Evaluation of Filter and Amplifier Transmission Characteristics

- Internal Signal Generator Control Function Option –

(Functions equivalent to tracking generator)

Signal Analyzer
MS2830A

- Contents -

1. Wide Applications in R&D, Manufacturing and I&M

The Signal Analyzer MS2830A **integrates all the functions required for evaluating the TRx characteristics** of various wireless technologies to support a wider R&D, production, and I&M application range.

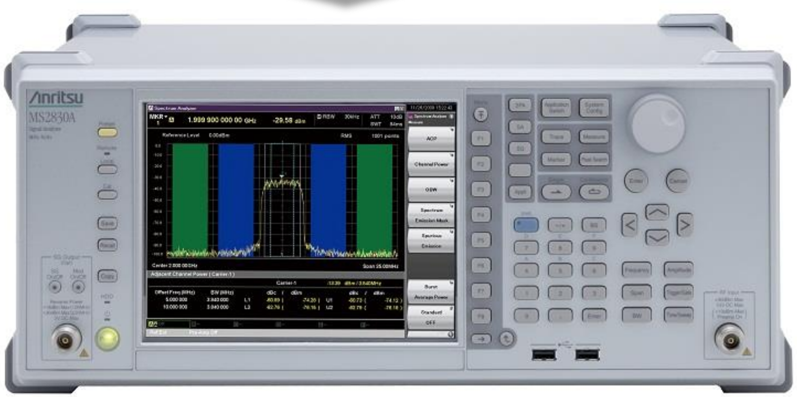
- Spectrum Analyzer
- Digital Modulation Analysis

- Vector Signal Generator

- Frequency Counter

- Analog Radio Tester

All-in-One Measurement !



✓ Cost Reduction

✓ Low Energy

✓ Small Footprint

1. Wide Applications in R&D, Manufacturing and I&M

The spectrum analyzer configuration **can be expanded to support required functions**. Some measurement functions are listed bellow; refer to the product brochure for more details.

MS2830A Measurement functions		Standard	Option
Spectrum Analyzer	Spurious Emission	✓	-
	Frequency Counter	✓	-
	Adjacent Channel Leakage Power	✓	-
	Internal Signal Generator Control Function	-	✓
Signal Analyzer	FFT(Fast Fourier Transformed) Spectrum Trace	-	✓
	Capture & Playback (Outputs captured RF signal from VSG)	-	✓
Modulation Analysis	Digital Analysis (π/4DQPSK, 4FSK, etc.,)	-	✓
	Analog Analysis (FM, ΦM, AM)	-	✓
	LTE, W-CDMA, GSM Analysis, etc.,	-	✓
Signal Generator	Vector Signal Generator (Pre-installed waveform patterns for each communications systems)	-	✓
	Analog Signal Generator (FM, ΦM, AM)	-	✓
	BER	-	✓

- Contents -

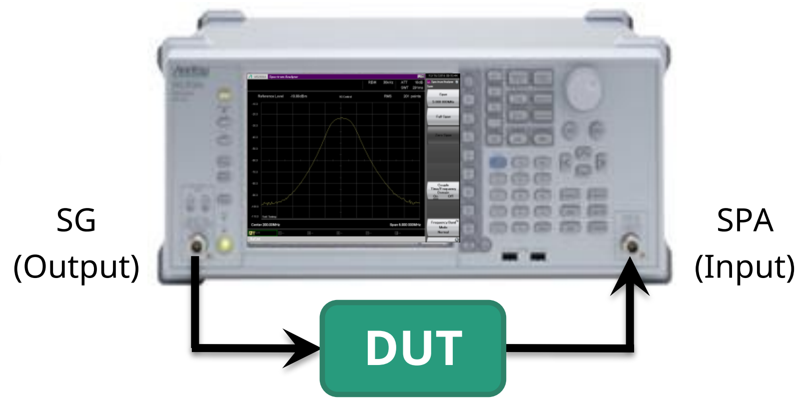
2. Filter and Amplifier Transmission Characteristics

The Internal signal generator control function operates in conjunction with the spectrum analyzer (SPA) function and built-in signal generator (SG) option to measure the transmission characteristics of filters, amplifiers, etc.

Devices Under Test

- **Filters**
- **Attenuators**
- **Amplifiers**
- **Isolators**
- **Switches**

:



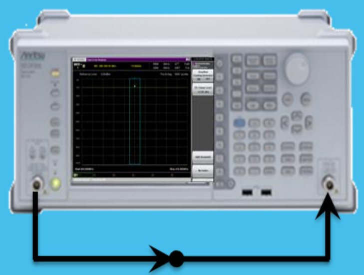
✓ **Measure Both Passive and Active Devices**

The DUT input signal source has a frequency range of 100 kHz to 6 GHz, an output level range of -136 to +15 dBm, a step resolution of 0.01 dB, and a level accuracy of ±0.5 dB to measure both passive and active devices using the built-in high-performance SG.

✓ **Accurate Frequency Characteristics**

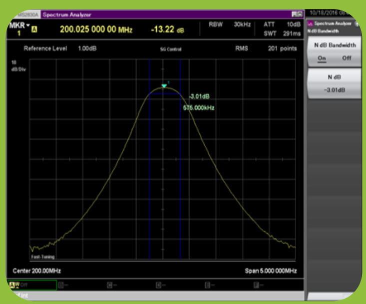
The SPA function displays the measured frequency characteristics results with an excellent linearity error of just ±0.07 dB to display the frequency characteristics of bandpass filters, etc., accurately.

2-1. Introduction to Main Functions



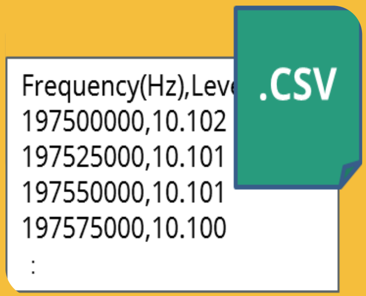
➢ Normalize Function

- Calibrate frequency characteristics of cables, etc., connected at measurement.



➢ N dB Bandwidth Measurement Function

- Measure frequency bandwidth from the peak marker point to any amplitude (N dB) to measure cutoff frequency of bandpass filter.



