied to the RBW and VBW.

4.1.18 P1dB Measurement

► **Description**

The P1dB compression point describes the point at which the gain of an active DUT is 1dB less than the ideal linear gain (or small signal gain) relative to the input.

► **Example**
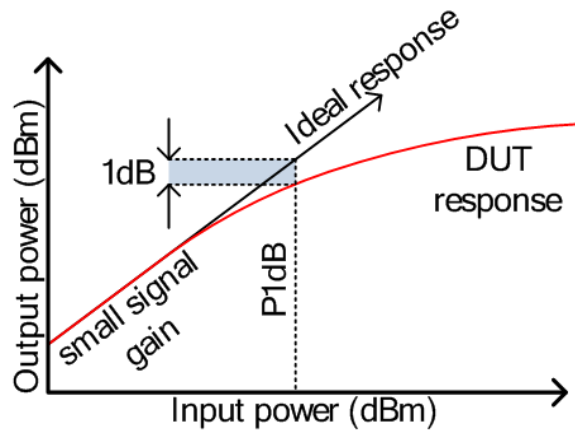
Figure 95.

► **P1dB Connection Setup**

Connect the DUT to the RF input. Connect the tracking generator output to the DUT input. The DC output can be used to power the DUT if necessary.
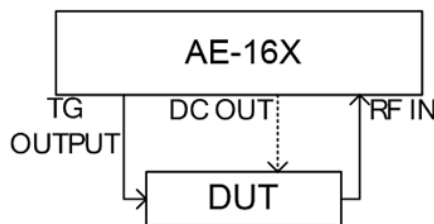
Figure 96.

► **Operation**

1 Press (Measure)*> More[F7] > P1dB[F4] > P1dB[F1]* and turn P1dB on.

- ▪ Any other measurement mode will automatically be disabled.
- ▪ It is not necessary to turn the tracking generator on.

2 The display splits into two screens. After setup has been completed (see step 3), the top shows the trace (yellow) with the ideal response in red. The P1dB measurement is shown in green. The bottom screen shows the P1dB measurement results in real time.
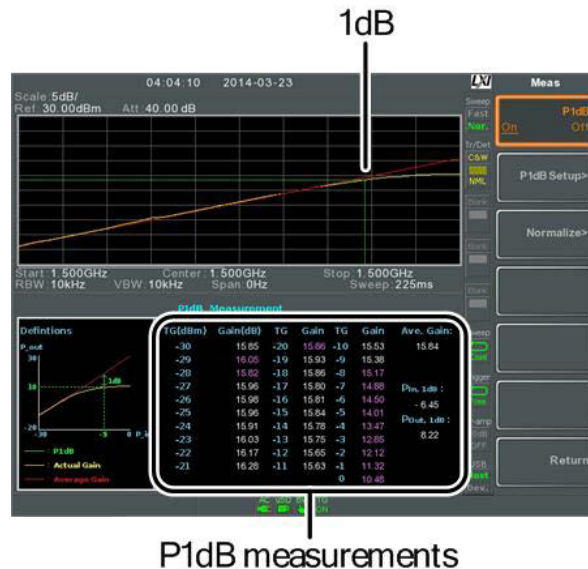
Figure 97.

The measurement results display a total of 31 points, incremented in 1 dB steps from -30 dBm to 0 dBm. In each column the left side shows the input power and the right side shows the gain. Gain marked in white is effective gain, while gain marked in purple is ineffective gain. The results also list the average gain, the output power at the P1dB point (Pout, 1 dB) and the input power at the P1dB point.

3 Press *P1dB Setup[F2]* to set the P1dB settings.

4 Press *Center Freq[F1]* to set the center frequency:

Frequency: 0 ~ 3 GHz

5 Press *Gain Offset[F2]* to set the gain offset of the ideal linear response.

Gain: -99.00 dB ~ 99.00 dB

6 To help smooth the actual frequency response and measure the P1dB compression point more accurately, press *Average[F3]* to set the average number. This is especially useful if *Start* is set around -50 dB.

Average number: 1 ~ 200

7 Press *Start[F4]* to set the "starting" output power for the P1dB measurement.

Start: -50 dB ~ -5 dB

8 Press *Reset[F5]* to restart the P1dB measurement function.

WARNING: If the equivalent gain exceeds 30 dBm the gridicule area will be bordered in red to indicate that the input exceeds specified levels.

Figure 98.

NOTE: The maximum power the DC output can provide is 7 volts / 500 mA.

4.1.19   P1dB Normalization

► **Description**

The normalize function is used to compensate for any loss from a long cable that may cause inaccurate measurements.

This function relies on the DUT being directly connected to either the TG or the RF input. The position of the long cable in relation to the DUT (input or output) will affect the P1dB measurement.

If the cable is at the DUT input, then the line loss of the cable will reduce the output of the TG before it is input to the DUT. This configuration (Location = Prev) can affect the position of the P1dB point if not normalized.

Likewise if the cable is connected to the output of the DUT, then the gain of the DUT will be reduced at the RF input by the line loss of the cable. In this configuration (Location = Post) the P1dB point will not be affected.

NOTE: If a DUT cannot be directly connected to the TG output or the RG input, try to use the shortest cable possible to reduce the effect of cable loss. The line loss from short cables cannot be measured when using the Normalize function.

► **Example 1**

Location = Prev
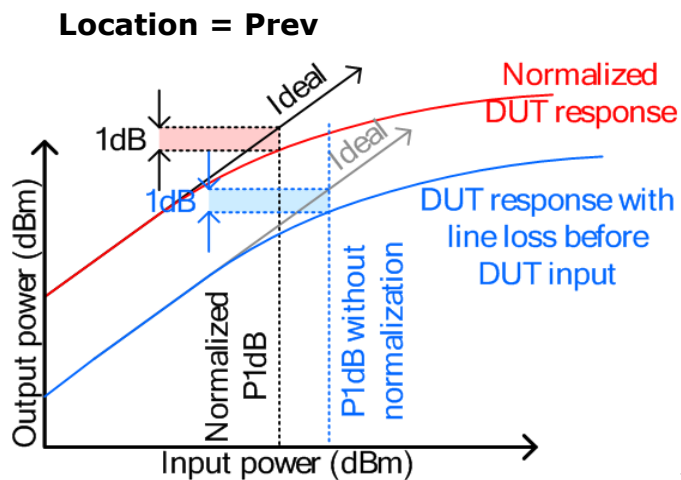
Figure 99.

► **Example 2**

Location = Post
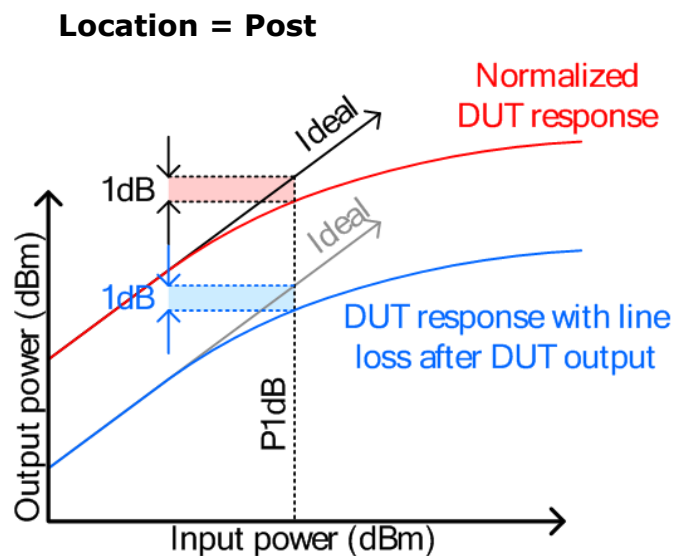
Figure 100.

NOTE:	This function can only be used when the P1dB is turned on.

► **Operation**

1. Connect the cable that is to be connected to the DUT between the TG and the other cable to the RF input.
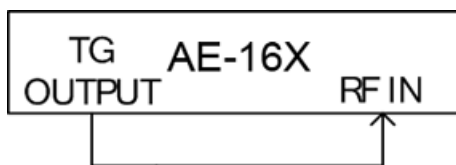
Figure 101.

2. Press (Measure) > *More[F7] > P1dB[F4] > Normalize[F3].*

3. Press *Execute Norm[F3]*. This will normalize the cable loss. The cable loss will be shown in the Execute Norm icon.
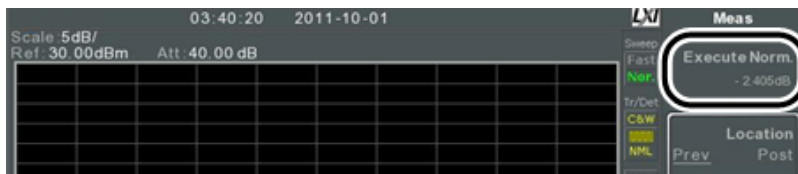
Figure 102.

4. Next connect the DUT either directly to the TG or directly to the RF input. The location of the DUT will determine whether the cable loss is normalized before or after the DUT.

   Connect the RF cable from the DUT to the either the TG or RF input, depending on where the DUT was connected.

Location = Prev   **Location = Post**
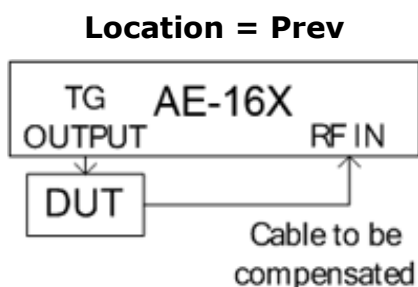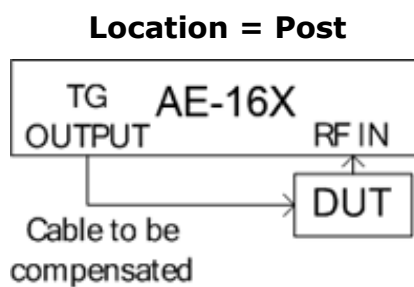
Figure 103.   **Figure 104.**

5. Set *Location[F2]* to either PREV or POST, depending on the location of the DUT, as shown above.

6. Turn *Norm.[F3]* on.

7. The cable loss will now be normalized, based on where the DUT is located.

4.2   **Limit Line Testing**

The limit line is used to set the upper or lower amplitude limits over the entire frequency range. The limit lines can be used to detect whether the input signal is above, below or within the limit lines.

The limit lines can be manually or automatically created. The limit lines can be manually edited by frequency or from the trace data or marker points.

- ■ Creating a Limit (Point by Point)
- ■ Creating a Limit (from Trace Data)
- ■ Creating a Limit (from marker data)
- ■ Creating a Limit (from marker data)
- ■ Delete Limit Line
- ■ Pass Fail Testing

4.2.1   **Creating a Limit (Point by Point)**

► **Description**

Create a limit manually, point by point. A maximum of ten points can be used.

► **Operation**

1   Press (Limit Line)> *Edit Select Limit[F1] > Limit Line [F1]* and choose a limit line.

Limit line: 1 ~ 5

2   Press *Point by Point[F2]*.

The **AE-166/167** is split into two screens. The top screen shows the trace and limit lines and the bottom screen shows the limit line table.

Spectrum display

Limit Line Table
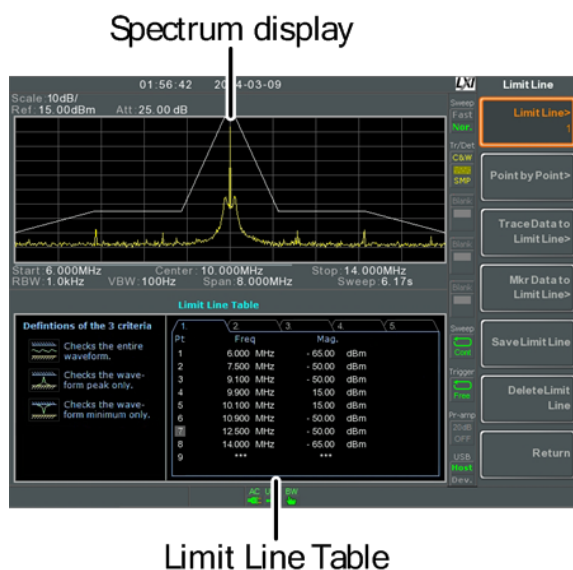
Figure 105.

3   Press *Point Num[F1]* and choose a point number to edit with the number pad (must start at #1).

4   Press *Frequency[F2]* and set the frequency of the point.

5   Press *Limit[F3]* and set the amplitude level of the point.

All the points will be displayed in a limit line table at the bottom of the display.

6   Repeat steps 3-5 for the remaining points (maximum of 10points. Points can only be created in numerical order).

7   To delete the selected point, press *Delete Point[F6]*.

8   Press *Return[F7] > Save Limit Line[F5]* to save the currently selected limit line.
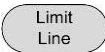
NOTE: Note that the limit lines are automatically sorted by frequency (low → high).

| 4.2.2 | | **Creating a Limit (from Trace Data)** |

▶ **Description**

Trace data can be used to create limit lines. A 10 point limit line is created from the trace data at each grid division as well as the start and stop frequencies.

▶ **Operation**

1   Press (Limit Line) *> Edit Select Limit[F1] > Limit Line [F1]* and choose a limit line.

Limit line: 1 ~ 5

2   Press *Trace Data to Limit Line[F3]*.

The **AE-166/167** is split into two screens. The top screen shows the trace and limit lines and the bottom screen shows the limit line table.
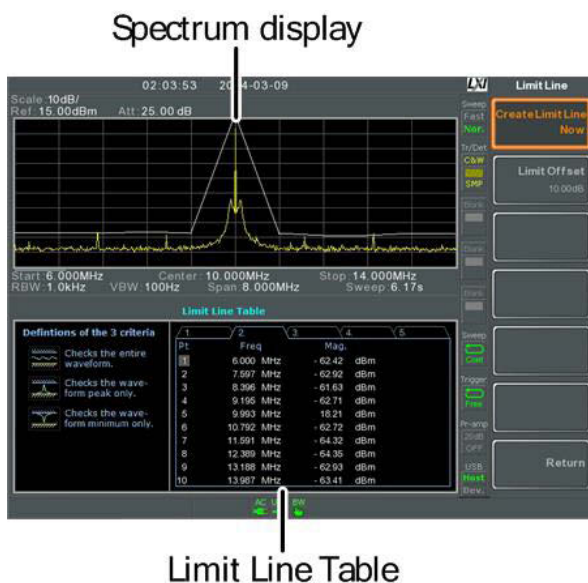
Figure 106.

3 Press *Limit Offset[F2]* and set an offset level.

4 Press *Create Limit Line Now[F1]*.
- A limit line will automatically be created based on the trace and offset level.
- A limit line can be created any number of times.

5 Press *Return[F7] > Save Limit Line[F5]* to save the currently selected limit line.

4.2.3	Creating a Limit (from Marker Data)

► **Description**

Marker data can be used to create limit lines. Please see the marker chapter for details on markers. A maximum of 10 points can be created.

► **Operation**

1 Press (Limit Line)*> Edit Select Limit[F1] > Limit Line [F1]* and choose a limit line.

Limit line: 1 ~ 5

2 Press *Mkr Data to Limit Line[F4]*.
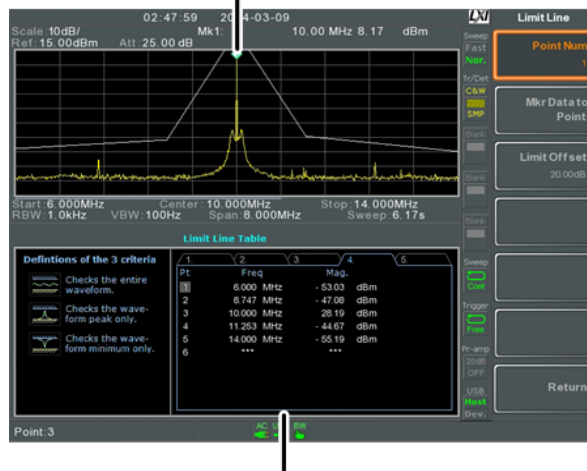
The **AE-166/167** is split into two screens. The top screen shows the trace and limit lines and the bottom screen shows the limit line table.

Figure 107.

3 Press *Point Num[F1]* and choose a point number to edit (must start at #1).

4 Press *Limit Offset[F3]* and set the offset level for the point.
- This will only create an offset for the currently selected point, not all the points.

5 Press *Mkr Data to Point[F2].*This adds the currently active marker's position to the selected point.

6 The marker position can be moved at this point using the scroll wheel. Press the Enter key to set the position.

7 Repeat steps 3-6 for any other points (max 10).

8 Press *Return[F7] > Save Limit Line[F5]* to save the currently selected limit line.

NOTE:	Using this function will also change the position of marker 1 outside of the limit function.
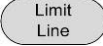
| 4.2.4 | | **Delete Limit Line** |

► **Description**

Any one of the 5 limit lines can be deleted.

► **Activate Correction**
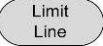
1   Press (Limit Line)> *Edit Select Limit[F1] > Limit Line[F1]* and choose a limit line (limit line 1~5) to delete.

2   Press *Delete Limit Line[F6].* The data from the chosen limit line will be deleted.

| 4.2.5 | | **Pass Fail Testing** |

► **Description**

Before pass/fail testing can begin, limit lines for the upper and lower limits must first be saved.

► **Operation**

1   Press (Limit Line)> *Pass/Fail Test*.

2   To set a high limit, press *High Limit[F1]* and choose one of the limit lines as the upper (high) limit.

3   To set the low limit, press *Low Limit[F2]* and select one of the limit lines as the lower limit.

4   Press *Pass Criterion[F3]* and select the pass criteria.

     Criteria: All-In, Max-In, Min-In

5   Press *Pass/Fail Mode[F5]* to select what the **AE-166/167** will do on a fail judgment. Single will stop testing after a single fail. Continue will continue testing after each fail judgment.

     Pass/Fail Mode: Single, Continue

6   Press *Pass/Fail Test[F4]* and turn the testing on.

7   The test result appears in the bottom of the display, and the high and low limit lines (if enabled) appear on the display.

     Pass: `PASS` , with green grid border.

     Fail: `FAIL` , with red grid border.

► **Display Icon**

The alarm icon is shown at the bottom of the display whenever testing is turned on.

► **Example**
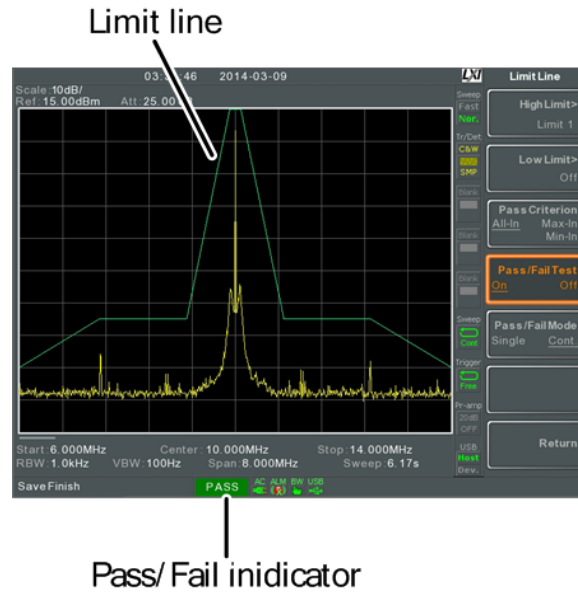
Figure 108.

NOTE: ⚠️	At least one limit line (high or low) must be turned on to enable testing.
	If the high limit or low limit is turned off, the maximum or minimum* display level is set automatically as the high or low limit, respectively.
	* +30 dBm + Ref level offset or -150 dBm + Ref level offset

4.3   Sequence

The Sequence function records and plays back user-defined macros. There are up to 5 sequences available in repeat or single running mode, with up to 20 steps each. Delays and pauses can also be introduced into a sequence to view measurement results during a sequence. Sequences can also call other sequences to create longer sequences.

