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Digitizer Applications Using High-Performance Signal Analyzer

Signal Analyzer MS2850A

Index

1 Introduction

1.1 Description

This Application Note explains how to cut development and manufacturing time and costs by combining the Signal Analyzer MS2850A with a dedicated data-transfer interface for high-speed transfer of large amounts of digitized data captured over long time periods. It also explains the excellent performance of the MS2850A as a single port digitizer for RF / microwave signals.

- Capture 1 GHz band signals up to 44.5 GHz at fast sampling speeds up to 1.3 GSa/s
- Higher measurement reliability due to excellent dynamic range and in-band flatness
- 3 seconds continuous capture of 1 GHz band signal using large built-in memory
- Fast transfer of digitized data to external PC via PCIe / USB3.0 dedicated data-transfer interface

Table 1.1-1 Performance of MS2850A

Model	Maximum sampling rate	Acquisition memory (total)	Input frequency setting range	Analysis bandwidth
MS2850A-047	1.3 GSa/s	32 GB	100 MHz to 32 GHz	50 MHz to 510 MHz
			4.2 GHz to 32 GHz	1 GHz
MS2850A-046	1.3 GSa/s	32 GB	100 MHz to 44.5 GHz	50 MHz to 510 MHz
			4.2 GHz to 44.5 GHz	1 GHz

1.2 Use Signal Analyzer as a Digitizer

Generally, digitizers have a function for collecting physical parameters (temperature, strain, rpm, frequency, etc.) converted to voltage as digital data. The MS2850A is a superheterodyne signal analyzer, converting inputted RF signals to Intermediate Frequency (IF), then capturing as digital data. As shown in Fig. 1.2-1, the MS2850A is composed of a frequency converter and a waveform memory, and allows RF signal data acquisition without an external down-converter. In addition, the MS2850A can also capture transient phenomena, such as momentary spectrum abnormalities, that cannot be captured by sweep-type spectrum analyzers. It can monitor signals for longer capture times to help easily troubleshoot the causes of transient responses and bugs, which helps improve development efficiency.

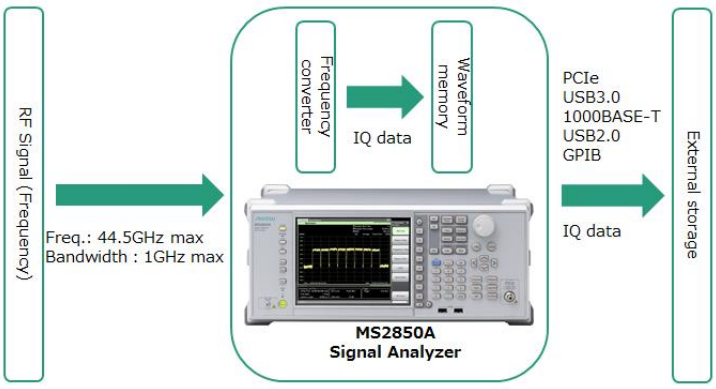

Figure 1.2-1 Flowchart of RF signal digitizer using MS2850A

Figure 1.2-2 shows digitizer applications using the MS2850A. The MS2850A is ideal for R&D and manufacturing of broadband communications equipment, especially for new 5G market, due to its excellent RF performance and large built-in memory. In addition, it demonstrates its abilities as a digitizer especially for monitoring high-frequency and wideband signals as well as RF signal in the field.