➢ Correction Value Capture Function

- Capture the measured path insertion loss correction value as a .csv file, and load the .csv file into the MS2830A.

2-2. Frequency and Output Level Ranges

The frequency and output level ranges differ according to the built-in SG type.
For details, refer to the product brochure.

MS2830A-052 Internal Signal Generator Control Function *1

SG Type	Frequency Range	Output Level Range
Vector SG	250 kHz ~ 3.6 GHz or 250 kHz ~ 6 GHz	–40 ~ +2 dBm (≤ 25 MHz) –40 ~ +20 dBm (> 25 MHz) or –136 ~ –3 dBm (≤ 25 MHz) –136 ~ +15 dBm (> 25 MHz)
Analog SG	100 kHz ~ 3.6 GHz	–127 ~ –3 dBm (≤ 25 MHz) –127 ~ +15 dBm (> 25 MHz)
Vector SG + Analog SG	100 kHz ~ 3.6 GHz or 100 kHz ~ 6 GHz	–136 ~ –3 dBm (≤ 25 MHz) –136 ~ +15 dBm (> 25 MHz)

*1 : Requires any one of MS2830A-020, or -021, or -088 options.

- Contents -

3-1. At New Purchase

This slide lists the required configuration at new purchase. There are also other various options. For details, refer to the configuration guide to select additional options in easy steps.

◆ When Built-in Vector SG :

	Model	Name	Note
1	MS2830A-040	3.6 GHz Signal Analyzer	Choose any one.
	MS2830A-041	6GHz Signal Analyzer	
	MS2830A-043	13.5 GHz Signal Analyzer	
2	MS2830A-020	3.6 GHz Vector Signal Generator	Choose any one.
	MS2830A-021	6 GHz Vector Signal Generator	
3	MS2830A-022	Low Power Extension for Vector Signal Generator	Expands lower output level from standard –40 dBm to –136 dBm. Choose if necessary.
4	MS2830A-052	Internal Signal Generator Control Function	Choose.

◆ When either Analog SG or Both Vector SG and Analog SG :

	Model	Name	Note
1	MS2830A-040	3.6 GHz Signal Analyzer	Choose any one.
	MS2830A-041	6GHz Signal Analyzer	
2	MS2830A-088	3.6 GHz Analog Signal Generator	Choose any one. ➢ MS2830A-088: Requires separate MS2830A-066, A0086, and MX269018A selection. ➢ MS2830A-029: Option for adding analog SG to vector SG. Requires separate vector SG (MS2830A-020 or -021), MS2830A-022, MS2830A-066, A0086, and MX269018A
	MS2830A-029	Analog Function Extension for Vector Signal Generator	
3	MS2830A-052	Internal Signal Generator Control Function	Choose.

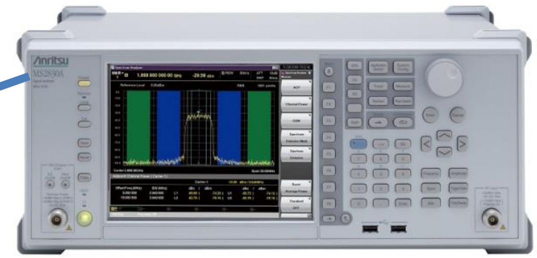
3-2. At Retrofit

This slide explains retrofitting the internal Signal Generator Control Function option when the Signal Analyzer MS2830A has been purchased previously. Choose by confirming the actual equipment using the following steps.

◆ **Step 1.** **Confirm option supporting retrofit :**

The option can be installed in the 3.6, 6, and 13.5 GHz models. Confirm the frequency printed at the top right of the front panel.

Addition	Frequency
✓	9kHz-3.6GHz
✓	9kHz-6GHz
✓*1	9kHz-13.5GHz
-	9kHz-26.5GHz
-	9kHz-43GHz



*1 : The SG cannot be retrofitted if the MS2830A-066 Low Phase Noise option has been installed.

◆ **Step 2.** **Confirm whether built SG installed or not :**

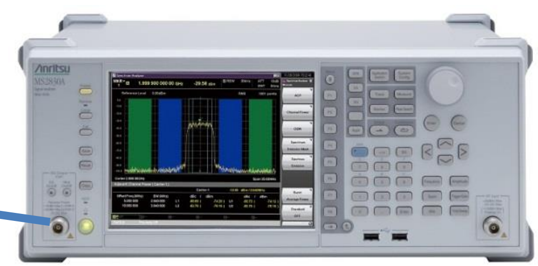
Check for the presence of an N-type RF connector at the bottom left of the front panel.

SG not installed

Go to **Step 3.**

SG installed

Go to **Step 4.**



3-2. At Retrofit

◆ **Step 3. Note on Built-in SG Retrofit :**

The MS2830A must be returned to the factory for upgrading.

➢ **When Installing Vector SG**

	Model	Name	Note
1	MS2830A-120	3.6 GHz Vector Signal Generator Retrofit	Choose any one.
	MS2830A-121	6 GHz Vector Signal Generator Retrofit	
2	MS2830A-122	Low Power Extension for Vector Signal Generator Retrofit	Expands lower output level from standard –40 dBm to –136 dBm. Choose if necessary.
3	Z1345A	Installation kit	Choose.

➢ **When installing either Analog SG or Both Vector SG and Analog SG :**

* The analog SG cannot be installed in the 13.5 GHz model (MS2830A-043).

	Model	Name	Note
1	MS2830A-188	3.6 GHz Analog Signal Generator Retrofit	Choose. Requires MS2830A-066, A0086, or MX269018A.
2	MS2830A-189	Vector Function Extension for Analog Signal Generator Retrofit	Option for adding analog SG to vector SG. Choose if necessary.
3	Z1345A	Installation kit	Choose.