The sections below can be used to skip to the relevant section:
- Edit Sequence
- Run Sequence

4.3.1   Editing a Sequence

► **Edit a Sequence**

1   Press (Sequence)> *Sequence[F1]* and choose a sequence to edit/create.

Sequence: 1 ~ 5

2   Press *Edit[F2] > Start Edit[F1]* to start editing the selected sequence.

3   The display splits into two screens. The top screen shows the main screen. The bottom screen shows the Sequence Editor with the sequence steps.
- The ● **Start Edit** icon appears in the sequence editor window.
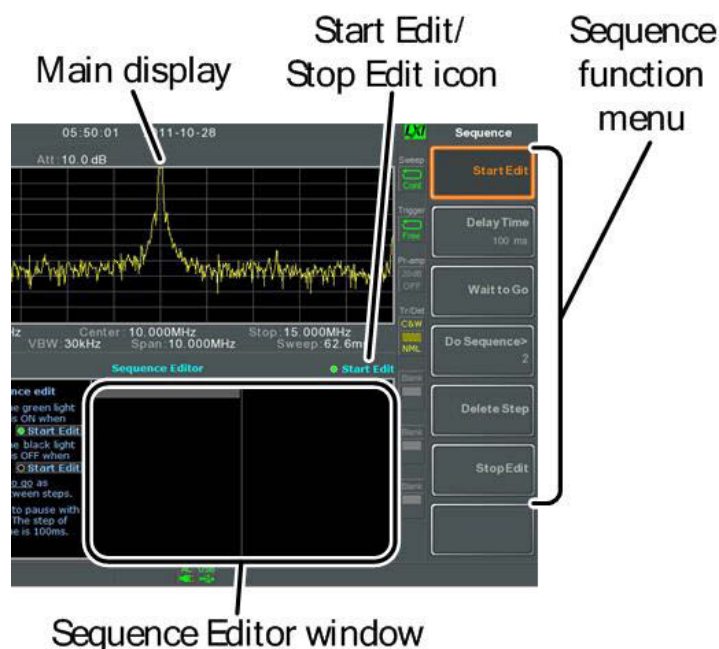
Figure 109.

► **Add a Step**

Up to 20 steps can be added to each sequence. Each panel operation is recorded as a step.

After each panel operation is performed, press (Enter) the key to record the step (in some cases this is not necessary – check if the operation appears in the sequence editor window).

In the following example the center frequency and span are added as steps to a sequence:

1   Press (Frequency)> *Center Freq[F1] > 20 MHz >* (Enter).

2   Press (Span)> *Zero Span[F3] >* (Enter).

3   The two operations are added to the Sequence Editor.
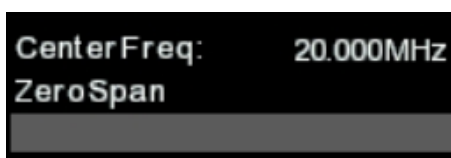
Figure 110.

4   Press the (Sequence) key again to return to the sequence function menu.

> **NOTE:** ⚠️   The arrow keys can be used to move the cursor to the desired step when in the *Sequence* menu.

► **Add Delay to Sequence**

The delay function adds a delay between steps.

1   Press *Delay Time[F2] >* and enter the delay time.

    Range: 100 ms ~ 10 s

2   Press (Enter) to add the delay time to the sequence editor.

    ▪ The delay time will be inserted as a step.

Figure 111.

> **NOTE:** ⚠️   The arrow keys can be used to move the cursor to the desired step.

► **Pause Sequence**

The Wait to Go function is used to pause a sequence until Continue[F1] is pressed. This is useful for observing measurements before moving onto the next step.

1 Press *Wait to Go[F3] >* (Enter).

- ■ Wait to Go will be inserted as a step.

CenterFreq: 20.000MHz
ZeroSpan
Wait to go

Figure 112.

2 When a sequence is running, Press *Continue[F1]* to resume running the sequence.

► **Insert Sequence**

Inserts another sequence into the current sequence.

Press *Do Sequence[F4] >* and select a sequence to insert into the current sequence.

- ■ The selected sequence will be inserted as a step.

CenterFreq: 20.000MHz
Sequence: 2
ZeroSpan
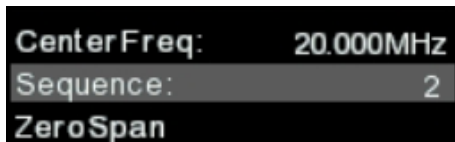
Figure 113.

NOTE:

The current sequence cannot be inserted into itself.

► **Delete Step**

Any step in the Sequence Editor can be deleted.

1 Use the arrow keys on the front panel to highlight the step you wish to delete.

CenterFreq: 20.000MHz
Span: 10.000MHz
RefLevel: 0.00dBm
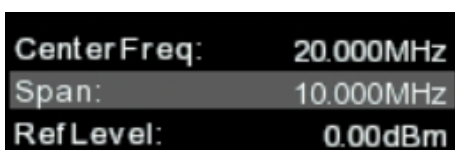
Figure 114.

2   Press *Delete Step[F5]* > to delete the step.

- The selected step will b removed from the Sequence editor.
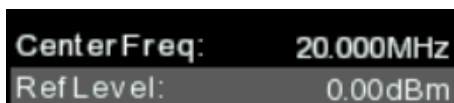
Figure 115.

► **Stop Editing**

1   Press Stop Edit[F6].

2   The **Start Edit** icon turns off.

► **Save Current Sequence**

After a sequence has been edited (and stopped) it can be saved.

1   Press (Sequence)> *Save Sequence[F4]* > to save the sequence.

2   The selected sequence will be saved.

► **Delete Current Sequence**

Press (Sequence)> *Delete Sequence [F5]* > to delete the current sequence.

4.3.2		**Running a Sequence**

► **Run Mode**

1   Press (Sequence)> *Sequence[F1]* and choose a sequence.

2   Press *Run Mode[F6]* and toggle the run mode:
- **Single:** Runs the sequence once only.
- **Cont.** Runs the sequence continually until Stop *Running Sequence[F7]* is pressed (Note: the Stop *Running Sequence[F7]* option only appears when the sequence is running).

► **Run Sequence**

3   Press *Run Now[F7]* to start running the selected sequence.

4   Press *Stop Running Sequence[F7]* to stop the sequence.
- In single mode the sequence will stop running when all steps have finished.

4.4 Traking Generator (only for AE-167)

The tracking generator is a factory installed option that generates a sweep signal with its sweep time and frequency range matching the **AE-166/167**. The amplitude is maintained at a constant value over the entire frequency range. This is useful for testing the frequency response of a DUT.

- Activate the Tracking Generator
- Normalize the Tracking Generator

4.4.1 Activate Tracking Generator

► **Operation**

1 Press (Option Control) > *Tracking Generator[F1] > TG[F1]* and toggle the tracking generator on.

The TG OUTPUT will be activated.

2 Press *TG Level[F2]* to set the output level of the tracking generator.

Range: -50 to 0 dBm

3 Press *TG Lvl Offset[F3]* to set the offset level of the tracking generator to compensate for system gain/loss.

Range: 0 dB to 50 dB

4 Press *TG Lvl Step[F4]* to set the step resolution of the TG level.

Range: Auto, Man; 0.5 to 50 dB, 0.5 dB step

5 Press *Power Sweep[F5]* to vary the output power of the TG to the rate of the sweep. At the beginning of the sweep, the output power is at the set TG Level and increases/decreases linearly to the set Power Sweep level at the end of the sweep.

Range: -5 dB to +5 dB

4.4.2   **Normalize the Tracking Generator**

► **Background**

The normalize function subtracts the trace after each sweep with a reference trace. The resultant trace is added to a normalized reference level.

► **Connection**

When normalizing the TG output, connect the TG output directly to the RF input.

After normalization, connect the DUT to the tracking generator and connect the output of the DUT to the RF input.
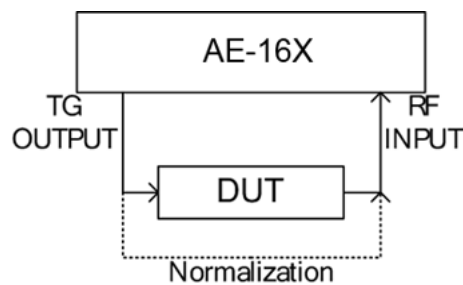
Figure 116.

► **Operation**

1   Press (Option Control)> *Tracking Generator[F1] > TG[F1]* and toggle the tracking generator on.

2   Press *Normalize[F6]* to enter the Normalization menu.

3   Press *Norm. Ref. Level[F2]* to set the vertical level of the normalized reference.

    Range: -100 dB ~ 100 dB

4   Press *Norm. Ref. Position[F3]* offsets the normalized trace on the screen.

    Range: 10 ~ 0 grid divisions. (top to bottom)

5   Press *Norm.[F4]* to toggle the normalized data on/off.

    Alternatively, press *Exe. Norm.[F1]* to perform the normalization again.
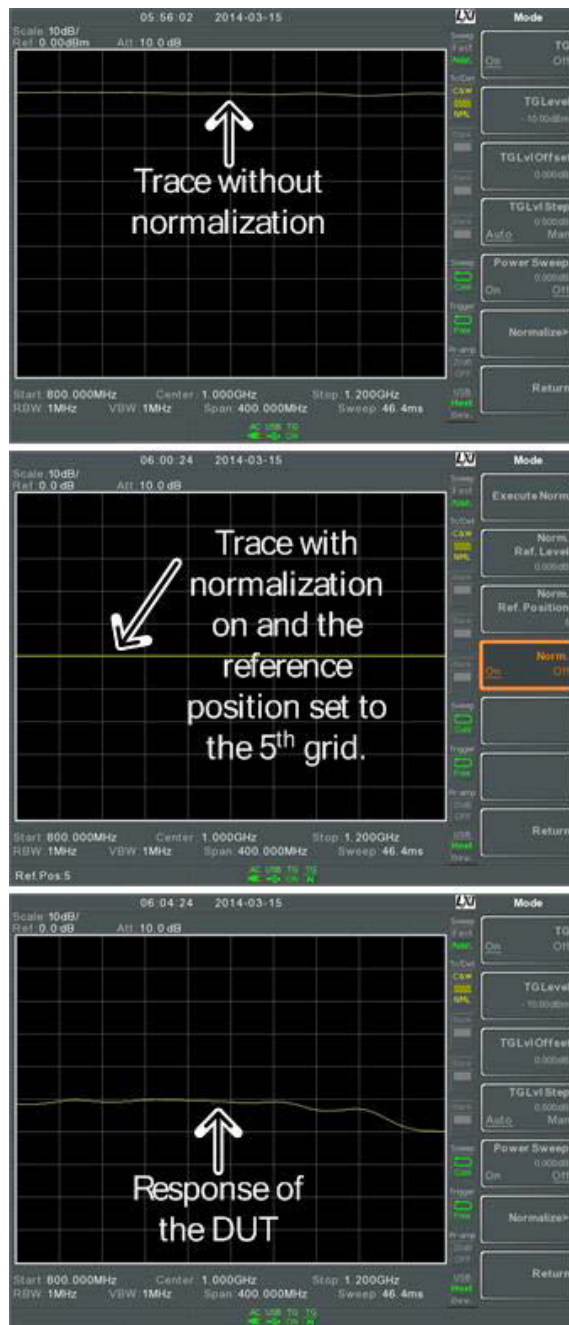
Figure 117.

NOTE: ⚠️	The normalized data will be turned off automatically if any X-axis related parameters are changed or if the TG output level is changed.
	The warning message, "Execute Normalization again!" will appear under these circumstances.

4.5 | Power Meter

When using the optional power meter, the AE-16X can measure and log the average signal power level of a DUT from -32 dBm ~ +20 dBm over an operating frequency range of 1 MHz to 6.2 GHz.

■ Activating Power Meter Mode
■ Data Logging Power Meter Measurements

4.5.1 | Activating Power Meter Mode

► **Connection**

1 Connect the power sensor to the front panel USB A port on the AE-166/167.

2 Connect the RF source to the power meter.
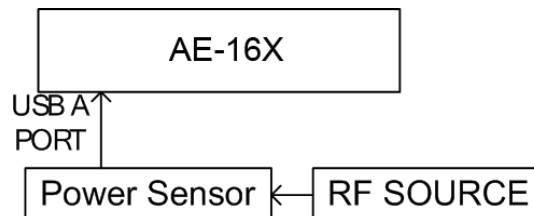
Figure 118.

► **Operation**

1 Press (Option Control) > *Power Meter[F2] > Power Meter[F1]* and toggle the power meter on.

NOTE: ⚠	The power meter option will not be available if the power meter is not connected properly.

2 The display splits into two screens. The top screen shows the power measurement in dBm or W. The bottom screen shows a graph of the measurements.

Power meter bar

Power meter measurement

Data log of power measurements
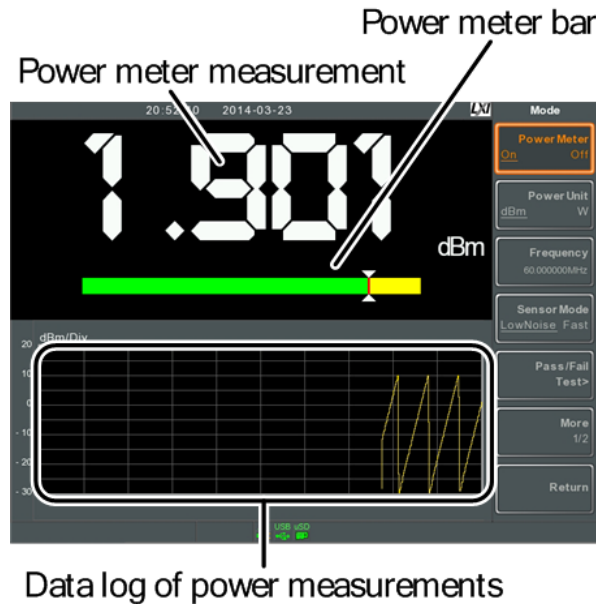
Figure 119.

3 Press *Power Unit[F2]* and choose the unit:

Unit: dBm, W

4 Press *Frequency[F3]* choose measurement frequency (use the number pad):

Frequency: 1 MHz ~ 6200 MHz

Resolution: 1 MHz

5 Press *Sensor Mode[F4]* to choose measurement speed (and thus accuracy) of the power meter:

Low Noise: 100 ms/sample, typical

Fast: 30 ms/sample, typical

6 To create pass fail tests, press *Pass/Fail Test[F5]* and set the following parameters:

High Limit[F1]:   -30 dB m ~ 20 dBm

Low Limit[F2]:   -30 dBm ~ 20 dBm

Pass/Fail Test[F3]: On, Off

Pass Icon: PASS

Fail Icon: FAIL

7 Press *More[F6] > Trigger[F1]* to toggle between a free run (internal) trigger and an external trigger.
- Trigger: Free, Ext
- Ext trigger input: 3.3 V CMOS

TRIG IN

GATE IN

8 Press *More[F6] > MAX/MIN HOLD[F2]* to toggle the MAX/MIN hold measurements on/off in the power meter bar.

- The MIN/MAX measurements will be displayed in the power bar meter in the center of the screen.

MIN HOLD measurement   MIN HOLD measurement

Figure 120.

NOTE: The return to the normal Spectrum Mode, turn the power meter off by pressing (Option Control) *> Power Meter[F2] > Power Meter[F1]* and toggle the power meter off.

| 4.5.2 | **Data Logging Power Meter Measurements** |

▶ **Description**

When in Power Meter mode, the spectrum analyser is able to log the power meter measurements over a user-defined time period at user-defined intervals.

▶ **Operation**

1 Press (Save) to enter the save menu.

2 Press *Type[F2]* and select *Power Meter[F7].*

3 *Data Source[F3]* will automatically be set to *Power State*.

4 Press *PMET Record Option[F4]* and set the recording options:
- *Record Stop[F1]:* Sets the recording time for automatic data logging: 00 :00 :00 (continuous) or 00 :00 :01 ~ 23 : 59: 59

- Record Step[F2]: 20 msec ~ 999 sec

5   Press *Save To[F1]* and select a destination source:

- ■ **Local:** Internal memory
- ■ **SD Card:** External micro SD card

NOTE:	The micro SD card option will only be available when a micro SD card is inserted into the front panel port.

6   After a destination has been selected, recording options appear.

7   To name the log file, press *Name[F1]*. Name the selected file using the F1 ~ F7 keys, as shown below or use the numeric keypad to enter numbers.
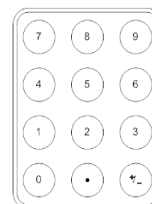
Limitations:

- ■ No spaces
- ■ Only 1~9, A~Z, a~z characters allowed
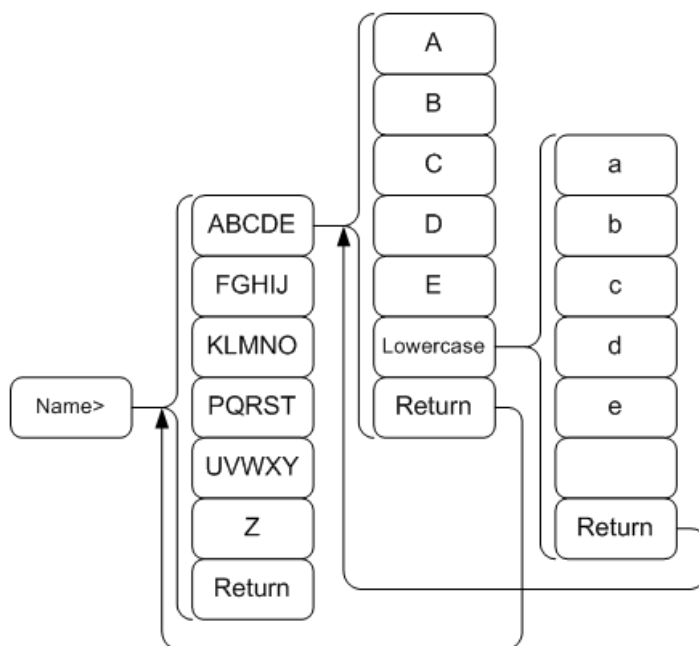
Figure 121.

8   The filename appears on the bottom of the screen as it is created.

Figure 122.

Press Enter to confirm setting the filename.

> **NOTE:** If the file name is not user-defined, a file name will be automatically created in the following format:
>
> File name: type_data source_file number.file extension
>
> The file number parameter is incremented each time the same file type is created.

9   To start recording power meter measurements, press *Record Now[F3]*.

A message "SaveFinish!!" will be displayed at the bottom of the screen when the recording has finished.

► **Stop Recording**

To manually stop the recording, press *Record Stop[F2]*.

5 FILE

5.1   File Overview

The File function is used for basic file related operations including navigation, sorting copying and deleting. The **AE-166/167** has a number of different file formats for trace data, limit lines, amplitude correction, sequences and other panel operations. File source and destination locations (local, USB or micro SD) can also be chosen with the file function.

- ■ File Type Overview
- ■ File Types
- ■ Using the File Explorer
- ■ Copy Files
- ■ Move Files
- ■ Delete Files
- ■ Rename Files
- ■ Save Files
- ■ Recall Files
- ■ Quick Save

5.1.1   File Type Overview

► **Local**

The **AE-166/167** has 16 MB of local memory to save data to.

► **USB**

The **AE-166/167** can save to an external USB flash memory drive.

USB Type: 1.1/2.0 (FAT32 and NTFS formatted)

► **Micro SD**

The **AE-166/167** can save to a micro SD card.

Format: SDSC, SDHC (FAT32 formatted)

5.1.2 | File Types

► **Overview**

The file types are listed in order as shown in the File menu.

► **State**

State data contains the state of the each of the panel operations:

- Frequency
- Span
- Amplitude
- BW/AVG
- Sweep
- Trace
- Display
- Measure

- Limit Line
- Sequence
- Trigger
- Marker
- Marker ▶
- Peak Search
- Preset
- System

► **Trace**

Trace data contains the trace data in comma separated values.

- Center frequency
- Span
- Resolution Bandwidth
- Video Bandwidth
- Reference Level
- Sweep Time
- Point number (trace data points)

► **Screen**

Contains the JPEG file of the display (800 X 600).

► **Limit Line**

The limit line data contains the following in comma separated values:

- Point number
- Frequency value of point
- Magnitude of point
- Magnitude unit

► **Correction**

Correction data contains the following correction (line) data:

- Point number
- Frequency value of point
- Gain offset of point
- Unit

► **Sequence**

The sequence files contain the sequence number and step operations for that sequence. This data is not designed to be user editable.

► **Tracking Generador**

- The TG data contains:
- TG level
- TG level offset
- TG level step
- Power sweep state and value
- Normalized reference level
- Normalized reference position
- Normalized state

► **Power Meter**

- The power meter data contains:
- Date
- Time
- Power in dBm
- Start time/end time
- Step time

5.1.3		**Using the File Explorer**

► **Connect External Memory**

To view files on a USB flash drive or micro SD card, insert the appropriate device into the front panel port.

► **Selecting files**

1. Press (File) > File Explorer.

2. Select memory location:

   Local[F1]: ternal memory.

   USB[F2]: ont panel USB memory.

   SD Card[F3]: icro SD card.

3. The up/down arrow keys or the scroll wheel can be used to move up/down the file list.

4. The left/right arrow keys can be used to move to the next/previous page of files in the file list.
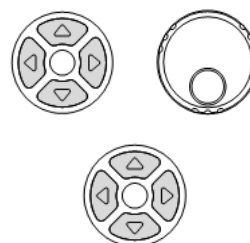
NOTE: The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

► **View Files by Type**

The file explorer can be configured to only view files of a certain type.