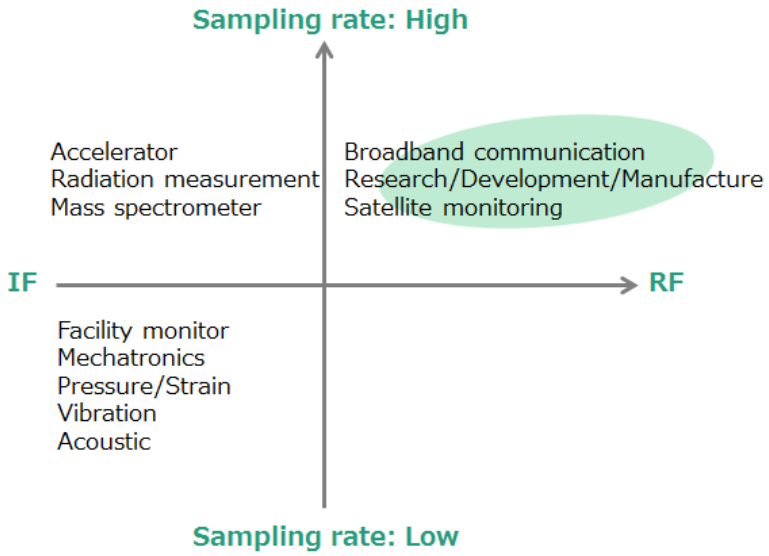

Figure 1.2-2 Application of RF signal digitizer using MS2850A

2 Application Example

2.1 Satellite Monitoring

Figure 2.1-1 shows a broadcast satellite monitoring application. Satellites are operated at different frequency bands, such as the Ka, Ku, and C bands; the earth station down-converts the signals received from the satellite to the intermediate frequency, then digitize them. The MS2850A can digitize received signals directly with its frequency converter inside, eliminating the need for an external converter. Since satellite monitoring always requires continuous observation of the satellite flight status, it needs data acquisition to be done continuously. The MS2850A can reduce transfer time with the External Interface PCIe MS2850A-053 option. By aggregating multiple frequency bands at a switchbox and measuring in a short cycle switching, the required number of measuring instruments can be reduced, which in turn helps cut costs. Additionally, the excellent RF characteristics of the MS2850A help with detection and characterization of interference carrier waves.

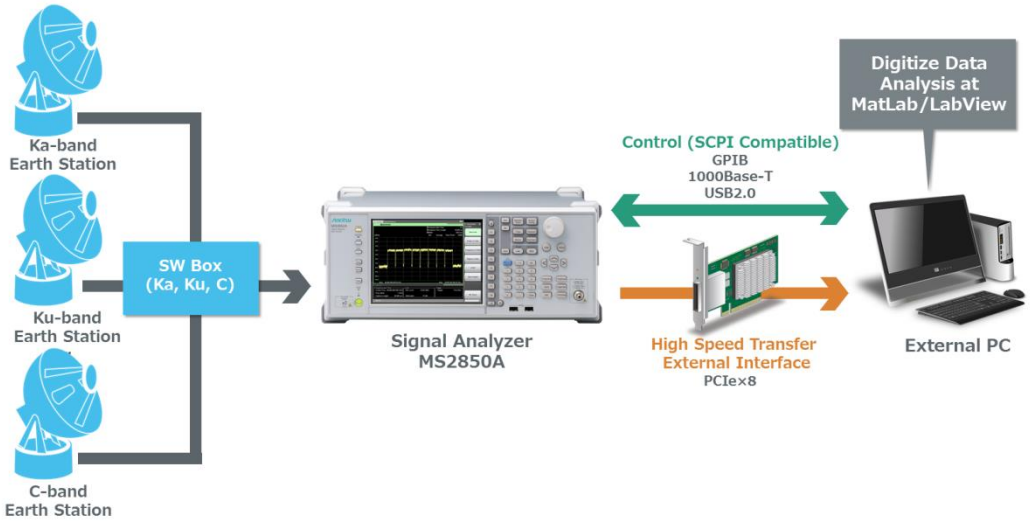

Figure 2.1-1 Satellite monitoring (with PCIe)

2.2 Application Example Using Measurement Instruments for High Speed Data Acquisition

Figure 2.2-1 shows applications on a wireless transmitter production line. Manufacturing are mass-producing and inspecting DUTs on multiple production lines. Generally, at DUT inspection, since Pass/Fail evaluation is performed on an external PC based on marker values and analysis results obtained from a signal analyzer, the digitized data itself is lost. However, saving the RF signals as digitized data supports re-analysis (replay) under different measurement conditions and domains. Moreover, managing at a single control center all the digitized data collected from production factories of different locations helps facilitate quality control without distance and time-based differences. Implementing this system requires transfer of digitized data from the measuring instruments to PCs, but using Ethernet may result in transfer delays and poor mass-productivity. With its dedicated interface for data transfer, the MS2850A slashes times for transferring data stored in the instrument (the built-in waveform memory) to the PC, helping cut production costs.