◆ **Step 4. Note on Installing this Option :**

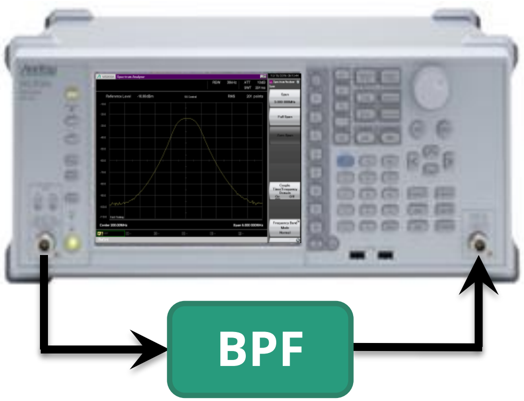
The license is shipped on an installation DVD. This function can be used by installing the license in the MS2830A. This upgrade does not require return to the factory.

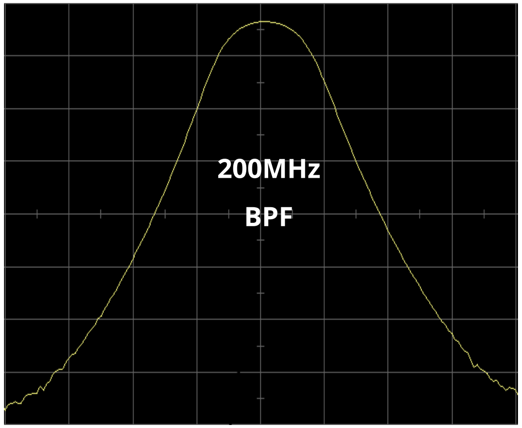
	Model	Name	Note
1	MS2830A-352	Internal Signal Generator Control Function User-Installable	Choose.
2	Z1345A	Installation Kit	Choose.

- Contents -

4-1. Common Settings

This slide introduces the functions and operation using measurement of the frequency characteristics of a 200-MHz bandpass filter as an example. The first step is setting the main parameters common to each function.



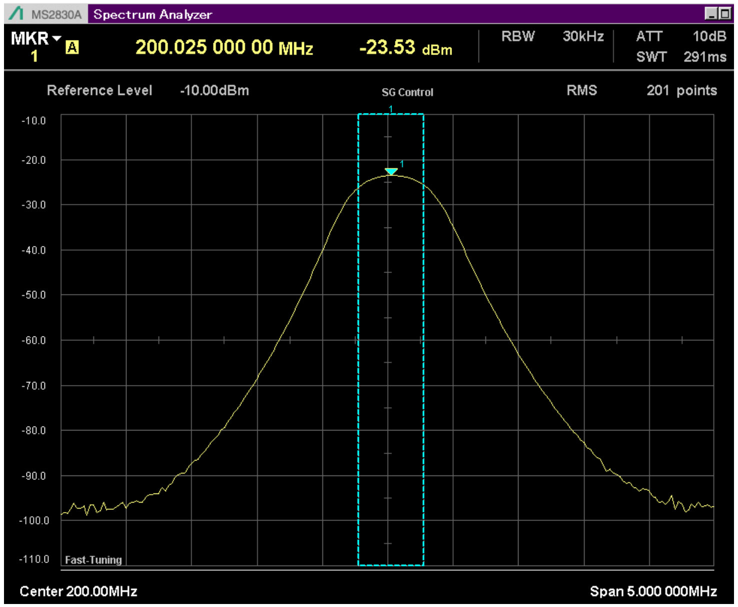


Connecting BPF and setting each parameter

- **Switch to Spectrum Analyzer mode.**
  > [Application Switch] > [Spectrum Analyzer]
- **Initialize parameters.**
  > [Preset] > [F1:Preset]
- **Set Signal Generator Tracking Function to On.**
  > [Measure] >[→(2of2)] > [F6:SG Control] > [F1:SG Control] = On
- **Set Output Level (–10 dBm as example) and set to On.**
  > [F2:SG Output Level] = [-10] [F1:dBm] > [F3:SG Output] = On
  *At output of –3 dBm or more, set Start Frequency to higher than 25 MHz.
- **Set Frequency (200 MHz as example).**
  > [Frequency] > [F1:Center] = [200][F2:MHz]
  *Both Frequency Start/Stop can be set.
- **Set Span (5 MHz as example).**
  > [Span] > [5][F2:MHz]   *Can be set using Up/Down keys.
- **Set RBW (30 kHz as example)**
  > [BW] > [F2:RBW Value] > [30][F3:kHz]   *Can be set using Up/Down keys.
  *The sweep speed changes according to the RBW setting.
- **Set Detection mode (RMS as example).**
  > [Trace] > [F8:Detection] > [F2:RMS]

To next slide

4-1. Common Settings



- **Adjust Reference Level (–10 dBm as example).**
  > [Amplitude] > [F1:Reference Level] > [-10][dBm]
  *Can be set using Up/Down keys.
- **Set Trace Points (201 as example).**
  > [Time/Sweep] >[F4:Trace Points] > (201)[F7:Set]
  *Can be set using Up/Down keys.
  *The sweep speed varies with the set number of Trace Points.
- **Set Frequency Switching Speed (Fast Tuning as example).**
  > [Frequency] > [F4:Switching Speed] > [F1:Fast Tuning]

Fast Tuning	Increases measurement speed by speeding up frequency switching.
Normal	Gives good SPA phase noise performance. Use when monitoring phase noise performance of narrowband filters, etc.

Setting SG output to OFF when changing DUT

- **Set SG output level to OFF.**
  > [Measure] >[(2of2)] > [F6:SG Control]
  > [F3:SG Output] = Off
  *Can set using SG On/Off key at bottom left of front panel

4-2. Normalize Function

This function is for calibrating the frequency characteristics of cables, etc., connected at measurement. It is used when accurate measurement is required for assessing the impact of insertion loss of coaxial cables, etc. An example of the operation is explained below.