Press *Type[F2]* and select a file type to view:

- **All**: All file types can be viewed
- **State**: View state files only
- **Trace**: View trace files only
- **Screen**: View screen shots only
- **Limit Line**   : View limit lines only
- **Correction**: View correction data only
- **Sequence**: View sequence files only
- **Power Meter**: View power meter files only

After selecting a file type, only those types of files will be listed by the file explorer.

► **Sort Files**

Files can be sorted in ascending order by either name or by date. By default, files are sorted by name.

Press *Sort By[F3]* and choose the sorting type:

- **Name:** Sort by alphabetical order
- **Date:** Sort by file creation date

► **Preview Image Files**

Image files can be previewed on the screen by enabling the preview function. Press *More[F7] > Preview[F2]* and toggle preview on or off.

► **Example**

Figure 123.

> **NOTE:** When Preview is turned on, other file types will not be viewable.

5.1.4 **Copy Files**

► **Description**

Files from local memory can be copied to external memory such as a USB flash drive or micro SD card and vice versa.

► **Connect External Memory**

Insert either a USB flash drive or micro SD card into the front panel ports.

► **Selecting files**

1. Press (File) > File Explorer.
2. Select a file from local or external memory.
3. Press *Copy to [F4]*.
4. Press *Media [F1]* and select the destination to copy to (local, USB, SD card).
5. Press *Copy Now [F2]*.
6. The file is copied to the destination directory.

NOTE:	The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

5.1.5   Move Files

► **Description**

Files from local memory can be moved to external memory such as USB or micro SD card and vice versa.

► **Connect External Memory**

Insert either a USB flash drive or micro SD card into the front panel connectors.

► **Selecting files**

1. Press (File)> File Explorer.

2. Select a file from local or external memory.

3. Press *More [F7] > Move to [F1]* .

4. Press *Media [F1]* and select the destination to move to (local, USB, SD card).

5. Press *Move Now [F2]*.

6. The file is moved to the destination.

NOTE:	The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

5.1.6   **Delete Files**

► **Description**

Any files in local memory or external memory such as USB or micro SD card can be deleted.

► **Connect External Memory**

To delete files on a USB flash drive or micro SD card, insert the appropriate device into the front panel port.

► **Delete File**

1. Press (File) > File Explorer.
2. Select a file from local or external memory.
3. Press *Delete[F5]*.
4. Press *Delete Now[F1].*
5. By default you will be asked to confirm any files marked for deletion. Choose *No[F1]* to cancel or *Yes[F2]* to confirm the deletion.

► **Delete Warning**

To disable the prompt to confirm the deletion of a file, press *Delete Warning[F2]* and select an option:

- **Don't Ask:** The user won't be prompted to confirm when a file is deleted.
- **Ask:** Will prompt for the user to confirm whether to delete the file or not.

NOTE: ⚠️	The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

5.1.7   **Rename Files**

► **Description**

Any files in local memory or external memory such as USB or micro SD card can be renamed.

► **Connect External Memory**

To rename files on a USB flash drive or micro SD card, insert the appropriate device into the front panel ports.

► **Rename File**

1. Press (File)> File Explorer.

2. Select a file from local or external memory.

3. Press *Rename[F6]*.

4. Rename the selected file using the F1 ~ F7 keys, as shown below or use the numeric keypad to enter numbers:
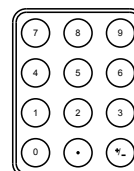
Limitations:
- ◾ No spaces
- ◾ Only 1~9, A~Z, a~z characters allowed
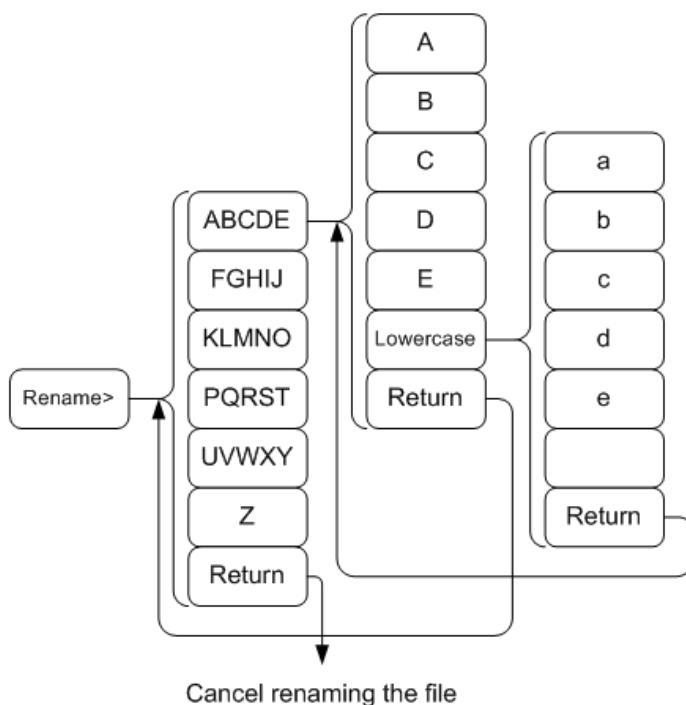
Figure 124.

5. The filename appears in the list as it is renamed.
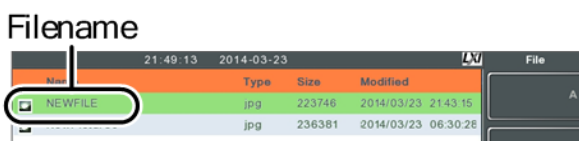
Figure 125.

6. Press (Enter) to confirm the renaming of the file.

> **NOTE:** The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

5.1.8 Save Files

► **Description**

Any function settings or configurations that have been applied to the spectrum analyser can be saved using the (Save) key.

► **Connect External Memory**

To save files on a USB flash drive or micro SD card, insert the appropriate device into the front panel ports.

> **NOTE:** To save power meter data (data logging). Saving power meter data will not be described in this chapter.

► **Save File**

1 Press (Save) to enter the Save menu.

2 Press *Type[F2]* and select a file type to save.
   - **State:** State data
   - **Trace:** Trace data
   - **Screen:** Screen shots
   - **Limit Line:** Limit line data
   - **Correction:** Correction data
   - **Sequence:** Sequence files
   - **Power meter**: Power meter data

3 Press *Data Source[F3]* to select a data source for the file type if possible:
   - **For state data:** Local state data (fixed, not selectable)
   - For trace data: Trace1~4
   - **For screen shots:** Normal: Screen shot is saved as is Save Toner: inverts the image file color to reduce ink when printing.
   - **For limit line:** Limit line 1 ~ 5
   - **For correction:** Correction data 1 ~ 5
   - **For sequence:** Sequence 1 ~ 5
   - For power meter: Power state

4   For trace data, press *Format[F4]* to select the format type to save:
- ▪ **Trace:** Save trace data only
- ▪ **Trace+State:** Save trace and state data

5   Press *Save To[F1]* and select a destination source:
- ▪ **Register 1~6:** Internal memory registers, these internal registers are not part of local memory.
- ▪ **Local:** Internal memory
- ▪ **USB:** External memory
- ▪ **SD Card:** External micro SD card

6   After a destination has been selected, the file can be named or saved immediately.

7   To name the selected file, press *Name[F5]*. Name the selected file using the F1 ~ F7 keys, as shown below or use the numeric keypad to enter numbers.:
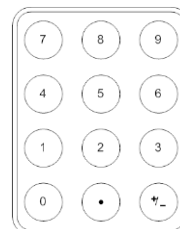
Limitations:
- ▪ No spaces
- ▪ Only 1~9, A~Z, a~z characters allowed
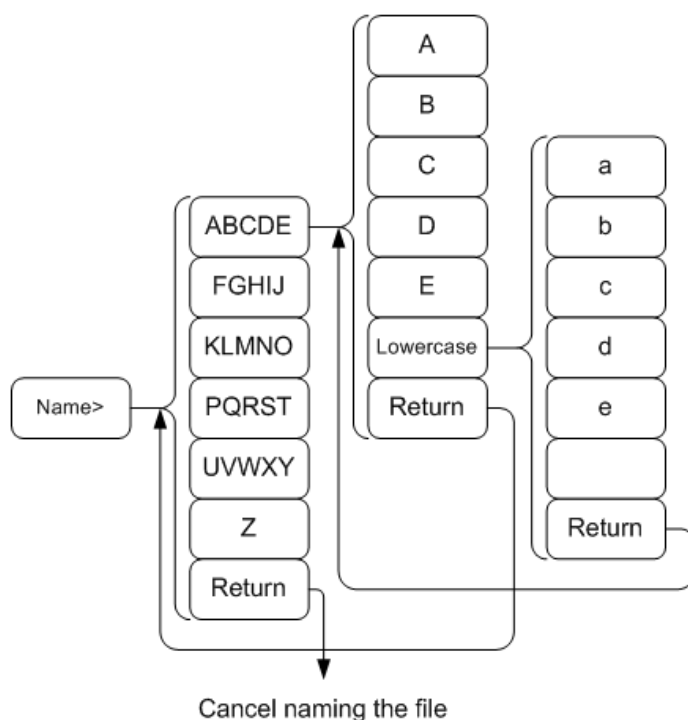
Figure 126.

8 The filename appears on the bottom of the screen as it is created.
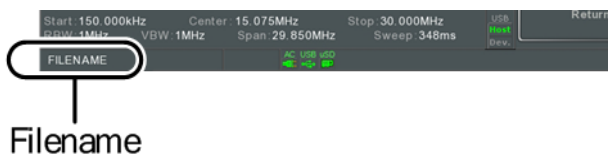
Figure 127.

9 Press (Save) to confirm the naming of the file.

NOTE:	If the file name is not user-defined, a default naming scheme will be used. See the note below for details.

10 To save the selected file type, press *Save Now[F7]*.

A message "SaveFinish!!" will be displayed at the bottom of the screen when the save is successful.

NOTE:	If the file name is not user-defined, a file name will be automatically created in the following format for data files:
	File name: Type_data source_XX.file extension
	The image file names will be automatically created in the following format:
	File name: QuickJpgX.jpg
	The X parameter is incremented each time the same file type is created.

NOTE:	The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.
	*The power meter option will only be available if the power meter option is plugged in. See the Power Meter section for power meter details.

5.1.9		**Recall Files**

► **Description**

Most files that have previously saved a setting or state can be recalled using the (Recall) key.

The exception to this are the data logging settings.

► **Connect External Memory**

To recall files from a USB flash drive or micro SD card, insert the appropriate device into the front panel ports.

1 Press (Recall) to enter the Recall menu.

2 Press *Type[F2]* and select a file type to recall.
- **State:** State data
- **Trace:** Trace data
- **Limit Line:** Limit line data
- **Correction:** Correction data
- **Sequence:** Sequence files

3 Press *Destination[F3]* to select the destination for the file type if possible:
- **For State data:** Local state data (fixed, not selectable)
- **For Trace data:** Trace1 ~ 4
- **For Limit Lines:** Limit line 1 ~ 5
- **For Correction:** Correction data 1 ~ 5
- **For Sequence:** Sequence 1 ~ 5

► **Recall File**

1 Press *Recall From[F1]* and select a source location:
- **Register 1~6:** Internal memory registers, these internal registers are not part of local memory.
- **Local:** Internal memory
- **USB:** External USB memory
- **SD Card:** External micro SD card

2 To Recall the selected file type, press *Recall Now[F4]*.

3 A message "Finish!!" will be displayed at the bottom of the screen when the recall is successful.

> **NOTE:** The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

5.1.10   Quick Save

► **Description**

The (Quick Save) key is a hot key to save files with a single press.

The type of file that is saved is pre-configured with the (Save) key.

By default, the (Quick Save) the key will save screen shots to the local memory or to an external flash drive (if inserted).

► **Supported File Types**

Screen, trace, state, limit line, correction, sequence, power meter*.

► **Connect External Memory**

To save files to a USB flash drive or micro SD card, insert the appropriate device into the front panel ports.

► **Quick Save Setup**

Press the (Save) key and configure the file Type, Data Source and Format.

► **Using the Quick Save key**

1 Press (Quick Save) at any time to save the selected file type using the settings above.

2 A "Save Finish!!" message will be shown at the bottom of the screen when the save has been completed.

NOTE: ⚠	The file name will be automatically created in the following format for data files:
	File name: Type_data source_XX.file extension
	The image file names will be automatically created in the following format:
	File name: QuickJpg_XX.jpg
	The XX parameter is incremented each time the same file type is created.

NOTE: ⚠	The USB and micro SD card options will only be available when a flash drive/SD card is inserted into the front panel ports.

*power meter accessory must first be installed before it can be saved.

6 REMOTE CONTROL

This chapter describes basic configuration of IEEE488.2 based remote control.

6.1 | Interface Configuration

6.1.1 | Configure to USB Remote Interface

▶ **USB configuration**
  - PC side connector: Type A, host
  - **AE-16X side connector:** Rear panel Type B, slave
  - **Speed:** 1.1/2.0 (full speed/high speed)
  - **USB Class:** USB TMC (USB T&M class)

▶ **Panel operation**

  1 Connect the USB cable to the rear panel USB B port.

  2 Press (System)> *More[F7] > RmtInterface Config[F1] > USB Mode* and toggle the USB mode to *Device*.

  > **NOTE:**
  > ⚠
  > It may take a few moments to switch USB modes.

6.1.2 | Configure the LAN Interface

The **AE-166/167** can be configured for remote control or monitoring over a LAN or WLAN. The **AE-166/167** supports HiSlip. HiSlip (High-Speed LAN Instrument Protocol) is an advanced LAN based standard for 488.2 communications.

▶ **Background**

The LAN interface is used for remote control over a network. The spectrum analyser supports DHCP connections so the instrument can be automatically connected to an existing network. Alternatively, network settings can also be manually configured.

► **LAN configuration Settings**

IP Address, Default Gateway, Subnet Mask, DNS Server, DHCP on/off.

► **Connection**

Connect an Ethernet cable from the network to the rear panel LAN port.

► **Settings**

1 Press (System) > *More[F7] > RmtInterface[F1] > LAN[F2] > LAN Config[F1]* to set the LAN settings:

- *IP Address[F1]*: Sets the IP address.
- *Subnet Mask[F2]*: Sets the subnet mask.
- *Default Gateway[F3]*: Sets the default gateway.
- *DNS Server[F4]:* Sets the DNS server address
- *LAN Config[F5]:* Toggles the LAN configuration between DHCP and manual settings.

  Hint: Use dotted decimal notation when entering IP addresses, ie., 172.16.20.8

2 Press *Apply[F6]* to confirm the LAN configuration settings.

► **Display Icon**

The LAN icon turns green when connected to a LAN and will flash if the "Identification".

► **Hi SLIP Port**

Press (System) > *More[F7] > RmtInterface Config[F1] > LAN[F2] > HiSLIPPort* to see the Hi Slip Port number.

HiSlip port 4880

► **Reset LAN**

It may be necessary to reset the LAN configuration settings before the LAN can be used.

1 Press (System) > *More[F7] > RmtInterface Config[F1] > LAN Reset[F3]* to reset the LAN.

2 It may take a few moments before the LAN is reset.

NOTE: ⚠	Each time the LAN is reset, the default password is restored.
	Default password: lxiWNpwd

6.1.3   Configure the WLAN Interface

The WLAN settings operate using any standard 3G USB modem. For remote locations, using a 3G modem allows you to access the **AE-166/167** web server or to control the **AE-166/167** via remote control commands.

► **Background**

To use the **AE-166/167** as a server using a 3G modem, you must first obtain a fixed IP address from a network provider. Each provider will assign different fixed IP addresses.

► **WLAN configuration Settings**

IP Address, Default Gateway, Subnet Mask, DNS Server

► **Connection**

Connect the 3G USB modem to the front panel USB A port.

The 3G status icon [3G USB] will appear when the 3G USB adapter is connected. When it is first connected it will be grayed-out to indicate that it is connected but not activated.
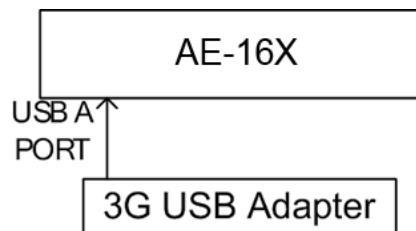
Figure 128.

▶ **Settings**

1 Insert the 3G USB modem into the front panel USB A port and wait for the 3G USB [3G/USB] icon to appear.

2 Press (System)> *More[F7] > RmtInterface[F1] > LAN[F2] > WLAN Config[F2] > Apply[F6]* and wait for the 3G USB modem to establish the WLAN settings.

"Finish!!", is shown when the configuration is complete.

3 The network settings will be displayed in the System menu icons.
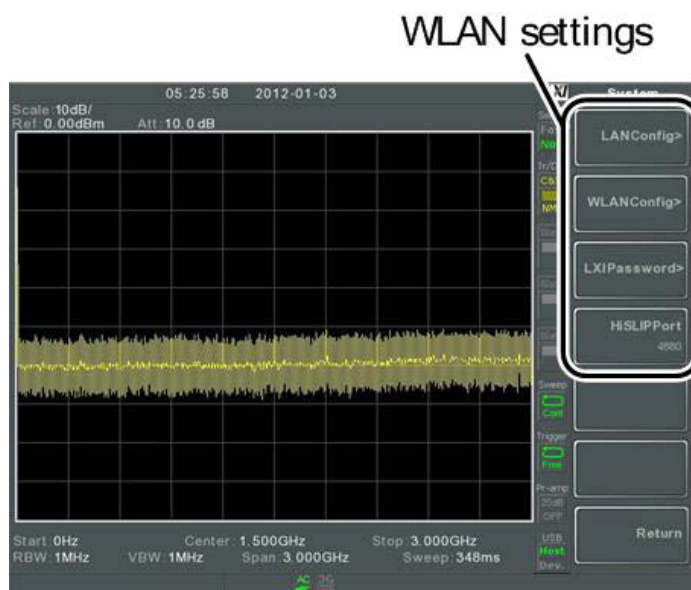
Figure 129.

▶ **Display Icon**

The 3G USB icon turns green when a successful connection has been made.

▶ **Hi SLIP Port**

8 Press (System)> *More[F7] > RmtInterface Config[F1] > LAN[F2] > HiSLIPPort* to see the Hi Slip Port number.

HiSlip port 4880

▶ **Reset LAN**

It may be necessary to reset the LAN configuration settings before the LAN can be used.

9 Press (System)> *More[F7] > RmtInterface Config[F1] > LAN Reset[F3]* to reset the LAN.

10 It may take a few moments before the LAN is reset.

> **NOTE:** Each time the LAN is reset, the default password is restored.
>
> Default password: lxiWNpwd

6.1.4   Configure RS232C

► **Background**

The RS232C interface is used for remote control with a PC.

► **RS232C Configuration settings**

Baud Rate, Stop bit: 1 (fixed), Parity: none (fixed), Data bit: 8 (fixed).

► **Connection**

Connect an RS232C cable from the PC to the rear panel RS232 port.
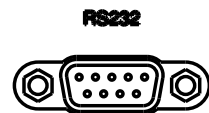
Press (System) > *More[F7] > RmtInterface Config[F1] > RS232 BaudRate[F4]* to set the baud rate.

300	**600**	**1200**	**2400**
4800	**9600**	**19200**	**38400**
57600	**115200**		

6.1.5   RS232C Remote Control Function Check

► **Functionality check**

Invoke a terminal application such as Realterm.

To check the COM port No, see the Device Manager in the PC. For WinXP; Control panel → System → Hardware tab.

Run this query command via the terminal after the instrument has been configured for RS232 remote control.

*idn?

This should return the Manufacturer, Model number, Serial number, and Firmware version in the following format.

PROMAX,AE-166 AES01,XXXXXXXX,V3.X.X.X

- Manufacturer: PROMAX
- Model number: AE-166 AES01
- Serial number: XXXXXXXX
- Firmware version: V3.X.X.X

6.1.6   Browser Interface and Function Check

► **Functionality check**

Enter the IP address of the spectrum analyser in a web browser after the instrument has been configured and connected to the LAN or WLAN.

http:// XXX.XXX.XXX.XXX

The web browser interface appears:

► **Welcome Page**

The Welcome Page lists all the LAN/WLAN configuration settings as well as the instrument identification. The instrument identification can be disabled from this page.

Figure 130.

► **View & Modify Configuration**

The View & Modify Configuration allows you to modify the LAN settings from the browser.

Press the *Modify Configuration* button to modify any of the configuration files.

A password must be entered to alter the settings.