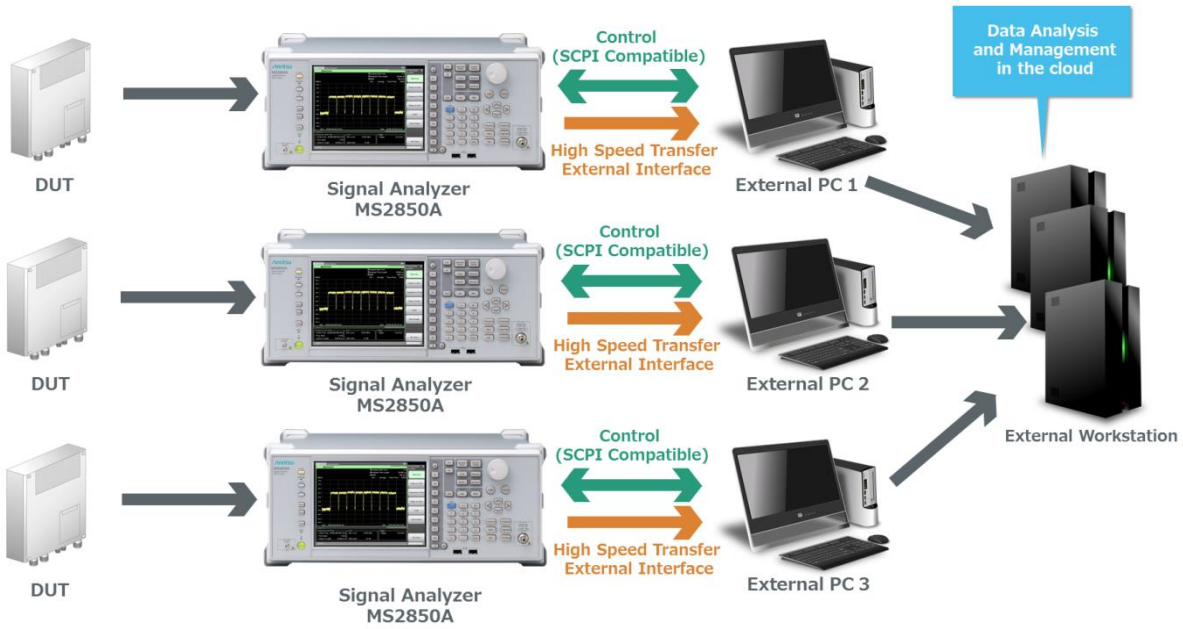

Figure 2.2-1 Data management on wireless transmitter manufacturing line

3 Introduction of Digitizer Function

3.1 Sampling Rate and Capture Time

The MS2850A has a signal analyzer mode as a standard function and the captured signal can be saved in the built-in waveform memory. Figure 3.1-1 shows a conceptual diagram for data transfer. High-speed data transfer directly transfers digitized IQ data in the MS2850A built-in waveform memory to the external PC memory without using the internal CPU.