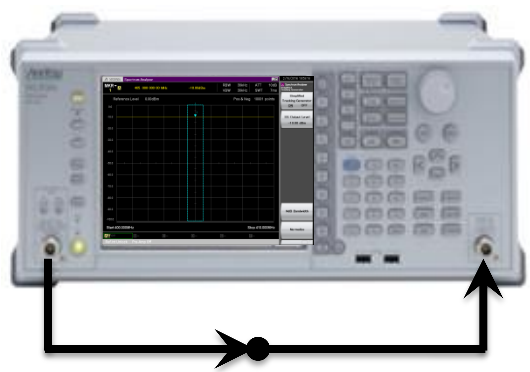
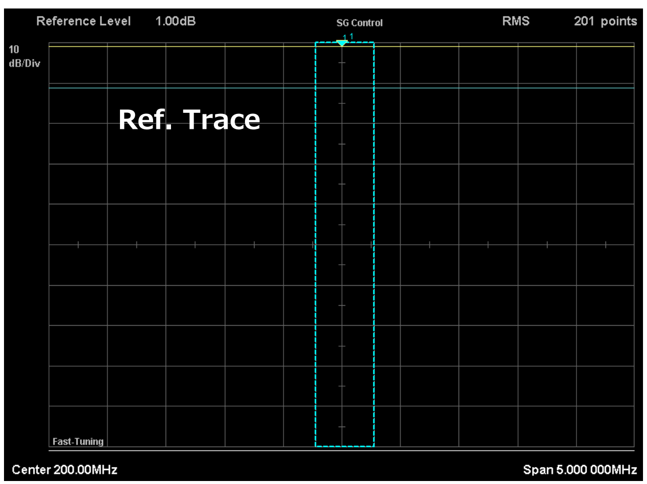


Fig. 1



■ Disconnecting DUT and connecting only cables to be calibrated as shown in Fig. 1

- **Set each parameter.**
  > Refer to previous **Common Settings.**
- **Set the Normalize function to On.**
  > [Measure] >[(2of2)] > [F6:SG Control]
  > [F6:Normalize]
- **Perform Single sweep.**
- > [Single] *Wait until sweep finishes.
- **Save Reference Trace.**
  > [Measure] >[(2of2)] > [F6:SG Control]
  > [F6:Normalize] > [F3:Store Ref.]
  *Always execute [F3:Store Ref.] after the sweep has finished.
  If this command is executed before the sweep has finished, the previous sweep data is saved and the Normalize function does not operate correctly.
- **Set Normalize function to On.**
  > [F1:Nomalize] = On
- **Perform Continuous sweep.**
  > [Continuous]
- **Set Reference Trace to Off.**
  > [F5:Ref Trace Display] > [F2:Blank]

To next slide

4-2. Normalize Function

■ Connecting BPF as shown in Fig. 2 and measuring

The level at the marker point displays the relative value based on the level displayed when Normalize is executed. The displayed level value is read as the insertion loss.

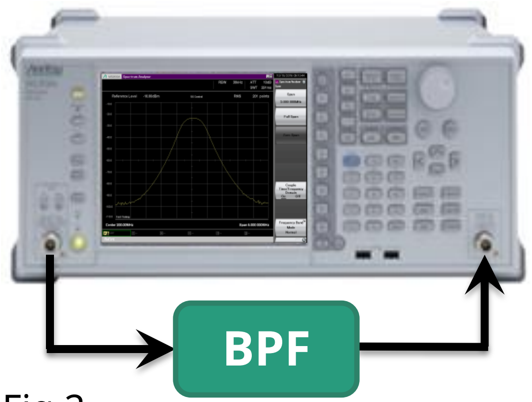
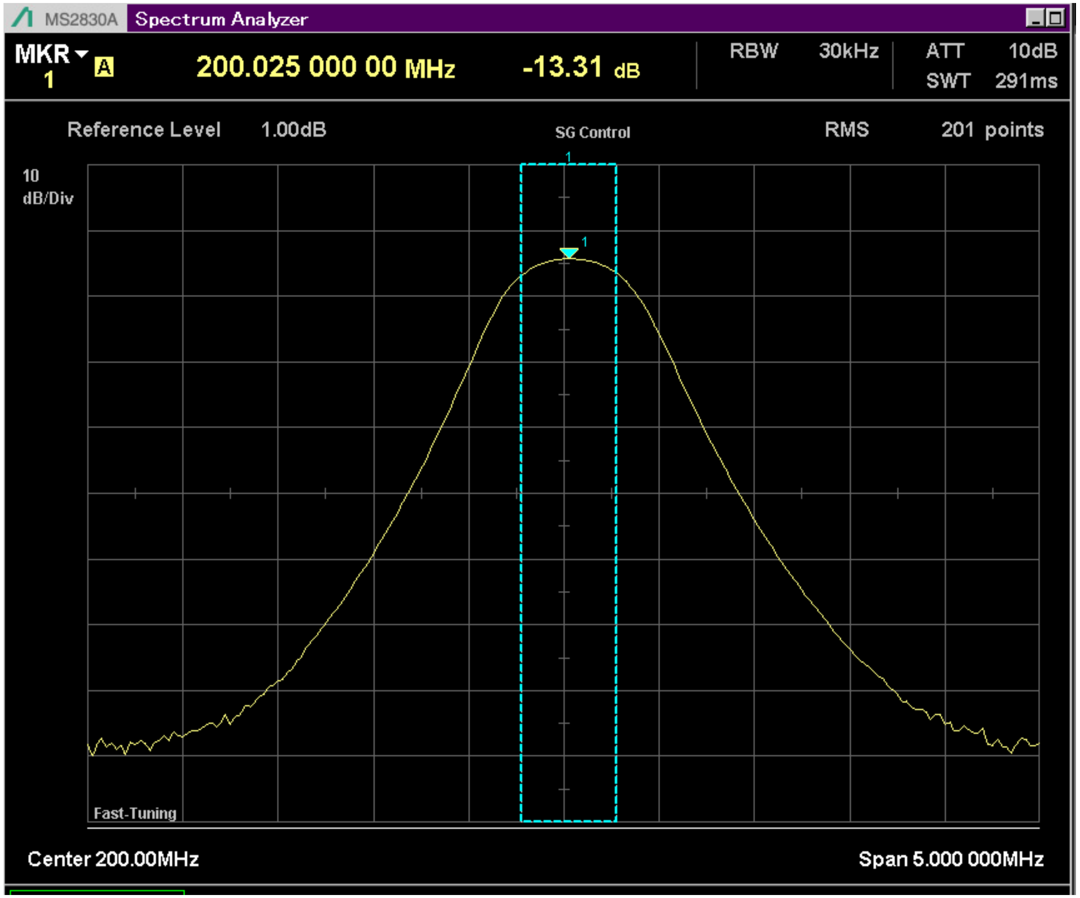