Default password: lxiWNpwd

[Note: password is case sensitive.]
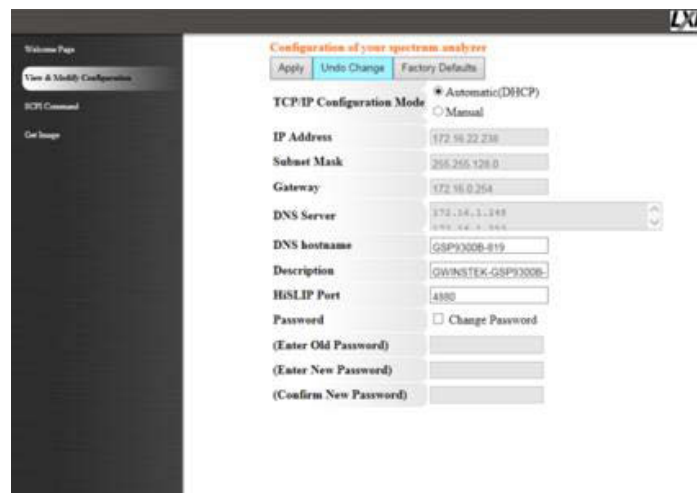
Figure 131.

NOTE: ⚠	If the "Factory Defaults" option is chosen, the password will be reset back to the default password
	It will also be necessary to manually reset the spectrum analyser when a message prompts you to do so on the web browser.

► **SCPI Command**

The SCPI Command page allows you to enter SCPI commands directly from the browser for full remote control. Please see the programming manual for details. A password must be entered before remote commands can be used.

Default password: lxiWNpwd

[Note: password is case sensitive.]

Figure 132.

► **Get Image**

The Get Image page allows the browser to remotely capture a screenshot of the **AE-166/167** display.
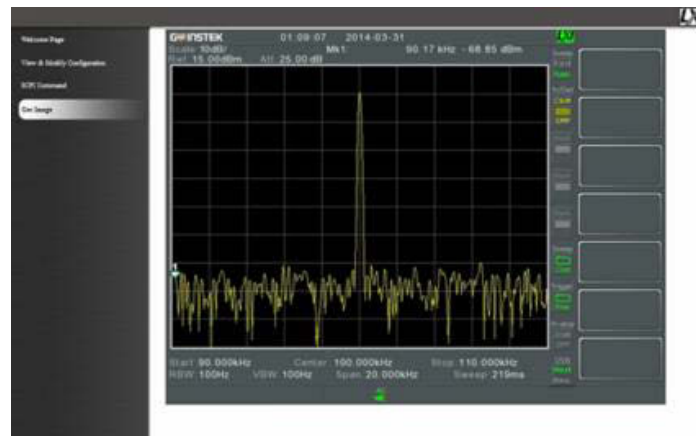
Figure 133.

6.1.7   GPIB/LAN/USB Control Function Check

► **Functionality check**

Please use the National Instruments Measurement & Automation Controller software to confirm GPIB/LAN functionality.

7 FAQ

I connected the signal but it does not appear on screen.

Run Autoset and let the AE-166/167 find the best display scale for your target signal. Press the Autoset key, then press Autoset[F1].

I want to see which optional items are installed.

Check the optional items in the system information window. Press the System key → System Information[F1].

The performance does not match the specification.

Make sure the device is powered On for at least 45 minutes, within +20°C~+30°C. This is necessary to stabilize the unit to match the specification.

8 APPENDIX

8.1   Replace the Clock Battery

► **Background**

The system clock and wake-up clock keep time using a button battery.

Battery type: CR2032, 3 V, 210 mAh

► **Connection**

1   Turn off the **AE-166/167** and remove the battery cover and battery (if connected).
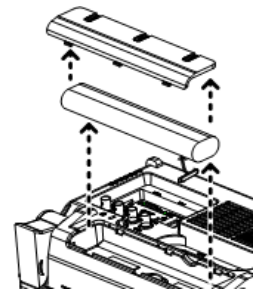
Figure 134.

2   Replace the battery with the same type and specification.
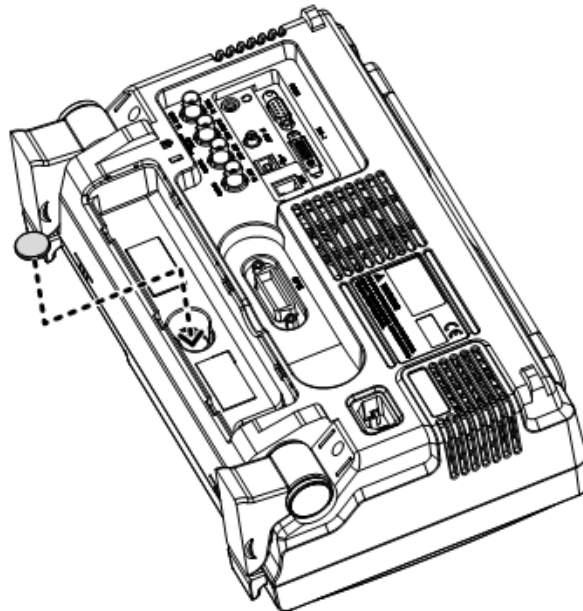
Figure 135.

8.2 | Glossary of Acronyms

Acronym	Definition
2FSK	Binary Frequency Shift Keying
3GPP	3rd Generation Partnership Project
ACPR	Adjacent Channel Power Ratio
BS	Base Station
CF	Center Frequency
CH BW	Channel Bandwidth
CH SPC	Channel Space
CISPR	International Special Committee on Radio Interference
CNR	Carrier to Noise Ratio
CSO	Composite Second Order
CTB	Composite Triple Beat
DANL	Displayed Average Noise Level
Def.	Default
DL	Down Link
DSSS-OFDM	Direct Sequence Spread Spectrum- Orthogonal Frequency Division Multiplexing
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMS	Electromagnetic Susceptibility
ERP-CCK	Extended Rate Physical layer- Complimentary Code Keying
ERP-DSSS	Extended Rate Physical layer- Direct Sequence Spread Spectrum
ERP-OFDM	Extended Rate Physical layer- Orthogonal Frequency Division Multiplexing
ERP-PBCC	Extended Rate Physical layer- Packet Binary Convolutional Code
ETSI	European Telecommunications Standards Institute
FDD	Frequency-Division Duplexing
IF	Intermediate Frequency
HiSLIP	High Speed LAN Instrument Protocol
LOI	Local Oscillator
LPF	Low Pass Filter
OCBW	Occupied Channel Bandwidth
PSD	Power Spectral Density

P1dB	One-dB compression point
RBW	Resolution Bandwidth
REF	Reference
SEM	Spectrum Emission Mask
SINAD	Signal to Noise and Distortion Ratio
TDD	Time-Division Duplexing
TG	Tracking Generator
TOI	Third Order Intercept
UE	User Equipment
UP	Up Link
VBW	Video Bandwidth

8.3 | AE-166/167 Default Settings

The following default settings are the factory configuration settings for the spectrum analyser (Function settings/Test settings).

Frequency		
	Center Frequency: 1.5 GHz	Start Frequency: 0 Hz
	Stop Frequency: 3 GHz	CF Step: Auto
	Frequency Offset: 0 Hz	

Span		
	Span: 3 GHz	

Amplitude		
	Reference level: 0.00 dBm	Attenuation: Auto
	Scale Div: 10	Scale: Off
	Y Axis: dBm	Scale Type: Log
	Reference level offset: 0.00 dBm	Correction: Off
	Input Z: 50 Ω	Input Z calibration: 6.000 Db
	Preamp: Bypass	

Autoset		
	Amp.Floor: Auto	Span: Auto

BW/AVG		
	RBW: Auto	VBW: Auto
	VBW/RBW: N/A	Average: Off
	Average Power: Log Power	EMI Filter: Off

Sweep		
	Sweep Time: Auto	Sweep: Continuous
	Gated Sweep Mode: Off	Gate Delay: 50 ms
	Gate Length: 540 ms	Sweep Control: Norm

Trace		
	Activated traces: trace 1	Trace Type: Clear and Write
	Trace Math: Off	Detection: Auto, Normal

Display		
	Window Setup: Spectrum	LCD Brightness: Hi
	LCD Backlight: On	Display Line, -50.0 dBm, Off

Meas	
	All measurement functions: Off

EMC Pretest	
	All EMC test functions: Off

Limit Line		
	Limit lines: Off	Pass/Fail Test: Off

Trigger		
	Free Run	Trigger Condition: Video
	Trigger Mode: Norm.	Trigger Delay: 50 ms

File		
	Type: All	Sort by: Name

Quick Save		
	Type: Screen	Data Source:Normal

Save		
	Type: Screen	Data Source:Normal

Recall		
	Type: State	Destination: Local State

Marker		
	Marker: Off	Data Source:Normal

Marker ▶	
	N/A

Peak Search		
	Peak Track: Off	Peak Excursion: 3 dB
	Peak Threshold: -50 dBm	Peak Table: Off

Mode	
	Mode: Spectrum

Sequence	
	Sequence Off

Option Control

| | Tracking Generator: Off | Power Meter: Off |

System

Language: region dependent   Power On: Preset

Preset Type: Factory Preset   Alarm Output: Off

Remote Interface Config
GPIB Address: 3
LAN: DHCP
HiSPIP Port:4880
RS232 BaudRate: 115200
USB Mode: Host

8.4 Menu Tree

8.4.1 Amplitude
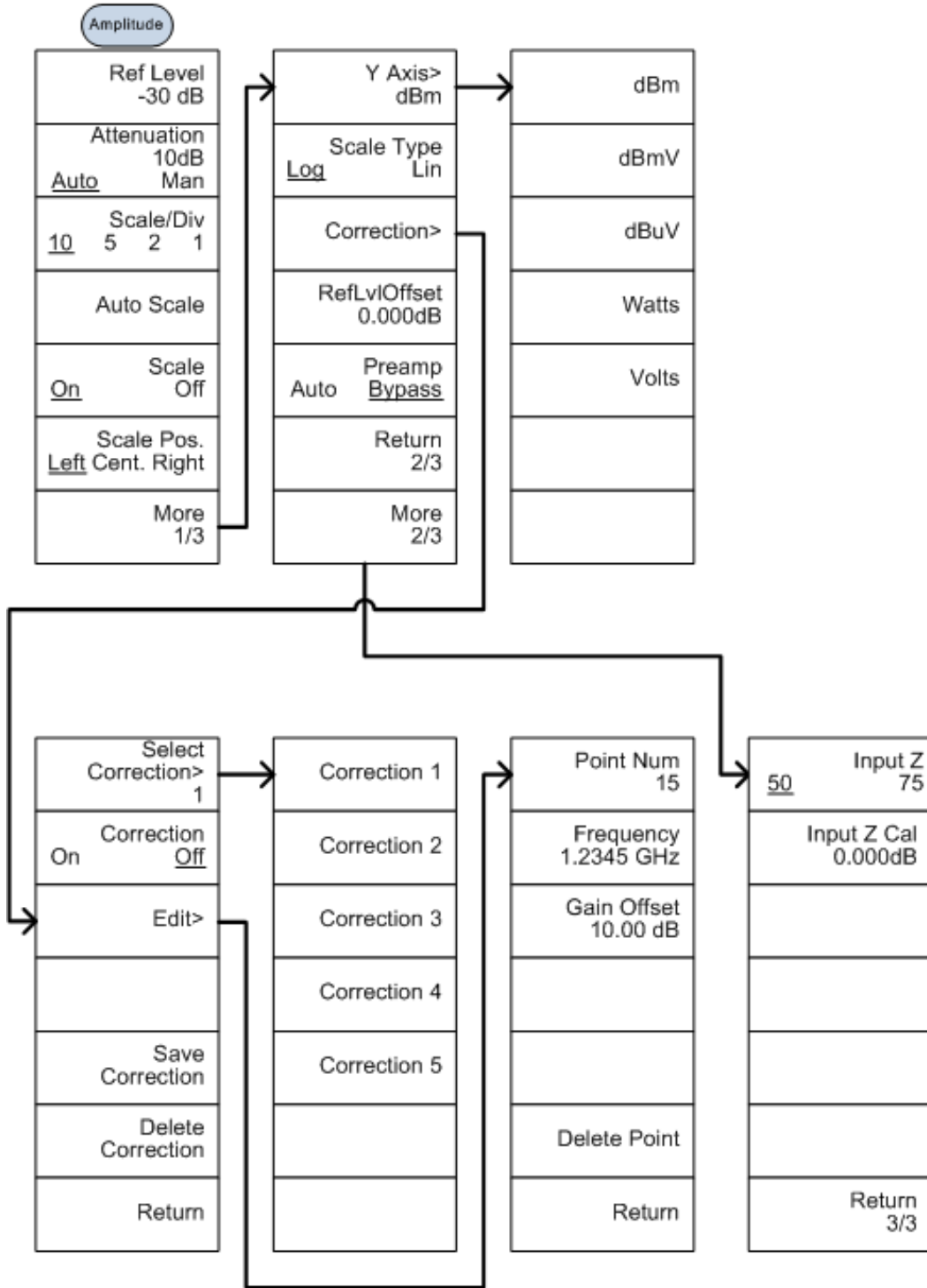
Figure 136.
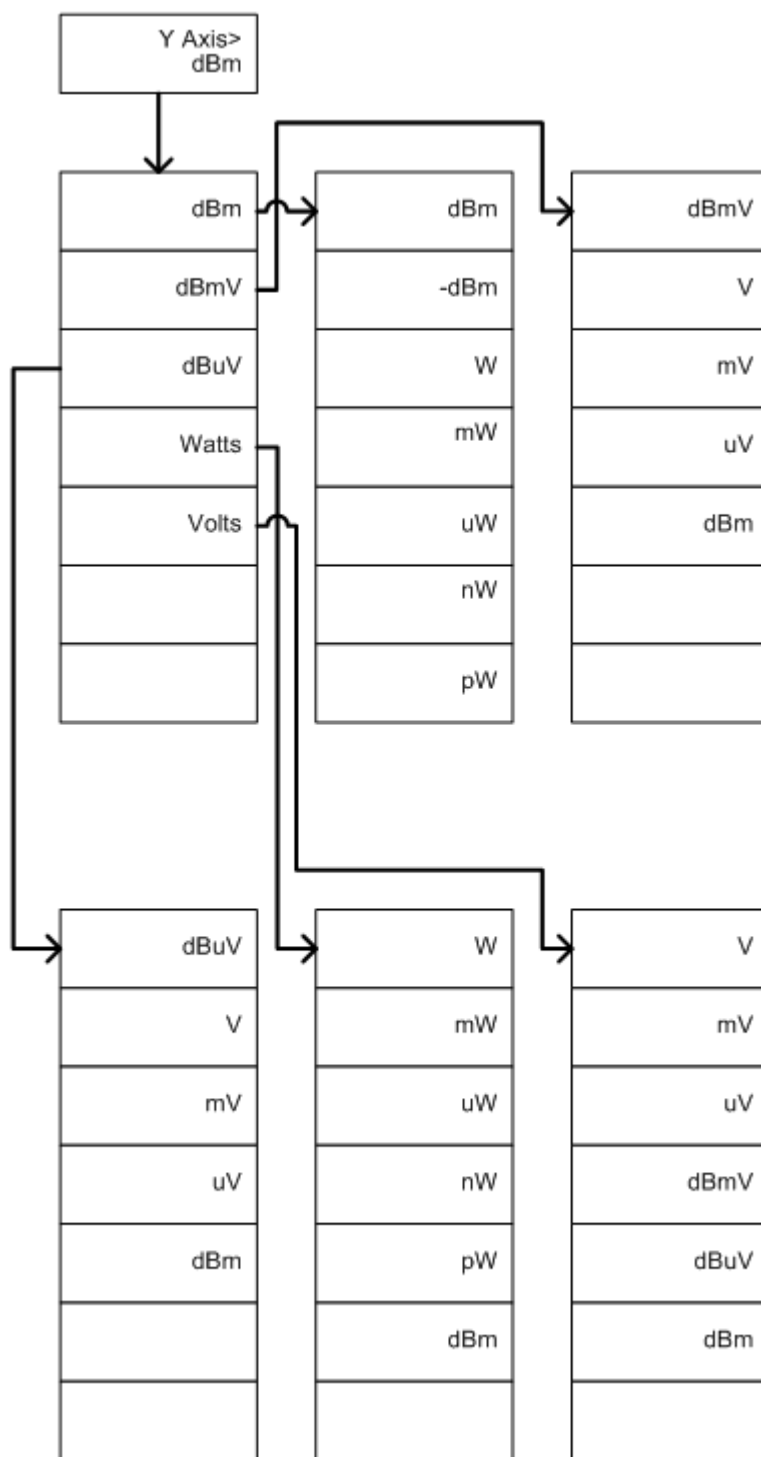
Figure 137.

8.4.2 **Frequency, Span, Autoset, BW Avg, Sweep**
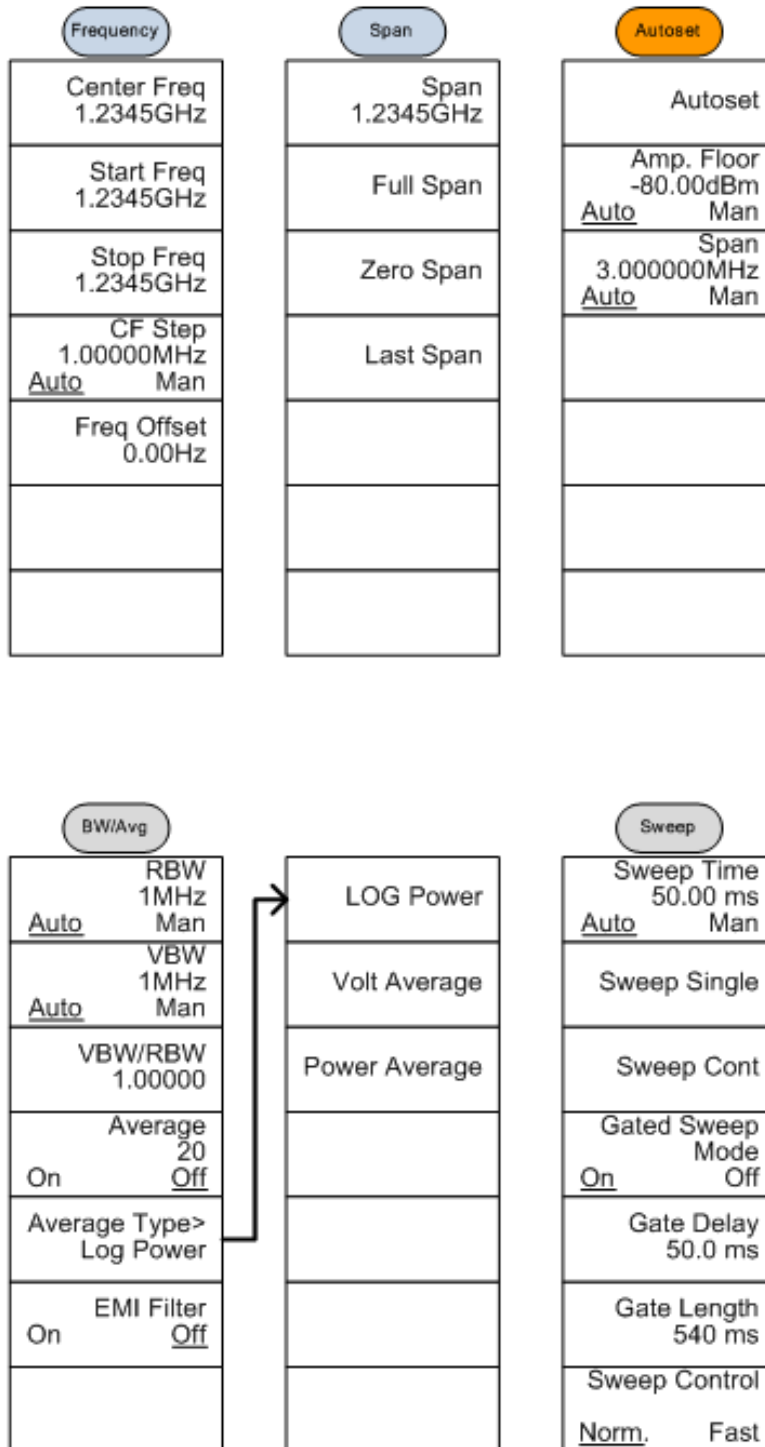
Figure 138.