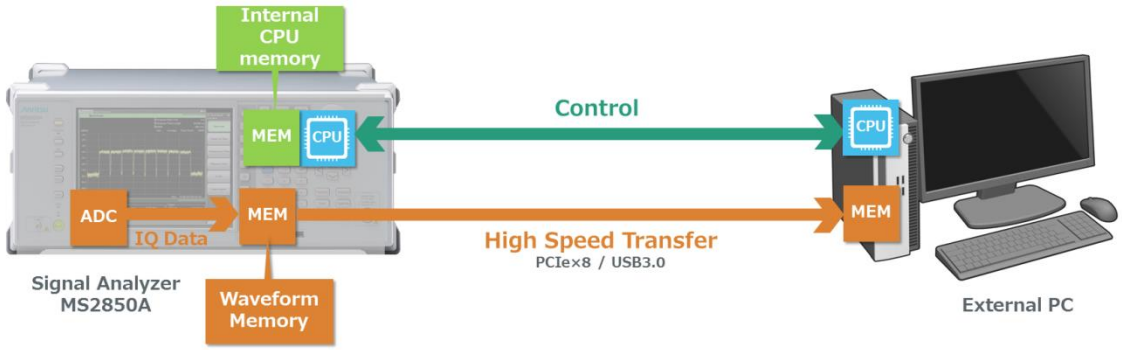

Figure 3.1-1 Conceptual diagram for data transfer

Table 3.1-2 lists the setting resolution and capture times at the frequency span settings and sampling rates. The MS2850A automatically determines the sampling rate based on the frequency span setting. Moreover, up to 3 s of digitized data can be saved at a maximum span of 1 GHz. At a frequency span of 1 GHz, since 1 sample is 8 bytes (Floating type, I,Q data), 0.1 s of digitized data has an extremely large size of 1,300,000,000 × 0.1 × 8 = 1,040,000,000 bytes (1.04 GB).

Table 3.1-2 Setting resolution and range by span and sampling rate

Span	Sampling rate	Setting resolution	Capture times	Sample number
50 MHz	81.25 MHz	160 ns	1600 ns to 48 s	730130 to 3900730000
62.5 MHz	81.25 MHz	160 ns	1600 ns to 48 s	730130 to 3900730000
100 MHz	162.5 MHz	80 ns	800 ns to 24 s	730130 to 3900730000
125 MHz	162.5 MHz	80 ns	800 ns to 24 s	730130 to 3900730000
255 MHz	325 MHz	40 ns	400 ns to 12 s	730130 to 3900730000
510 MHz*1	650 MHz	20 ns	200 ns to 6 s	730130 to 3900730000
1 GHz*2	1300 MHz	10 ns	100 ns to 3 s	730130 to 3900730000

*1: Requires Analysis Bandwidth Extension to 510 MHz MS2850A-033 or Analysis Bandwidth Extension to 1 GHz MS2850A-034.
*2: Requires Analysis Bandwidth Extension to 1 GHz MS2850A-034.

When digitizing using either the External Interface for High Speed Data Transfer PCIe or USB3.0 option, the lower limit of the frequency span is 50 MHz. If the frequency span is less than 50 MHz, use the Ethernet or USB2.0 interface.

3.2 Interface and Transfer Speed

As described in section 3.1, the digitized data size becomes extremely large when capturing wideband signals. Table 3.2-1 lists the transfer rates, transfer times, and applications for each interface. These data are actual values when transferring 32 GB (about 4000 MSa) of IQ data to an external PC; 32 GB is equivalent to about 3 s of digitized data at a span of 1 GHz. Changing from 1000Base-T to USB3.0, the transfer time is reduced to about 1/10. Moreover, changing to PCIe (x8/Gen2), it is reduced to about 1/100.

Table 3.2-1 Comparison of measured values when 32GB IQ data is transferred

	1000Base-T	USB3.0	PCIe (x8/Gen2)
Transfer rate (measured)	23 MB/s	340 MB/s	2400 MB/s
Transfer time (Average)	1,380 s Standard	96 s Fast	13 s Very fast
Versatility / Easiness	Available with a commercial cable	Available with a commercial cable	Require exclusive host adapter and cable There are notes on power supply sequence
Application	Research / Development Construction of measurement system at low cost	Research / Development Improve development efficiency by reducing time	Manufacturing Reduction of manufacturing cost by reducing tact time

4 RF Performance of Digitizer using Signal Analyzer

4.1 Spurious Free Dynamic Range (SFDR)

SFDR is the amplitude ratio of the fundamental signal to either the maximum harmonic distortion or the non-harmonic spurious. The signal and spurious are more easily distinguished as the SFDR becomes larger. Figure 4.1-1 shows actual values measured with the MS2850A. The nominal value is –70 dBc at a center frequency of 28 GHz and span of 1 GHz.