Fig.2

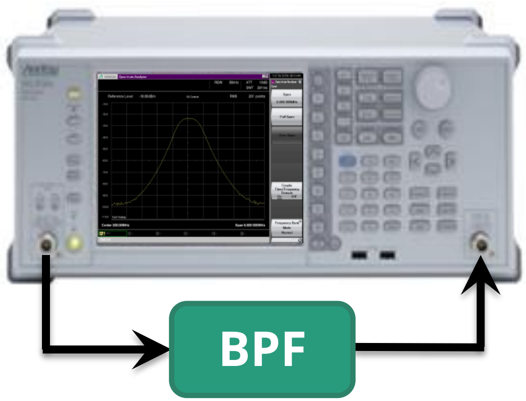
*After executing the Normalize function, **Normalize is initialized** if parameters such as the frequency, trace points, RBW, etc., are changed.

Execute Normalize again after initialization.



4-3. N dB Bandwidth Measurement Function

This function is used when measuring the bandwidth of a bandpass filter (BPF) from the selected marker peak point. The following example explains operation using a BPF with a cut-off frequency of –3.01 dB (1/2 pass-through power).

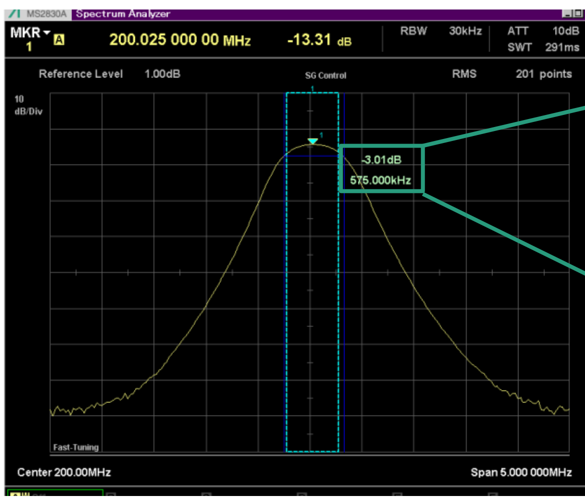


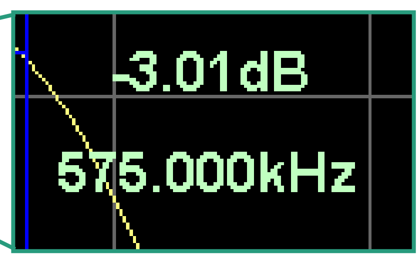
■ Connecting BPF and setting each parameter

➢ **Set each parameter.**
> Refer to previous **Common Settings.**

➢ **Execute Normalize.**
> Refer to previous **Normalize Function.**

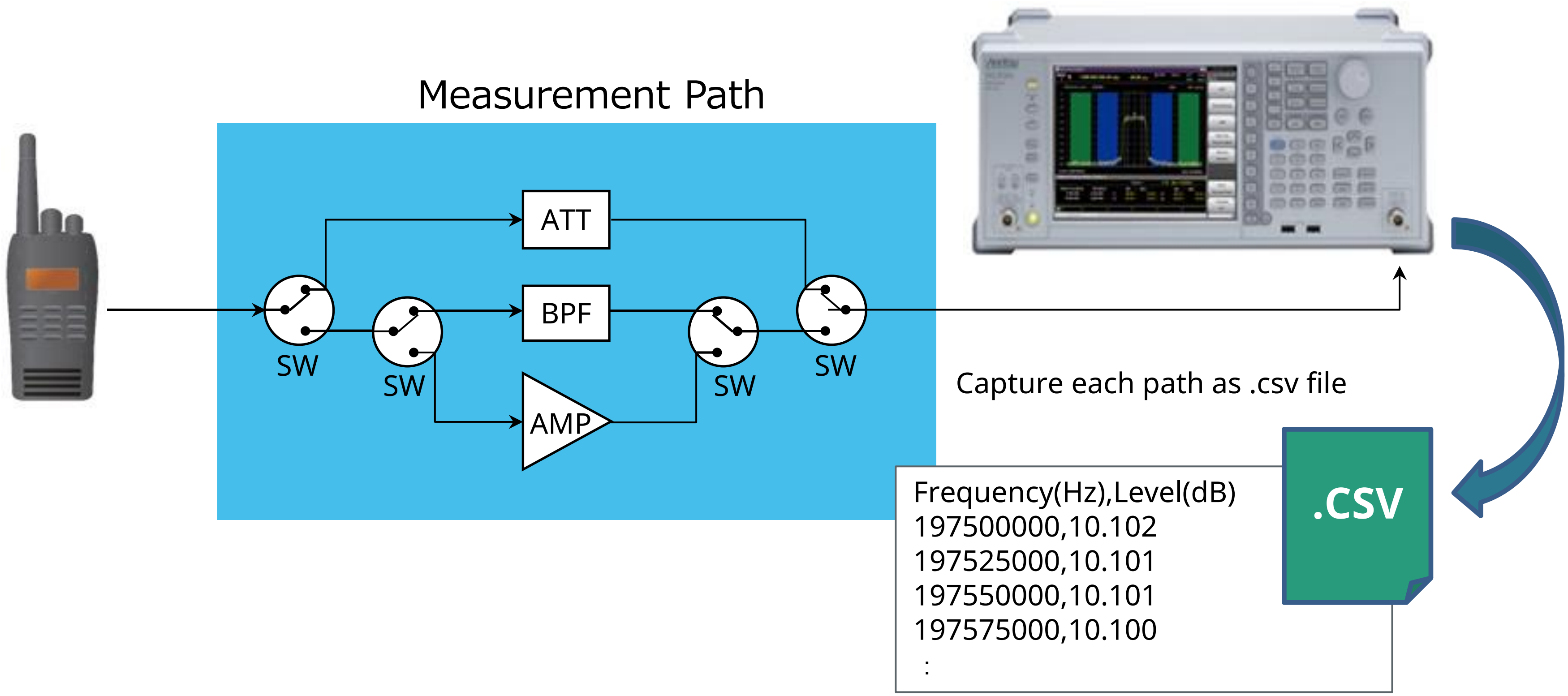
➢ **Set N dB bandwidth Measurement Function to On.**
> [Measure] >[→ (2of2)] > [F6:SG Control]
> [F7:N dB Bandwidth]
> [F2:N dB] = [-3.01][F1:dB]
> [F1:NdB Bandwidth] = On





4-4. Correction Value Capture Function

At radio TRX tests, measurement is performed by switching the measurement path containing filters, amplifiers, attenuators, etc. This function captures the correction value for the measurement path as a .csv file. The captured .csv file can be read by the MS2830A Correction Table function to correct the frequency characteristics of the measurement path.