8.4.3   **Limit Line**
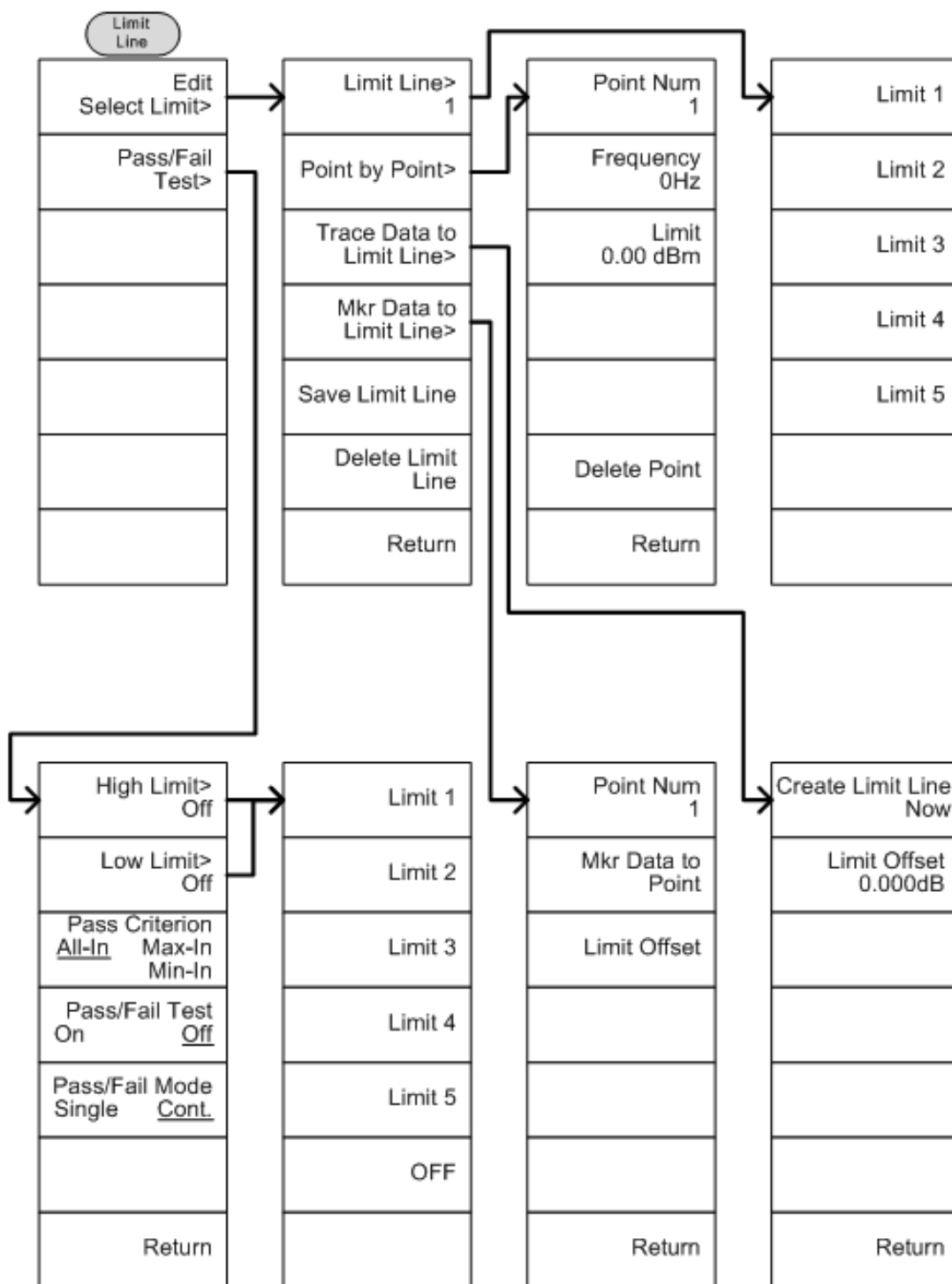
Figure 139.

8.4.4 Trigger, Sequence
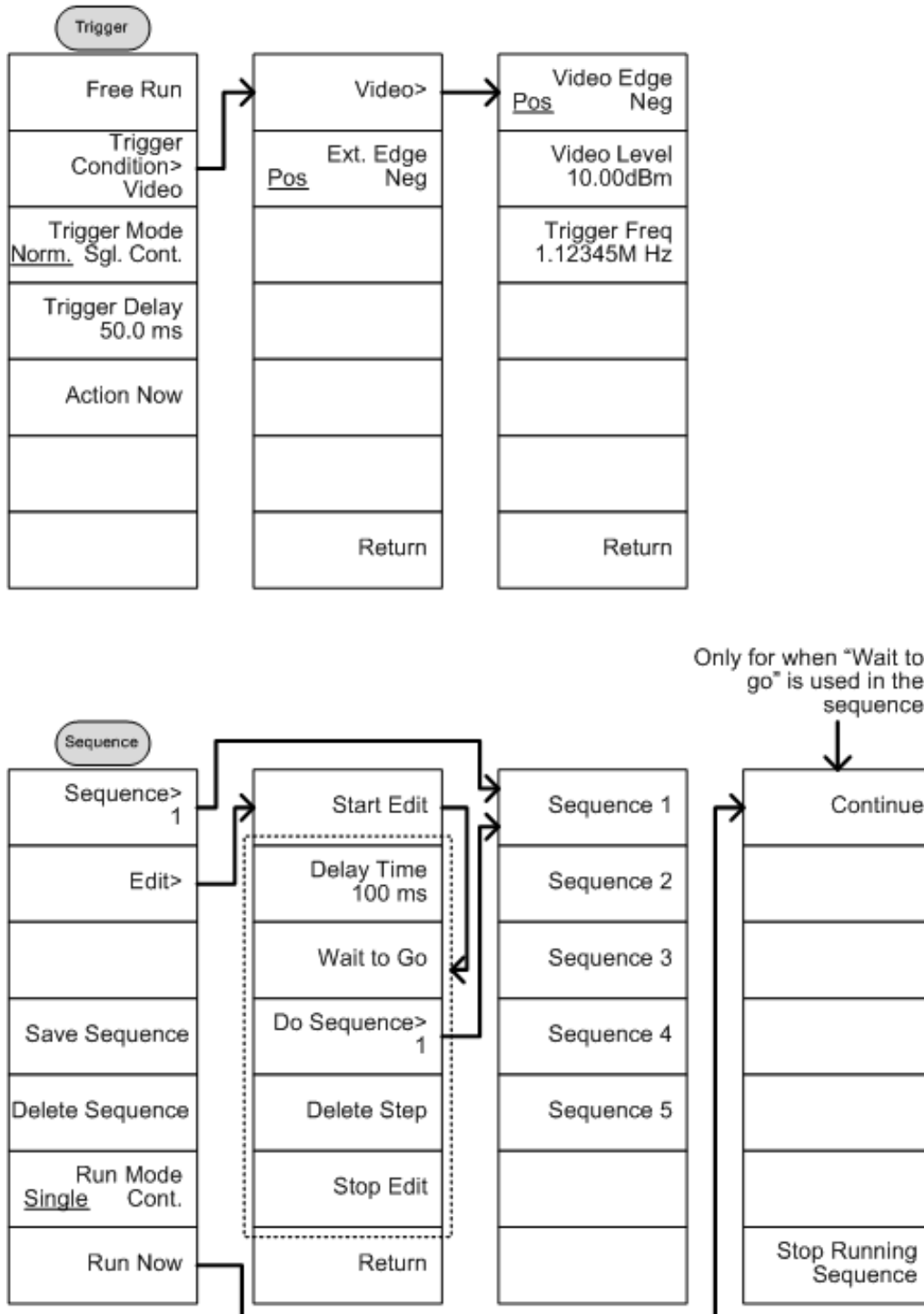
Figure 140.

8.4.5   **Trace**
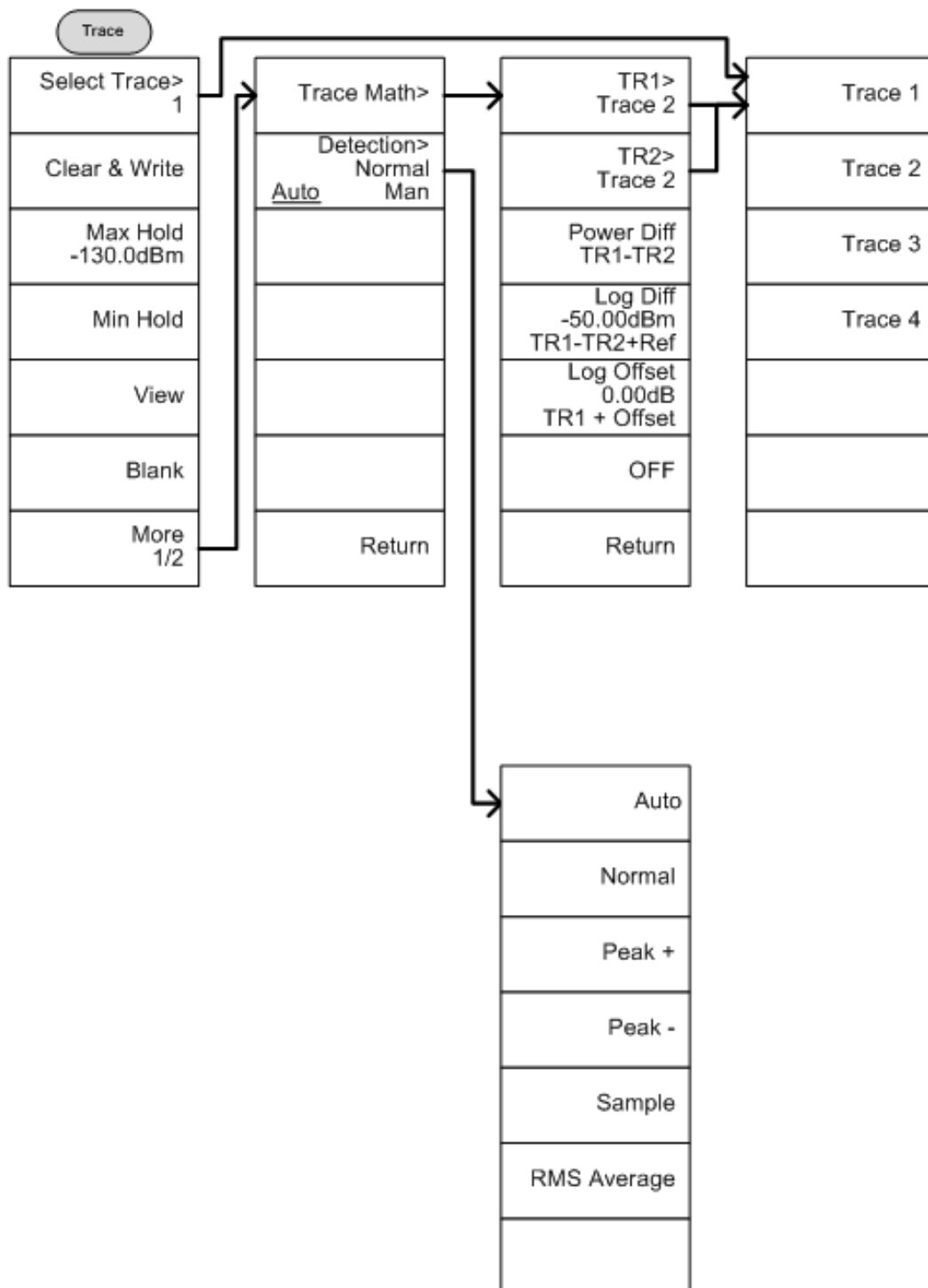
Figure 141.

8.4.6 **Display**
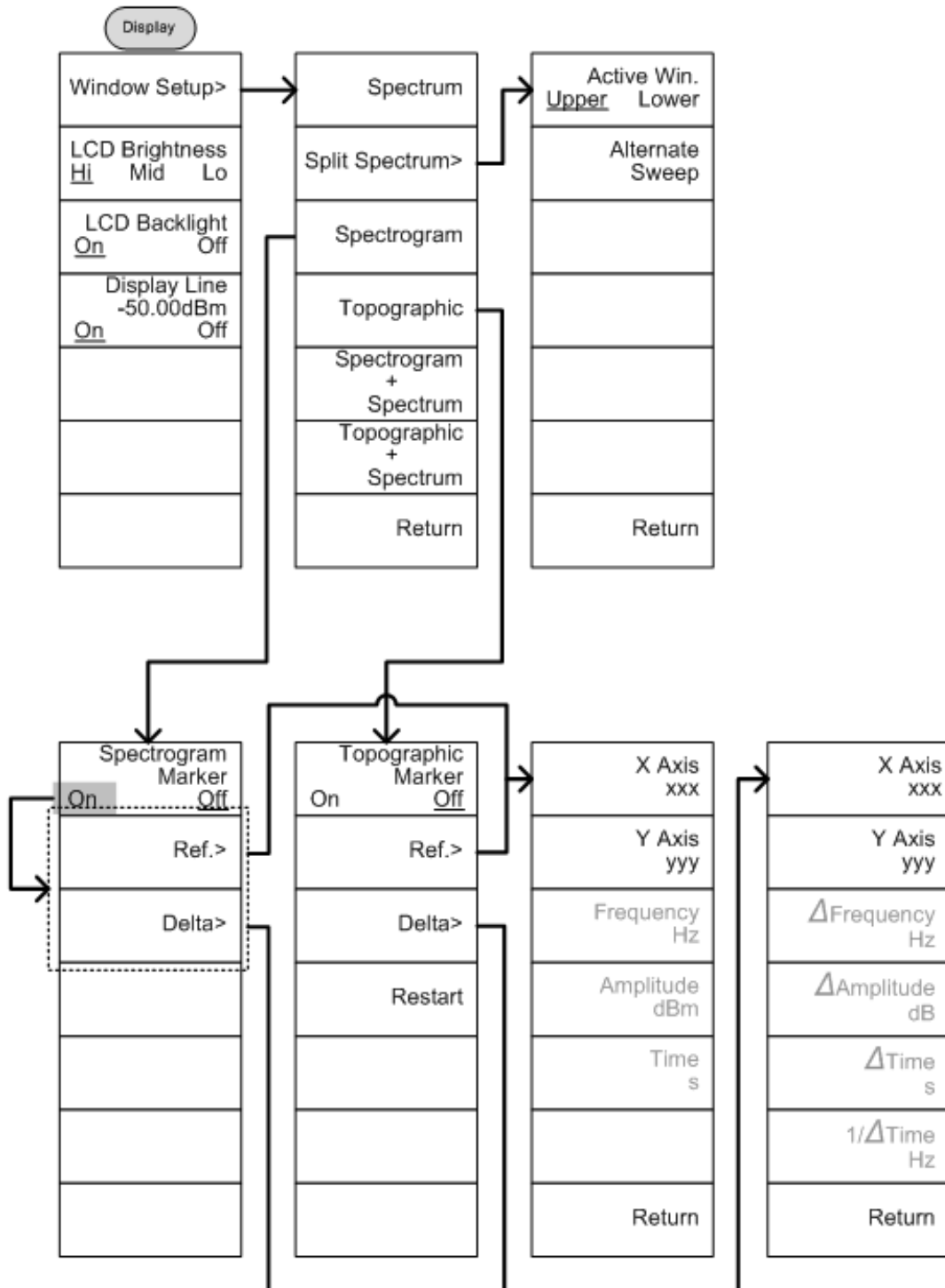
Figure 142.

8.4.7 **Marker**
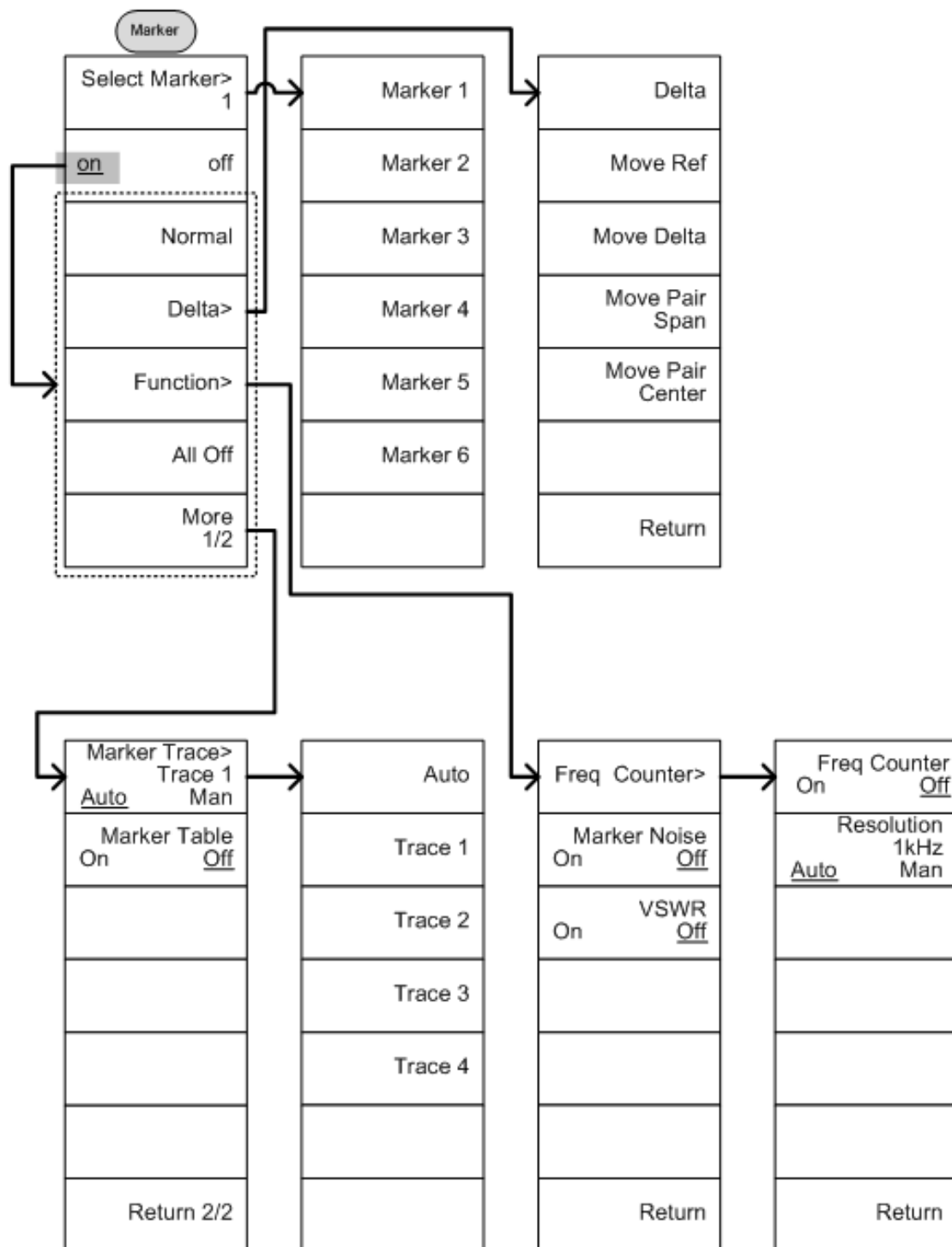
Figure 143.

8.4.8   **Peak Search, Marker ▶**
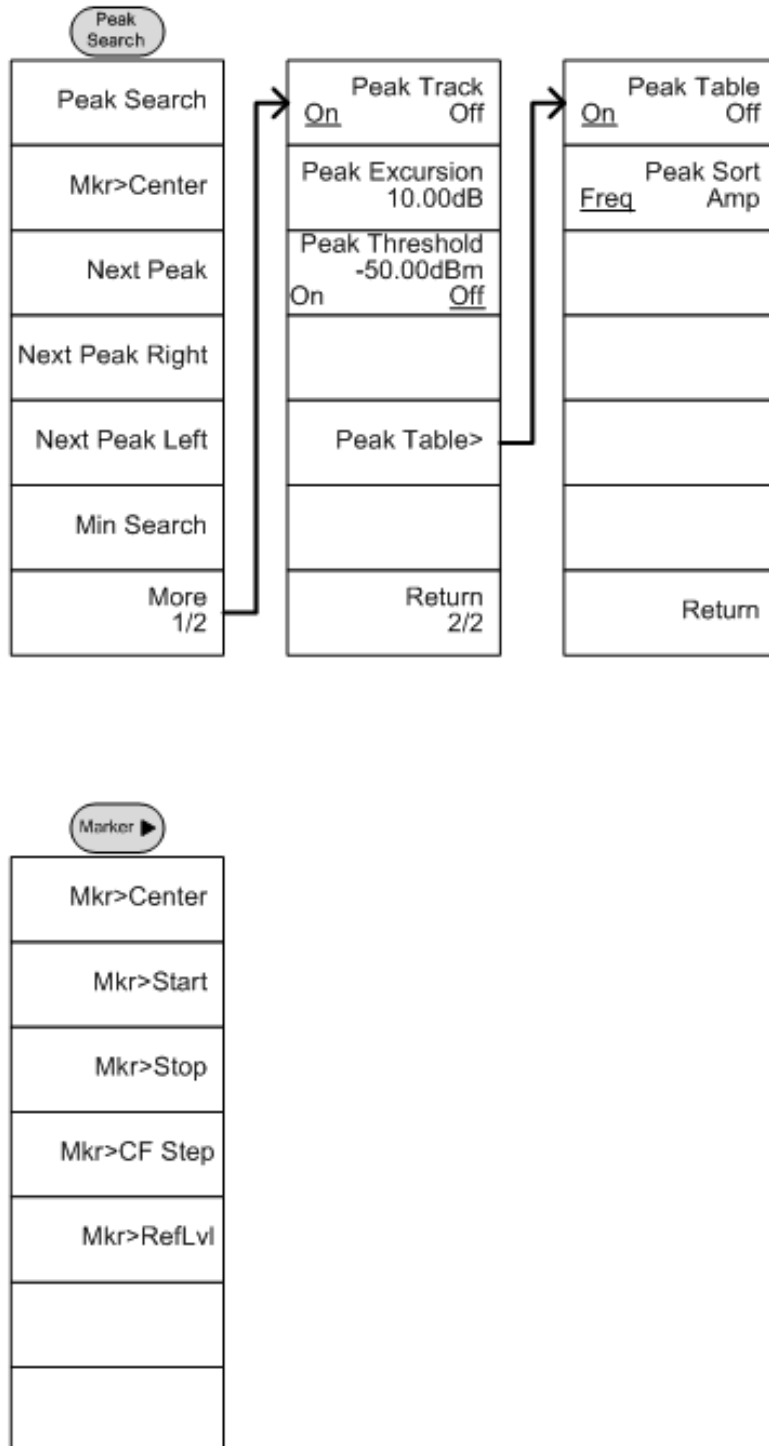
Figure 144.