4-4. Correction Value Capture Function

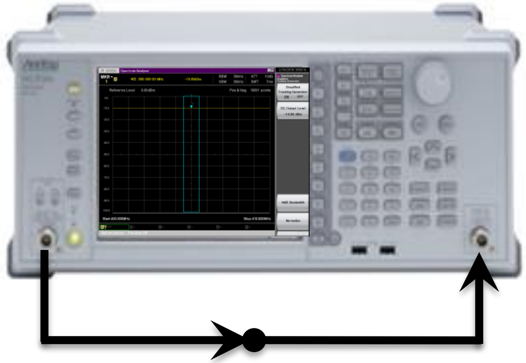


Fig. 1

■ Connecting cables for calibration as shown in Fig. 1 and executing Normalize

- **Set each parameter** *1
  - > Refer to previous **Common Settings.**
- **Execute Normalize.**
  - > Refer to previous **Normalize Function.**

*1: The maximum settable SPA Trace point number is 10001 but the Correction Table function can read up to 4096 point. Be careful when setting the Trace point number.

■ Connecting path for capturing calibration value as shown in Fig. 2

- **Perform single sweep.**
  - > [Single] *Wait until sweep finishes
- **Save calibration value.**
  - > [Save] > [F6:Save Correction CSV DATA]
  - *Set save name
  - Default name: Corr + yyyymmdd + sequential number
  - (example) Corr20161024_003
  - > [F7:Set] = On

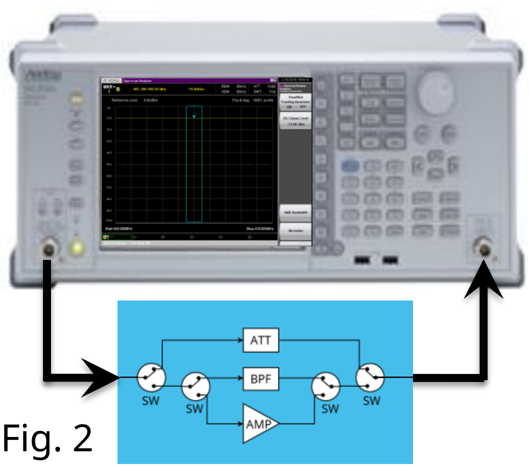
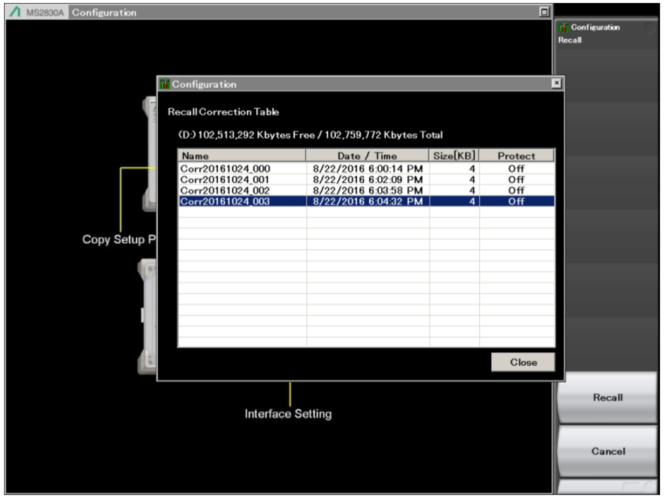
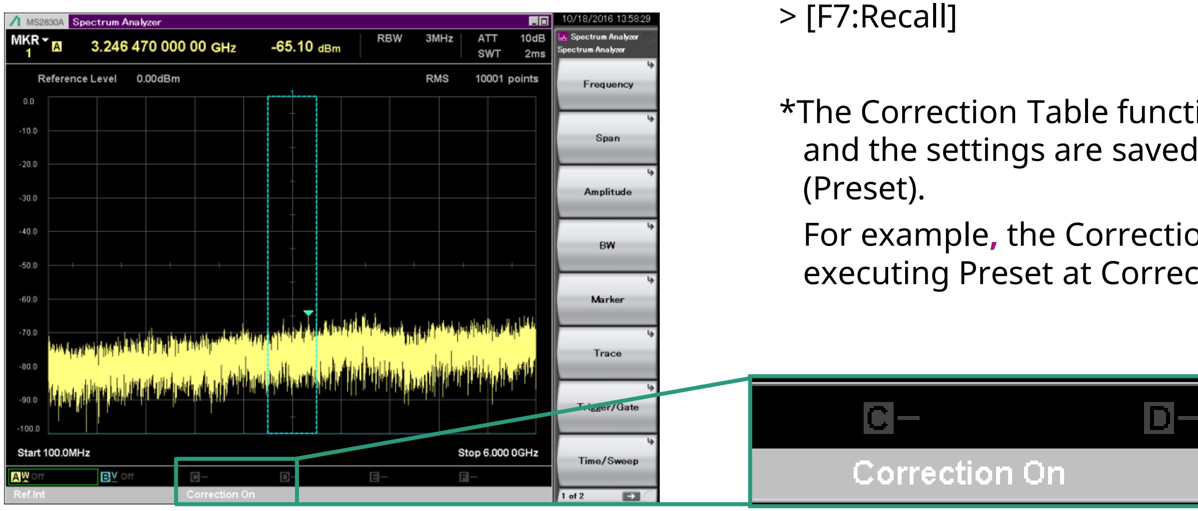


Fig. 2

The calibration is saved as a .csv file in the following path:
[MS2830A]
" D:/Anritsu Corporation¥Signal Analyzer/User Data¥Corrections/ "

4-4. Correction Value Capture Function





■ Using Correction Table function

The captured .csv file can be read by the MS2830A Correction Table function to calibrate the frequency characteristics of the measurement path.