8.4.9 | **System**
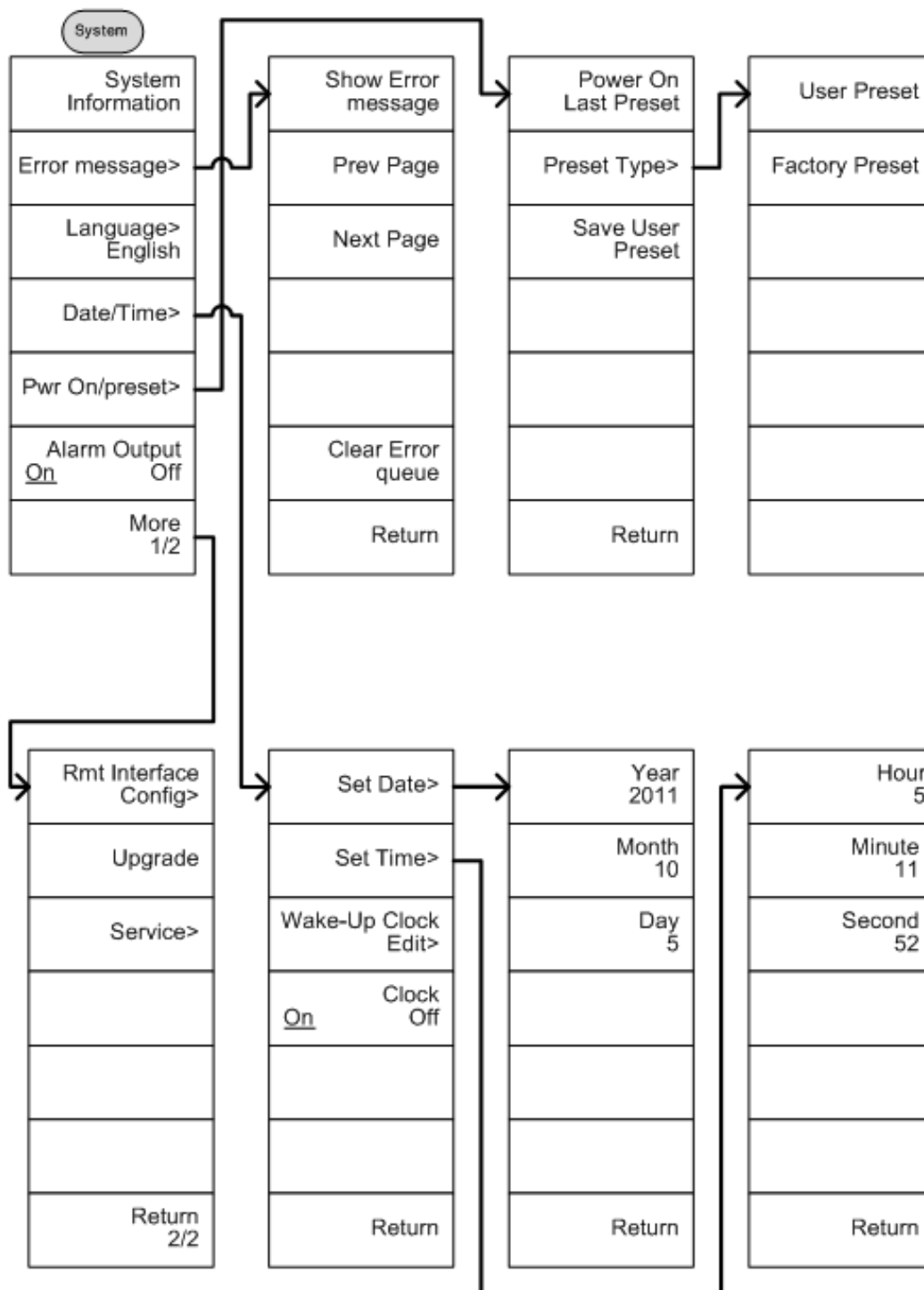
Figure 145.

From: System>
Language

↓

English
Español

From: System>Date/
Time>Wake-Up Clock Edit>

↓

Select Clock> 1		Clock 1		Monday
State On Off		Clock 2		Tuesday
Hour 13		Clock 3		Wednesday
Minute 08		Clock 4		Thursday
Rept. Single		Clock 5		Friday
Select Date> Monday		Clock 6		Saturday
Return		Clock 7		Sunday
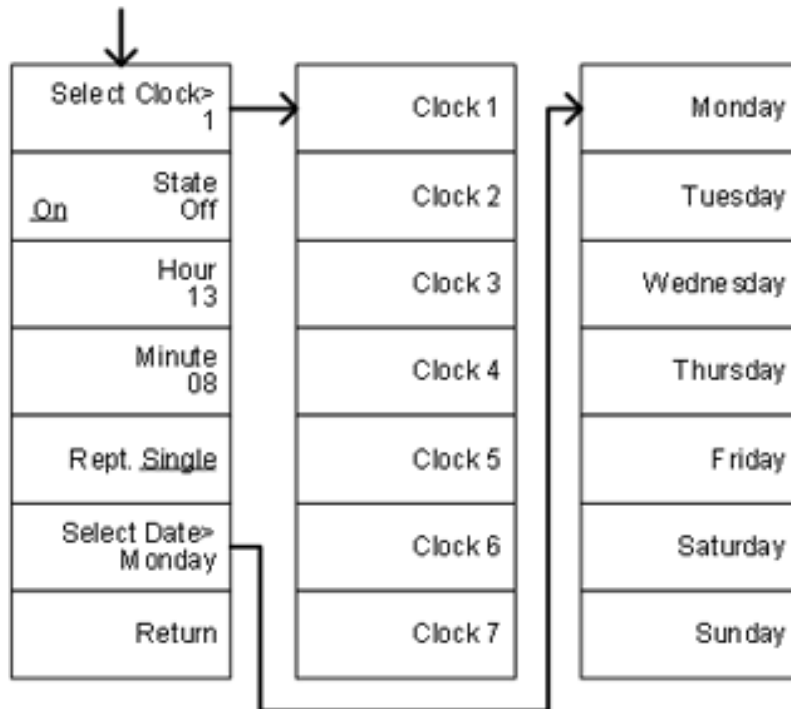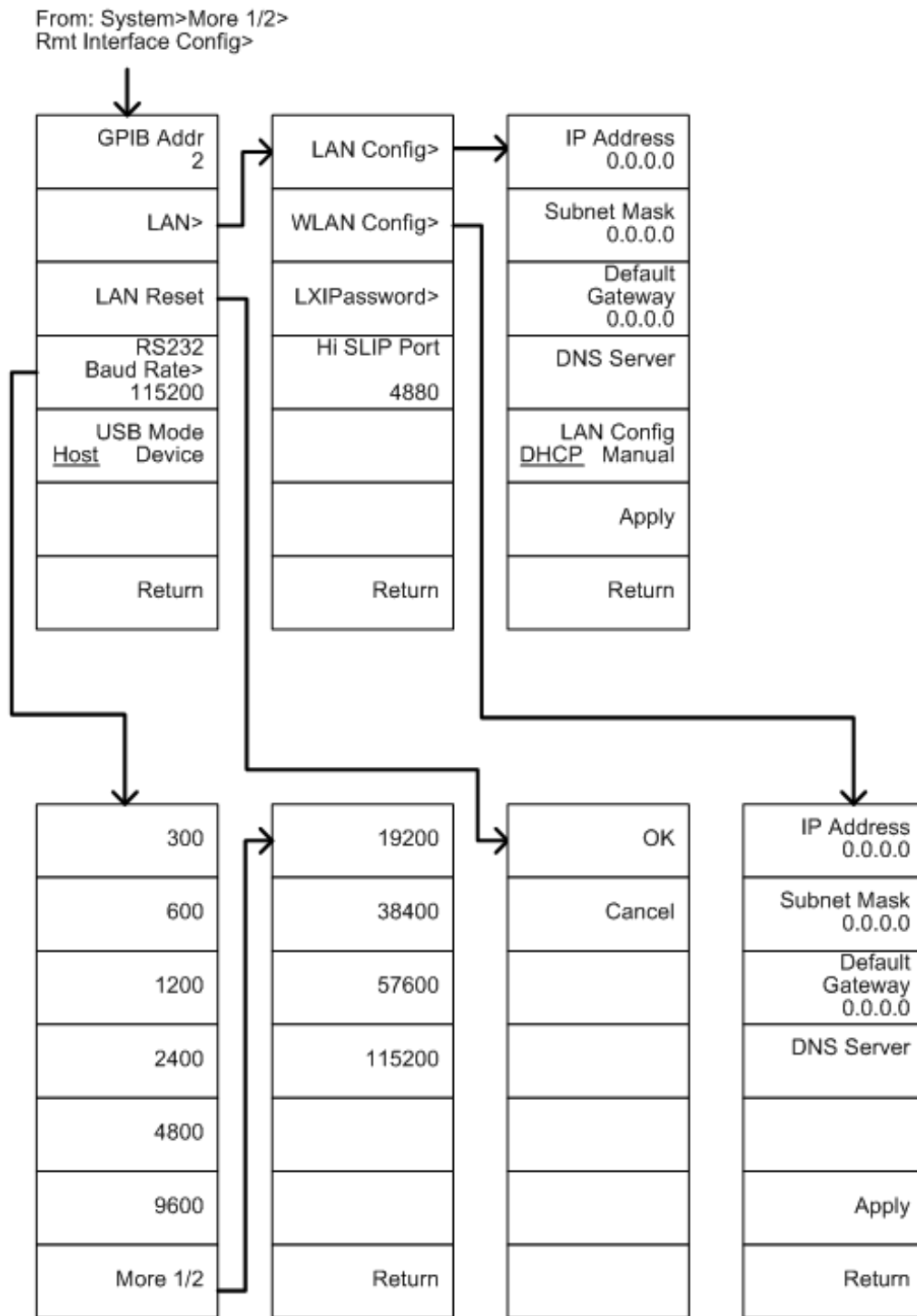
Figure 146.

Figure 147.

From: System>More 1/2> Rmt
Interface Config>LAN>LXIPassword

ABCDE		A		a
FGHIJ		B		b
KLMNO		C		c
PQRST		D		d
UVWXY		E		e
Z		Lowercase		
Return		Return		Return
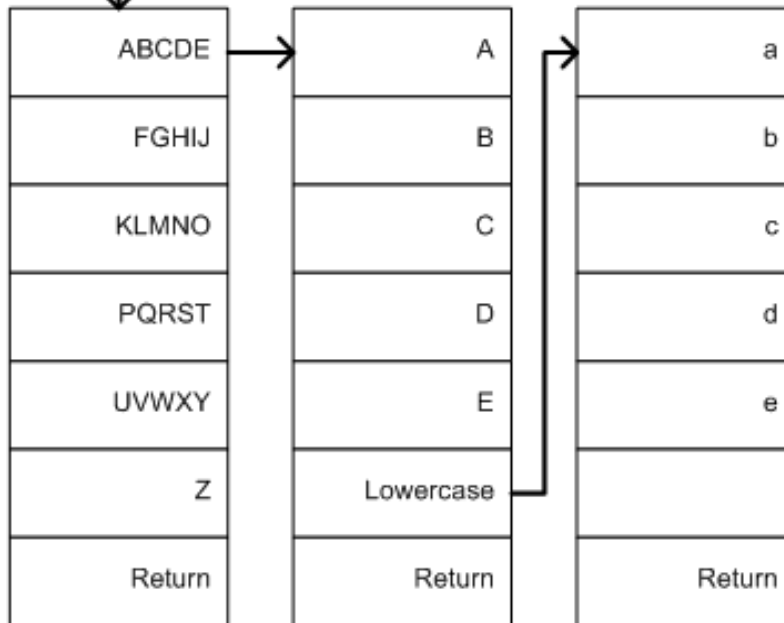
Figure 148.

8.4.10		Option Control
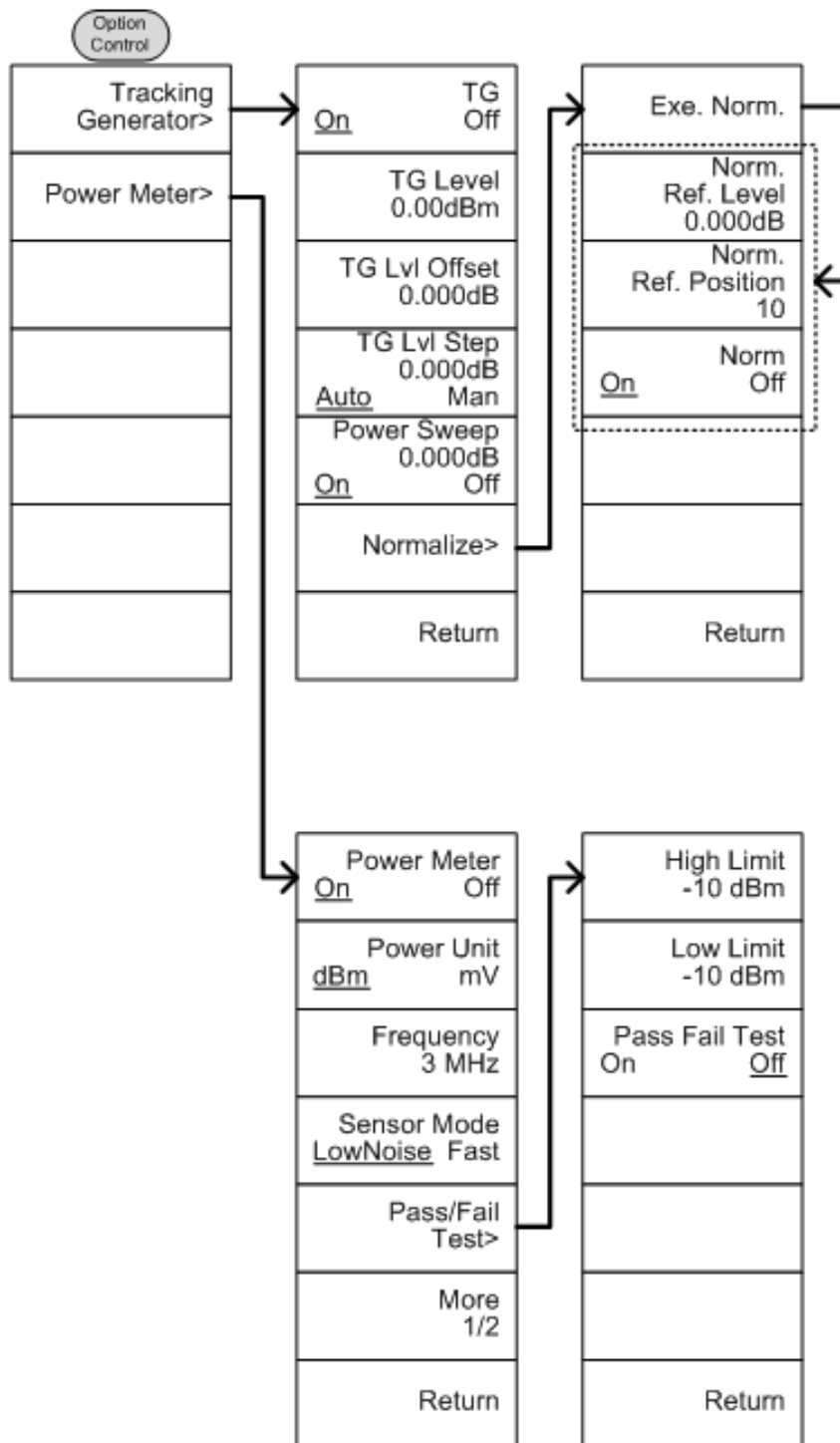
Figure 149.

8.4.11 | **File**

Figure 150.