➢ **Read calibration value.**

> [System Config] > [(2of2)]]

> [F7:Correction] > [F1:Correction] = On

> [F3:Recall Correction Table] > [F7:Recall Correction Table]

*The calibration value file to be read can be selected using the cursor keys.

> [F7:Recall]

*The Correction Table function is part of the System Config function and the settings are saved even after executing initialization (Preset).

For example, the Correction setting remains On even after executing Preset at Correction = On.

*Correction On displayed at bottom of SPA screen

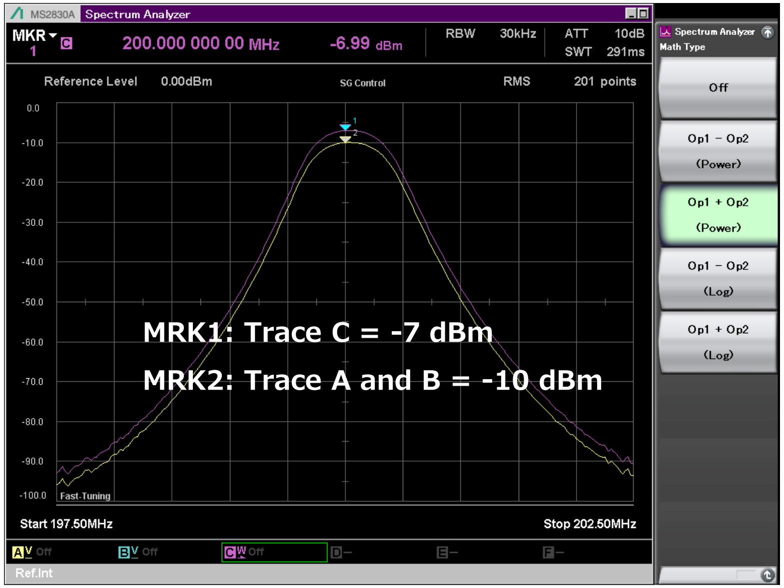
4-5. Trace Math Function

Each trace has a Write function for updating the display at each measurement, and a View function for temporarily saving measured data. These functions can be used to compare each trace and calculate measurement data differences.

Math type *1	Function
Op1 – Op2 (Power)	Converts logarithm value (dBm) to true value (W) and performs subtraction. Result displayed as logarithmic value (dBm).
Op1 + Op2 (Power)	Converts logarithm value (dBm) to true value (W) and performs addition. Result displayed as logarithmic value (dBm).
Op1 – Op2 (Log)	Subtracts logarithm values (dB).
Op1 + Op2 (Log)	Adds logarithm values (dB).

*The Op (Operand) can be selected from any of the A, B, C, D, E, and F traces.

■ Adding true values of trace A (–10 dBm) and trace B (–10 dBm) as power and displaying results at trace C (–7 dBm)



- **Save trace A measurement data (View).**
  - > [Trace] >[F1:Active Trace] = A
  - > [F2:Trace Type] > [F2:View]
- **Save trace B measurement data (View).**
  - > [Trace] >[F1:Active Trace] = B
  - > [F2:Trace Type] > [F2:View]
- **Make trace C Active.**
  - > [Trace] > [F1:Active Trace] = C
- **Calculate trace.**
  - > [Trace] > [F7:Math Type] > [F3:Op1 + Op2 (Power)] = A

4-6. Reflection Characteristics Measurement

Reflection characteristics can be measured by using with either a Return Loss Bridge (SWR Bridge) or Directivity Bridge Coupler, etc. The measurement error is determined by the directivity performance of the bridge being used *1.

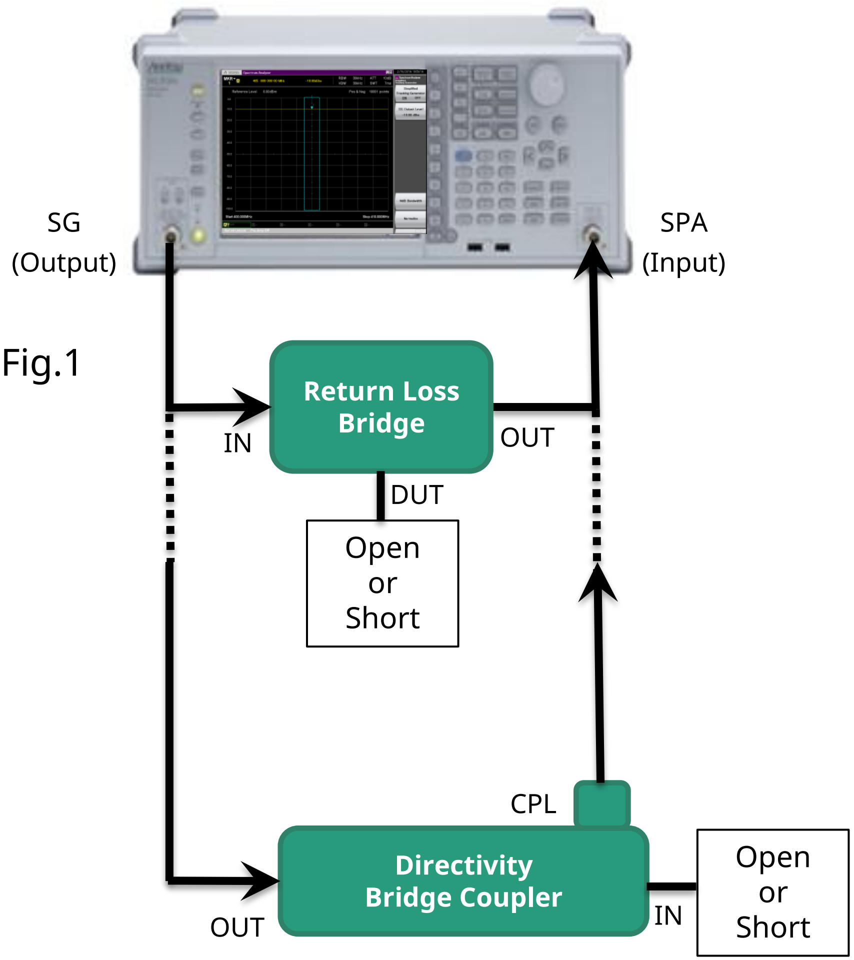


Fig.1

■ Connecting cables as shown in Fig. 1 and executing Normalize.

Set the terminal connected to the DUT to either Open or Short.
Take care about the connected terminals.

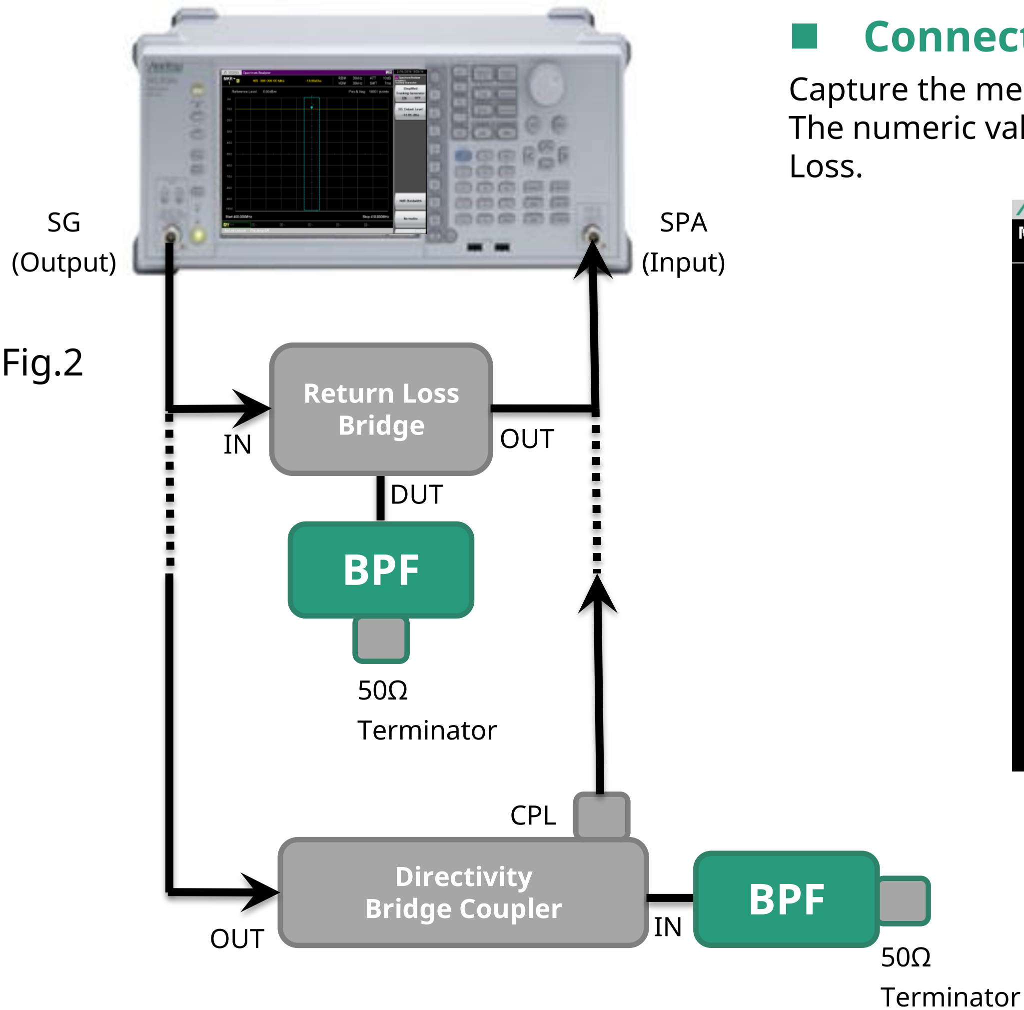
- **Set each parameter**
  > Refer to previous **Common Settings.**
- **Execute Normalize.**
  > Refer to previous **Normalize Function.**

To next slide

*1 For example, the measurement error is +1.7/–1.4 dB when measuring a DUT with a return loss of 20 dB using a bridge with a directivity of 35 dB.

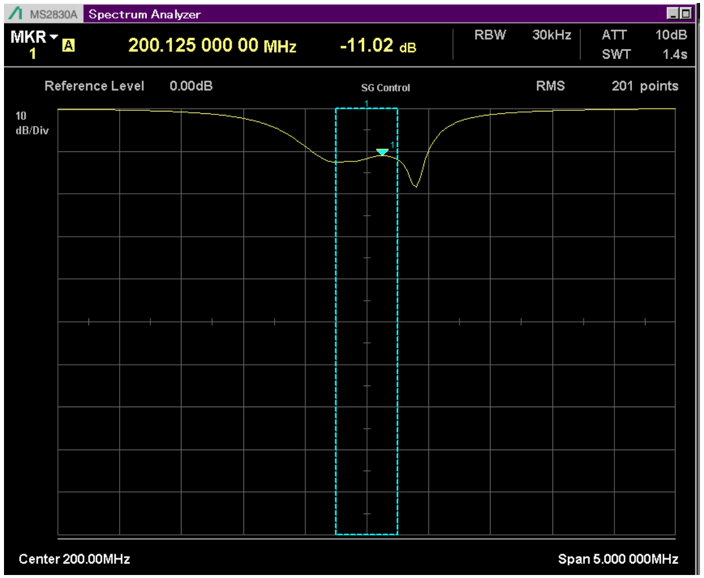
4-6. Reflection Characteristics Measurement

Fig.2



■ Connecting BPF and measuring Return Loss.

Capture the measurement result as shown in the following figure. The numeric value at the marker level display is read as the Return Loss.



➢ The equation for conversion from Return Loss (RL) to VSWR is:

$$\mathrm{VSWR} = \frac{10^{\left(\frac{RL}{20}\right)}+1}{10^{\left(\frac{RL}{20}\right)}-1}$$

Anritsu
envision : ensure