From: File>Type

All
State
Trace
Screen
Limit Line
Correction
More 1/2

.sta

.tra

.jpg

.cor

.seq

.pmet

Sequence
Power Meter
Return 2/2

From: File>Delete

Delete Now
Delete Warning Don't Ask   Ask
Delete All
Return

No
Yes

From: File>Rename

ABCDE
FGHIJ
KLMNO
PQRST
UVWXY
Z
Return

A
B
C
D
E
Lowercase
Return

a
b
c
d
e
Return
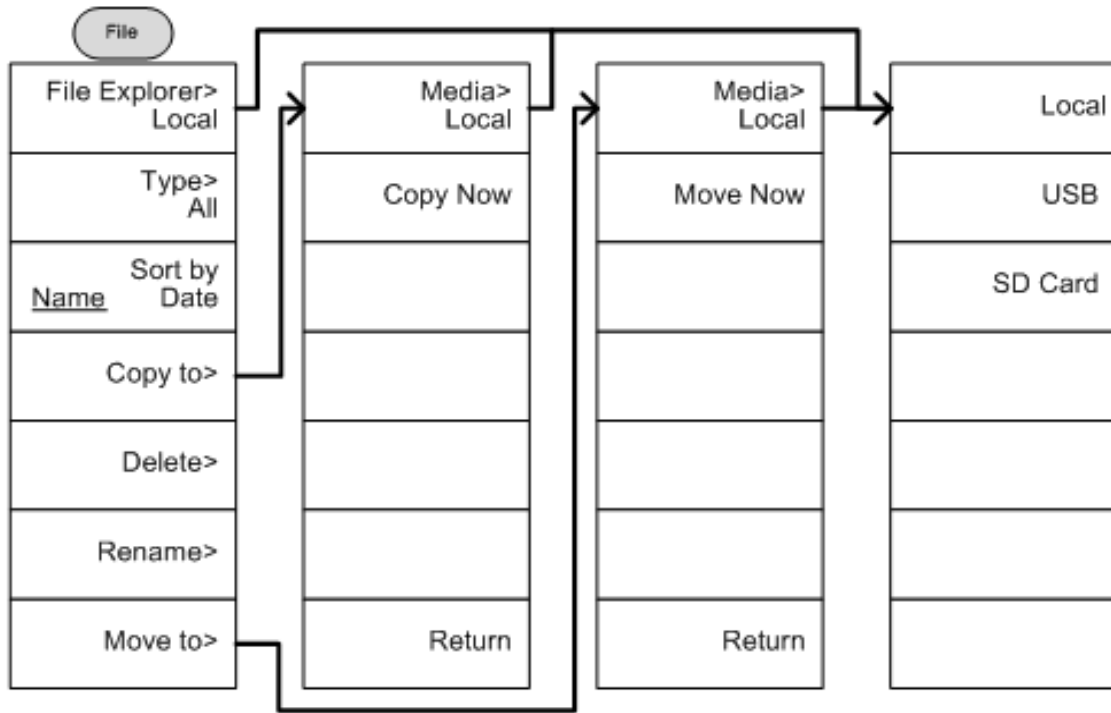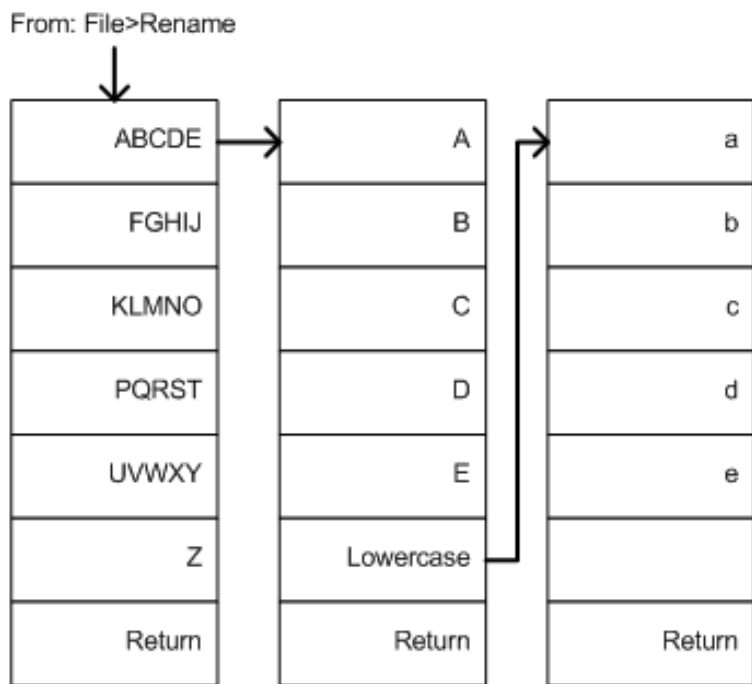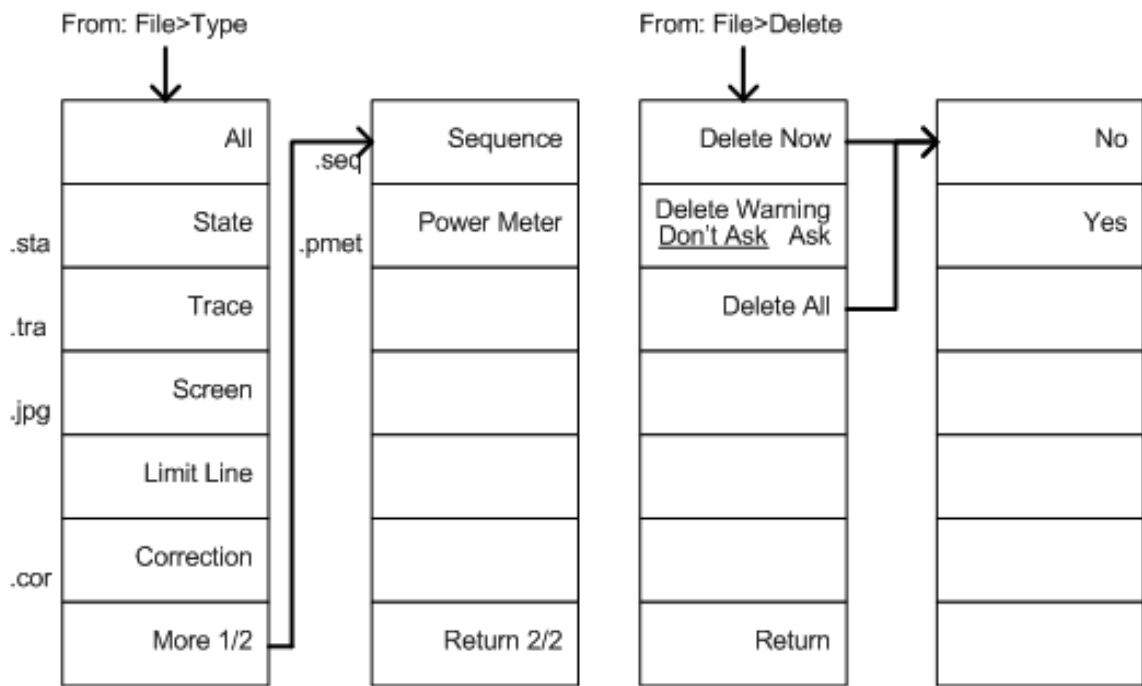
Figure 151.

8.4.12		Save

(Mode = Power Meter)
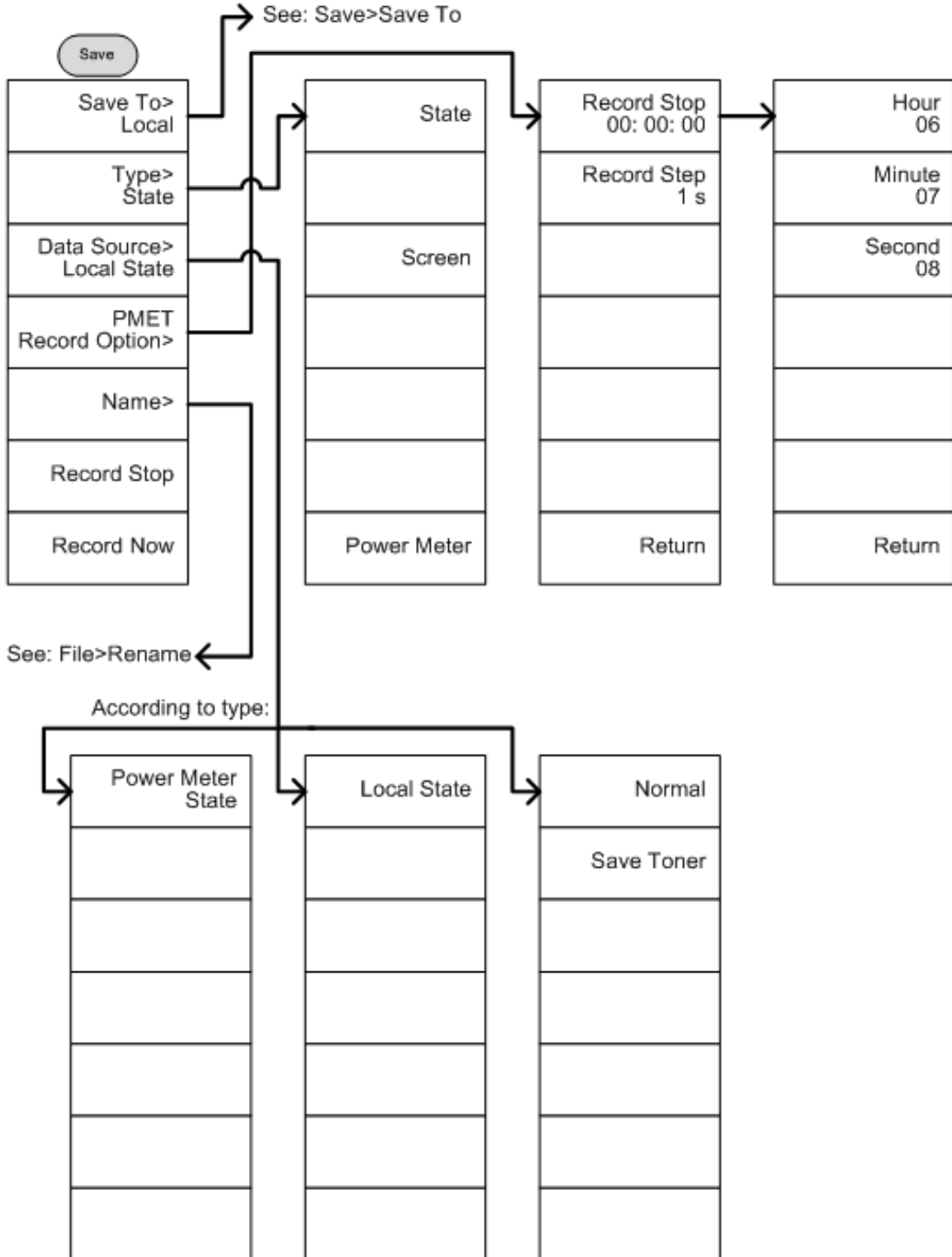
Figure 152.

From: Save>Save To
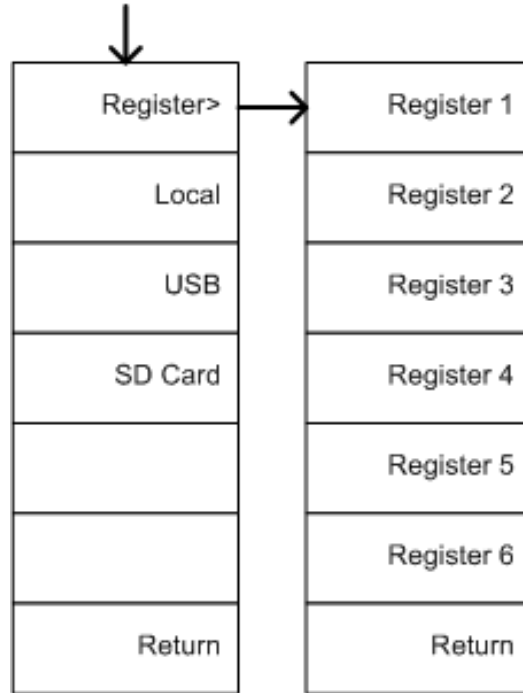
Figure 153.

(Mode = Spectrum)
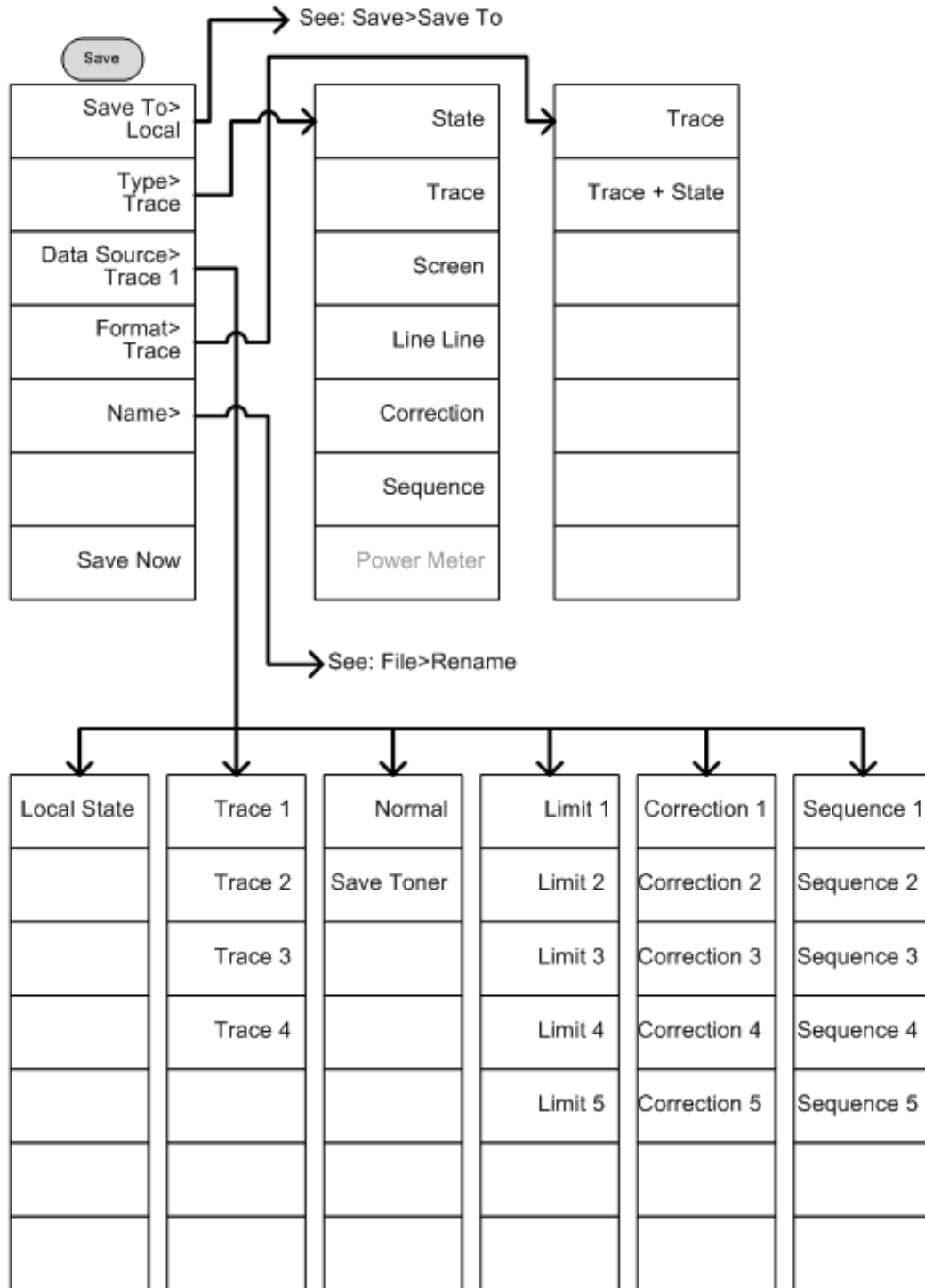
Figure 154.

8.4.13   **Recall**

(Mode = Power Meter)
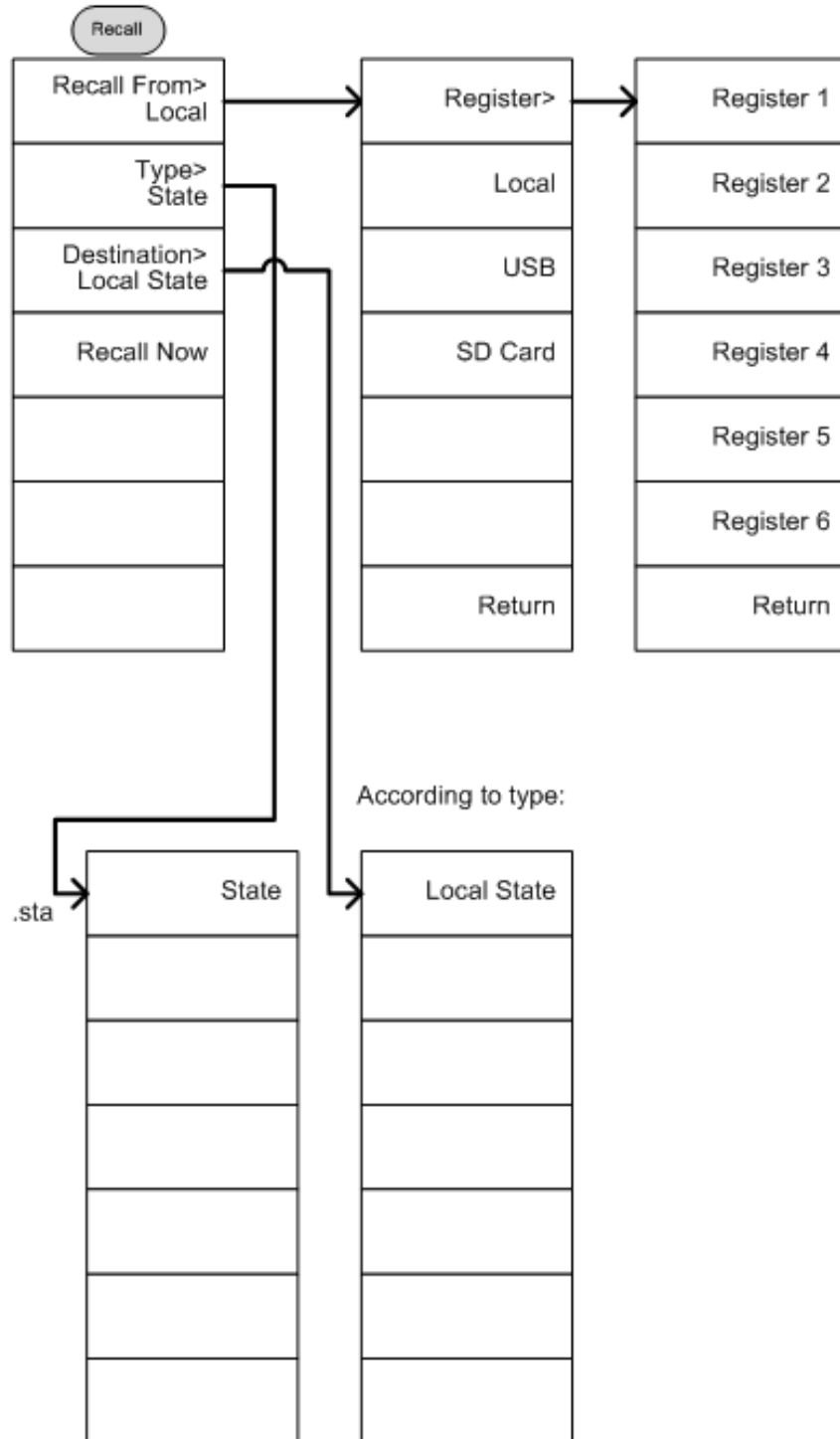
Figure 155.

(Mode = Spectrum)

Recall			
Recall From> Local	State	Register>	Register 1
Type> Trace	Trace	Local	Register 2
Destination> Trace 1		USB	Register 3
Recall Now	Line Line	SD Card	Register 4
	Correction		Register 5
	Sequence		Register 6
	Power Meter	Return	Return

.sta
.tra
.lmt
.cor
.seq

Local State	Trace 1	Limit 1	Correction 1	Sequence 1
	Trace 2	Limit 2	Correction 2	Sequence 2
	Trace 3	Limit 3	Correction 3	Sequence 3
	Trace 4	Limit 4	Correction 4	Sequence 4
		Limit 5	Correction 5	Sequence 5

Figure 156.

8.4.14 Measure

Figure 157.

From: Measure>Demod

| AM Analysis> |
| FM Analysis> |
| Sound> |
| |
| |
| |
| Return |

From: Measure>Demod (Sound)

| Earphone Out
On   Off |
| Volume
10 |
| Digital Gain
Control
0.000dB |
| Demod Type
AM   FM |
| |
| |
| Return |

From: Measure>TOI

| TOI
On   Off |
| Reference
Lower   Upper |
| Limit
-30.00dBm |
| Pass/Fail Test
On   Off |
| |
| |
| Return |

From: Measure>More>
NdB Bandwidth

| NdB BW
On   Off |
| N dB
0.000dB |
| |
| |
| |
| |
| Return |

From: Measure>More>CNR/CSO/CTB

| Setup>
CNR |
| CNR
On   Off |
| CNR
CH SPC
6.000 MHz |
| Channel
Move Down |
| Channel
Move Up |
| |
| Return |

| CNR> |
| CSO |
| CTB> |
| |
| |
| |
| Return |

| Noise Marking
Min   ΔMarker |
| |
| |
| |
| |
| |
| Return |

| Restart |
| |
| |
| |
| |
| |
| Return |

Figure 158.

From: Measure>Demod>AM
Analysis

| AM Analysis
On   Off |
| Setup> |
| Min/Max Reset |
| |
| Limit Edit> |
| Pass/Fail Test
On   Off |
| Return |

| IF Bandwidth
300kHz |
| LPF>
Bypass |
| Time Axis> |
| Depth Axis> |
| AF Trigger> |
| Squelch Level
-130.0dBm |
| Return |

| Bypass |
| 1.6MHz |
| 781kHz |
| 521kHz |
| 391kHz |
| 313kHz |
| |

Decimation
frequency*

| Ref. Value
0.0ns |
| Ref. Pos
5 |
| Scale/Div
10.00ms |
| Auto Scale
On   Off |
| |
| |
| Return |

| Ref. Value
0.0 % |
| Ref. Pos
5 |
| Scale/Div
10 % |
| Auto Scale |
| |
| |
| Return |

| Free Run |
| Trigger Setup> |
| Start Time
0.00 ns |
| Stop Time
20.0 ms |
| Action Now |
| |
| Return |

| Edge Slope
Rising   Falling |
| Trigger Mode
Norm. Sgl. Cont. |
| Trigger Level
10 % |
| Trigger Delay
50 ms |
| |
| |
| Return |

Figure 159.

From: Measure>Demod>FM
Analysis

Figure 160.

From: Measure>Demod>AM Analysis>Limit Edit

↓

AM Depth 100.0%
Carr.Offset 200.000kHz
Carr.Power 0.00dBm
Return

From: Measure>Demod>FM Analysis>Limit Edit

↓

Freq. Deviation 200.000kHz
Carr.Offset 200.000kHz
Carr.Power 0.00dBm
Return

Figure 161.

From: Measure>SEM

SEM Setup> 3GPP
SEM On   Off
Def. Help On   Off
Return

3GPP>
802.11b>
802.11g>
802.11n>
802.16>
User Define>
Return

Meas Type> Total pwr Ref
Ref. Channel>
Offset/Limit>
Return

Meas Type> PSD Ref
Ref. Channel>
Offset/Limit>
Return

From: Measure>SEM>3GPP>
REF. Channel

Chan Integ BW 3.84 MHz
Chan Span 3.96 MHz
RBW 10kHz Auto   Man
Total Pwr Ref -74.3dBm Auto   Man
Return

From: Measure>SEM>3GPP>
Offset/Limit

Duplexing Mode FDD   TDD
FDD Setup>
TDD Setup>
Return

Figure 162.

Figure 163.

From: Measure>SEM>3GPP>
Offset/Limit>FDD Setup

UE Mode | Transmission
BS   UE

None | Band XIII
Band II | Band XIV
Band IV
Band V
Band X
Band XII
More 1/2

Add. Limits
None

Min Offset/Limit
Value>

Return

Offset
1 2 3 4 5

Start Freq
27 MHz

Stop Freq
27MHz

RBW

More
1/2

Return

Offset
1 2 3 4 5

Abs Start
-22 dBm

Abs Stop
-22dBm

Rel Start
-35dBc

Rel Stop
-50dBc

Return

Figure 164.

From: Measure>SEM>3GPP>
Offset/Limit>TDD Setup

Chip Rate = 3.84/7.68M

BS Mode	Transmission BS UE
	Chip Rate 3.84M 1.28M 7.68M
	Max Out Pwr> P>=43
	Min Offset/Limit Value>
	Return

Offset 1 2 3 4 5
On   Off
Start Freq 2.7MHz
Stop Freq 2.7MHz
RBW 3MHz
More 1/2
Return

Offset 1 2 3 4 5
Abs Start -22dBm
Abs Stop -22dBm
Return

P>=43
39<=P<43
31<=P<39
P<31

Chip Rate = 1.28M

P>=34
26<=P<34
P<26

From: Measure>SEM>3GPP>
Offset/Limit>TDD Setup

Transmission BS UE	UE Mode
Chip Rate 3.84M 1.28M 7.68M	
Min Offset/Limit Value>	
Return	

Offset 1 2 3 4 5
On   Off
Start Freq 2.7MHz
Stop Freq 2.7MHz
RBW 3MHz
More 1/2
Return

Offset 1 2 3 4 5
Rel Start -22dBm
Rel Stop -22dBm
Return

Figure 165.

From: Measure>SEM>
802.11b/g/n/
802.16>Ref. Channel
↓

| Chan Integ BW 3.84MHz |
| Chan Span 3.96MHz |
| RBW 10kHz |
| PSD Ref -74.3dBm/Hz |
| |
| |
| Return |

From:
Measure>SEM>
802.11g>Offset/
Limit
↓

| Modulation> ERP-OFDM/ DSSS-OFDM |
| Min Offset/Limit Value> |
| |
| |
| |
| |
| Return |

→

| ERP-OFDM/ DSSS-OFDM |
| ERP-DSSS/ ERP-PBCC/ ERP-CCK |
| |
| |
| |
| |
| |

From:
Measure>SEM>
802.11n>Offset/
Limit
↓

| CH BW 20M   40M |
| Min Offset/Limit Value> |
| |
| |
| |
| |
| Return |

From:
Measure>SEM>
802.16>Offset/Limit
↓

| Channelization 10M   20M |
| Min Offset/Limit Value> |
| |
| |
| |
| |
| Return |

From:
Measure>SEM>
802.11b>Offset/Limit
↓

| Offset 1   2 |
| Start Freq 2.7MHz |
| Stop Freq 2.7MHz |
| RBW 3MHz |
| Rel Start -22dBc |
| Rel Stop -22dBc |
| Return |

From: Measure>SEM>
802.11n/802.16>Offset/Limit>
Min Offset/Limit
↓

| Offset 1   2   3   4 |
| Start Freq 2.7MHz |
| Stop Freq 2.7MHz |
| RBW 3MHz |
| Rel Start -22dBc |
| Rel Stop -22dBc |
| Return |

Figure 166.

From: Measure>SEM>802.11g>
Offset/Limit>Min Offset/Limit

802.11g modulation=DSSS

	Offset
1	2
On	Off
Start Freq 2.7MHz	
Stop Freq 2.7MHz	
RBW	
More 1/2	
	Return

	Offset
1	2
	Rel Start -22dBc
	Rel Start -22dBc
	Return

From: Measure>SEM>802.11g>
Offset/Limit>Min Offset/Limit

802.11g modulation=OFDM

		Offset	
1	2	3	4
On		Off	
Start Freq 2.7MHz			
Stop Freq 2.7MHz			
RBW			
More 1/2			
		Return	

		Offset	
1	2	3	4
		Rel Start -22dBc	
		Rel Start -22dBc	
		Return	

Figure 167.

From: Measure>SEM>
User Define>

| Meas Type>
Total Pwr Ref |
| Ref. Channel> |
| Offset/Limit> |
| |
| |
| |
| |
| Return |

| Total Pwr Ref |
| PSD Ref |
| |
| |
| |
| |
| |
| |

| Chan Integ BW
3.84MHz |
| Chan Span
3.96MHz |
| RBW
10kHz
<u>Auto</u>   Man |
| Total Pwr Ref
-74.3dBm
<u>Auto</u>   Man |
| |
| |
| |
| Return |

| Offset
<u>1</u> 2 3 4 5 |
| <u>On</u>   Off |
| Start Freq
2.7MHz |
| Stop Freq
2.7MHz |
| RBW
10kHz
<u>Auto</u>   Man |
| More
1/2 |
| Return |

| Offset
<u>1</u> 2 3 4 5 |
| Abs Start
-22dBm |
| Abs Stop
-22dBm |
| Rel Start
-22dBc |
| Rel Stop
-22dBc
<u>Couple</u>   Man |
| Fail Mask>
Absolute |
| Return |

| Absolute |
| Relative |
| Abs AND Rel |
| Abs OR Rel |
| |
| |
| |

Figure 168.

From: Measure>TOI

```
            TOI
On          Off

        Reference
Lower    Upper

          Limit
        0.00dBm

Pass/Fail Test
On          Off




        Return
```

From: Measure>More
>Harmonic

```
        Harmonic
On          Off

       Fundamental
          Freq.
       1.000000MHz

Number of Order
              5

          RBW
          10kHz
Auto      Man




        Return
```

From: Measure>
More>NdB Bandwidth

```
          NdB BW
On          Off

            NdB
          3.000dB







        Return
```

From: Measure>More>P1dB

```
          P1dB
On          Off

          P1dB
        Setup >

       Normalize >





        Return
```

```
   Center Freq
   100.000MHz

   Gain Offset
   0.000dB

     Average
        1

      Start
    -30.00dB

      Reset



      Return
```

```
     Exec. Norm
            0dB

         Location
Prev        Post

           Nomr.
ON          OFF




      Return
```

Figure 169.

8.5 | AE-166/167 Specifications

The specifications apply when the AE is powered on for 45 minutes* to warm-up to a temperature of 20°C to 30°C, unless specified otherwise:

8.5.1 | Frequency

Frequency		
Range	9 kHz to 3 GHz	
Resolution	1 Hz	
Frequency Reference		
Accuracy	±(period since last adjustment X aging rate) + stability over temperature + supply voltage stability	
Aging Rate	±1 ppm max.	1 year after last adjustment
Frequency Stability over Temperature	±0.025 ppm	0 to 50 °C
Supply Voltage Stability	±0.02 ppm	
Frequency Readout Accuracy		
Start, Stop, Center, Marker	±(marker frequency indication X frequency reference accuracy + 10% x RBW + frequency resolution[1])	
Trace points	Max 601 points, min 6 points	
Marker Frequency Counter		
Resolution	1 Hz, 10 Hz, 100 Hz, 1 kHz	
Accuracy	±(marker frequency indication X frequency reference accuracy + counter resolution)	RBW/Span > = 0.02 ; Mkr level to DNL > 30 dB
Frequency Span		
Range	0 Hz (zero span), 100 Hz to 3 GHz	
Resolution	1 Hz	
Accuracy	± frequency resolution[1]	RBW: Auto;

---

* 45 minutes typical, 90 minutes maximum

Phase Noise

	Offset from Carrier		Fc =1 GHz; RBW = 1 kHz, VBW = 10 Hz; Average = 40
	10 kHz	<-88 dBc/Hz	*Typical*[2]
	100 kHz	<-95 dBc/Hz	*Typical*
	1 MHz	<-113 dBc/Hz	*Typical*

Resolution Bandwidth (RBW) Filter

	Filter Bandwidth	1 Hz to 1 MHz in 1-3-10 sequence	-3dB bandwidth
		200 Hz, 9 kHz, 120 kHz, 1MHz	-6dB bandwidth
	Accuracy	± 8 %, RBW = 1 MHz	Nominal3
		± 5 %, RBW < 1 MHz	Nominal
	Shape Factor	< 4.5:1	Nominal ; Normal Bandwidth ratio: -60 dB: -3 dB

Video Bandwidth (VBW) Filter

	Filter Bandwidth	1 Hz to 1 MHz in 1-3-10 sequence	-3 dB bandwidth

---

[1] Frequency Resolution = Span/(Trace points - 1)

[2] Typical specifications in this datasheet mean that the performance can be exhibited in 80% of the units with a 95 % confidence level over the temperature range 20 to 30 °C. They are not covered by the product warranty.

[3] Nominal values indicate expected performance. They are not covered by the product warranty.

8.5.2   Amplitude

Amplitude Range

	Measurement Range	100 kHz to 1 MHz	Displayed Average Noise Level (DANL) to 18 dBm
		1 MHz to 10 MHz	DANL to 21 dBm
		10 MHz to 3 GHz	DANL to 30 dBm

Attenuator

	Input Attenuator Range	0 to 50 dB, in 1 dB step	Auto or manual setup

Maximum Safe Input Level

	Average Total Power	= +33 dBm	Input attenuator =10 dB
	DC Voltage	± 50 V	

1 dB Gain Compression

	Total Power at 1st Mixer	> 0 dBm	*Typical*;Fc = 50 MHz; preamp. off
	Total Power at the Preamp	> -22 dBm	*Typical*;Fc = 50 MHz; preamp. on
		mixer power level (dBm)= input power (dBm)-attenuation (dB)	

Displayed Average Noise Level (DANL)[4]

	Preamp off	0 dB attenuation; RF Input is terminated with a 50 Ω load. RBW 10 Hz; VBW 10 Hz; span 500 Hz; reference level = -60dBm; trace average = 40	
	9 kHz to 100 kHz	< -93 dBm	
	100 kHz to 1 MHz	< -90 dBm - 3 x (f/100 kHz) dB	Nominal
	1 MHz to 2.7 GHz	< -122 dBm	
	2.7 GHz to 3 GHz	< -116 dBm	
	Preamp on	0 dB attenuation; RF Input is terminated with a 50 Ω load ; RBW 10 Hz; VBW 10 Hz; span 500 Hz; reference level = -60dBm; trace average = 40	

100 kHz to 1 MHz	< -108 dBm - 3 x (f/100 kHz) dB	
1 MHz to 10 MHz	< -142 dBm	Nominal
10 MHz to 3 GHz	< -142 dBm + 3 x (f/1 GHz) dB	

Level Display Range

Scales	Log, Linear	
Units	dBm, dBmV, dBuV, V, W	
Marker Level Readout	0.01 dB	Log scale
	0.01 % of reference level	Linear scale
Level Display Modes	Trace, Topographic, Spectrogram	Single / split Windows
Number of Traces	4	
Detector	Positive-peak, negative-peak, sample, normal, RMS(not Video)	Can be setup for each trace separately
Trace Functions	Clear & Write, Max/Min Hold, View, Blank, Average	

Absolute Amplitude Accuracy

Absolute Point	Center=160 MHz ; RBW 10 kHz; VBW 1 kHz; span 100 kHz; log scale; 1 dB/div; peak detector; 23°C ± 1°C; Signal at Reference Level	
Preamp off	± 0.3 dB	Ref level 0 dBm; 10 dB RF attenuation
Preamp on	± 0.4 dB	Ref level -30 dBm; 0 dB RF attenuation

[4] DANL spec excludes spurious response.

Frequency Response

Preamp off	Attenuation: 10 dB; Reference: 160 MHz; 20 to 30°C	
100 kHz to 2.0 GHz	± 0.5 dB	
2 GHz to 3 GHz	± 0.7 dB	
Preamp on	Attenuation: 0 dB; Reference: 160 MHz; 20 to 30°C	
1 MHz to 2 GHz	± 0.6 dB	
2 GHz to 3 GHz	± 0.8 dB	

Attenuation Switching Uncertainty

Attenuator setting	0 to 50 dB in 1 dB step	
Uncertainty	± 0.25 dB	reference: 160 MHz, 10dB attenuation

RBW Filter Switching Uncertainty

1 Hz to 1 MHz	± 0.25 dB	reference : 10 kHz RBW

Level Measurement Uncertainty

Overall Amplitude Accuracy	± 1.5 dB	20 to 30°C; frequency > 1 MHz; Signal input 0 to -50 dBm; Reference level 0 to -50 dBm; Input attenuation 10 dB; RBW 1 kHz; VBW 1 kHz; after cal; Preamp Off
	± 0.5 dB	*Typical*

Spurious Response

Second Harmonic Intercept		Preamp off; signal input -30 dBm; 0 dB attenuation
	+35 dBm	*Typical*; 10 MHz < fc < 775 MHz
	+60 dBm	*Typical*; 775 MHz = fc < 1.625 GHz
Third-order Intercept		Preamp off; signal input -30 dBm; 0 dB attenuation
	> 1dBm	300 MHz to 3 GHz
Input Related Spurious	< -60 dBc	Input signal level -30 dBm, Att. Mode, Att=0dB; 20-30ºC
Residual Response (inherent)	<-90 dBm	Input terminated; 0 dB attenuation; Preamp off

8.5.3   Sweep

Sweep Time

Range	310 us to 1000 s	Span > 0 Hz
	50 us to 1000 s	Span = 0 Hz; Min Resolution = 10 us
Sweep Mode	Continuous; Single	
Trigger Source	Free run; Video; External	
Trigger Slope	Positive or negative edge	

8.5.4   RF Preamplifier

Frequency Range	1 MHz to 3 GHz	
Gain	18 dB	Nominal
		(installed as standard)

8.5.5   Front Panel Input/Output

RF Input

Connector Type	N-type female	
Impedance	50 ohm	Nominal
VSWR	<1.6 :1	300 kHz to 3 GHz; Input attenuator = 10 dB

Power for Option

Connector Type	SMB male	
Voltage/Current	DC +7V / 500 mA max	With short-circuit protection

USB Host

Connector Type	A plug	
Protocol	Version 2.0	Supports Full/High/Low speed

MicroSD Socket

Protocol	SD 1.1	
Supported Cards	microSD, microSDHC	Up to 32GB capacity

8.5.6   Rear Panel Input/Output

Reference Output

Connector Type	BNC female	
Output Frequency	10 MHz	Nominal
Output Amplitude	3.3 V CMOS	
Output Impedance	50 ohm	

Reference Input

Connector Type	BNC female	
Input Reference Frequency	10 MHz	
Input Amplitude	-5 dBm to +10 dBm	
Frequency Lock Range	Within ± 5 ppm of the input reference frequency	

Alarm Output

	Connector Type	BNC female	Open-collector

Trigger Input/ Gated Sweep Input

	Connector Type	BNC female
	Input Amplitude	3.3V CMOS
	Switch	Auto selection by function

LAN TCP/IP Interface

	Connector Type	RJ-45
	Base	10Base-T; 100Base-Tx; Auto-MDIX

USB Device

	Connector Type	B plug	For remote control only; supports USB TMC
	Protocol	Version 2.0	Supports Full/High/Low speed

IF Output

	Connector Type	SMA female	
	Impedance	50 ohm	Nominal
	IF Frequency	886 MHz	Nominal
	Output level	-25 dBm	10 dB attenuation; RF input: 0 dBm @ 1 GHz

Earphone Output

	Connector Type	3.5mm stereo jack, wired for mono operation

Video Output

	Connector Type	DVI-I (integrated analog and digital) , Single Link. Compatible with VGA or HDMI standard through adapter

RS232 Interface

	Connector Type	D-sub 9-pin female	Tx,Rx,RTS,CTS

GPIB Interface (Optional)

	Connector Type	IEEE-488 bus connector

AC Power Input

	Power Source	AC 100 V to 240 V, 50 / 60 Hz Auto range selection

Battery Pack (Optional)

Battery pack	6 cells, Li-Ion rechargeable, 3S2P	With UN38.3 Certification
Voltage	DC 10.8 V	
Capacity	5200 mAh / 56Wh	

8.5.7   General

Internal Data storage	16 MB nominal	
Power Consumption	<82 W	
Warm-up Time	< 45 minutes	
Temperature Range	+5 °C to +45 °C	Operating
	-20 °C to + 70 °C	Storage
Weight	4.5 kg (9.9 lb)	Inc. all options (Basic+TG+GPIB+Battery)
Dimensions	210 x 350 x 100 (mm)	Approximately
	8.3 x 13.8 x 3.9 (in)	

8.5.8 **Tracking Generator[5] (only for AE-167)**

Frequency Range	100 kHz to 3 GHz	
Output Power	-50 dBm to 0 dBm in 0.5 dB steps	
Absolute Accuracy	± 0.5 dB	@160 MHz, -10 dBm, Source attenuation 10 dB, 20 to 30°C
Output Flatness	Referenced to 160 MHz, -10 dBm	
	100 kHz to 2 GHz	± 1.5 dB
	2 GHz to 3 GHz	± 2 dB
Output Level Switching Uncertainty	± 0.8 dB	Referenced to -10 dBm
Harmonics	< -30 dBc	Typical, output level = -10 dBm
Reverse Power	+30 dBm max.	
Connector type	N-type female	
Impedance	50 ohm	Nominal
Output VSWR	< 1.6:1	300 kHz to 3 GHz, source attenuation = 12 dB

[5] The minimum RBW filter is 10 kHz when the TG output is ON.
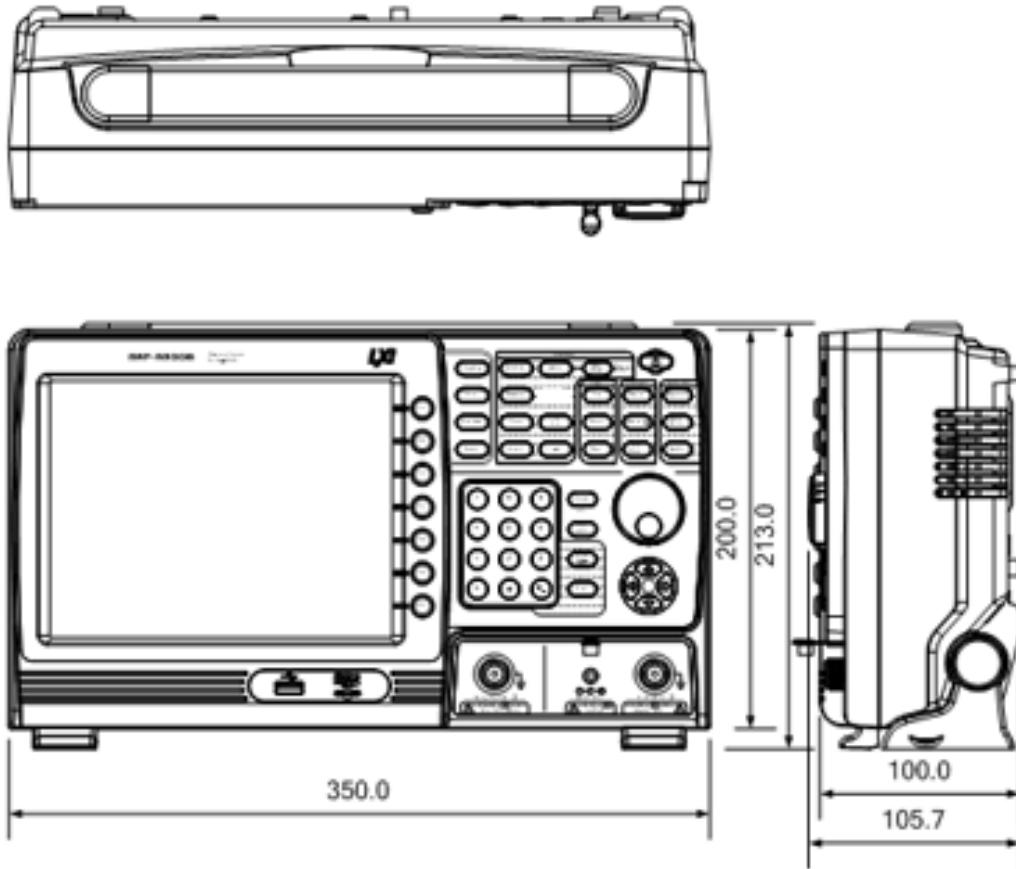
8.6 | AE-166/167 Dimensions

Figure 170.

PROMAX ELECTRONICA, S. L.