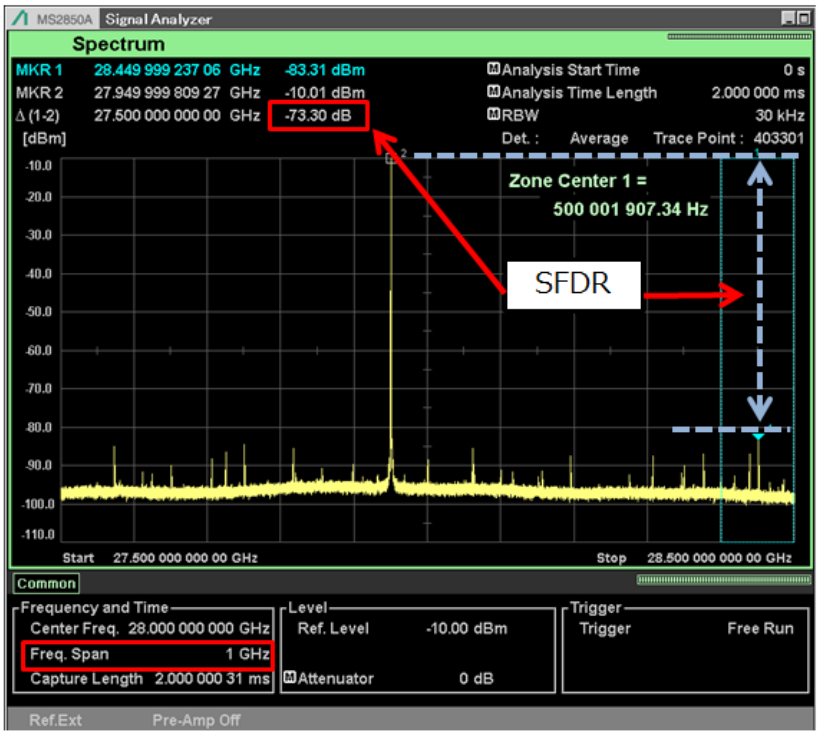

Figure 4.1-1 Measurement example of SFDR (Center frequency: 28 GHz, Span: 1 GHz, Measured)

4.2 Dynamic Range (Signal to Noise Ratio)

Dynamic range is the difference between the input signal level and the noise floor of the signal analyzer itself. As the dynamic range gets larger, the signal and noise can be clearly separated for more accurate modulation analysis results. In particular, when evaluating a wideband signal, the dynamic range may have more effect than the SFDR. Figure 4.2-1 shows a schematic chart for dynamic range. The normalized value at a noise floor of 1 Hz is called the signal analyzer Display Average Noise Level (DANL) which indicates the lowest level of the signal analyzer itself that can be measured. On the other hand, the ADC Clipping Level indicates the maximum signal level that can be input to the signal analyzer, and the difference between the ADC Clipping Level and the DANL is defined as the dynamic range. The MS2850A has a dynamic range of 142 dB at 28 GHz.
In case of measuring a 100 MHz band modulation signal with a peak factor of 14 dB, the converted value of the dynamic range becomes 142 dB – (10 x log100 MHz) –14 dB = 48 dB, the SNR is determined by the dynamic range rather than the SFDR.

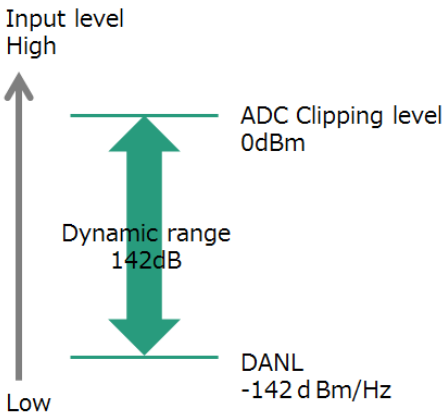

Figure 4.2-1 Schematic chart for dynamic range (Center frequency: 28 GHz, CW, Reference)

4.3 In-band Flatness

In-band flatness means the difference in dB units of the maximum and minimum change in the signal amplitude at the analysis bandwidth range. When capturing a wideband modulated signal, flatness shows how accurately the input signal amplitude can be captured. In particular, at measurement of wideband signals, it is important that the signal analyzer itself has excellent flatness performance. The MS2850A has excellent flatness because it has been calibrated at all frequencies.

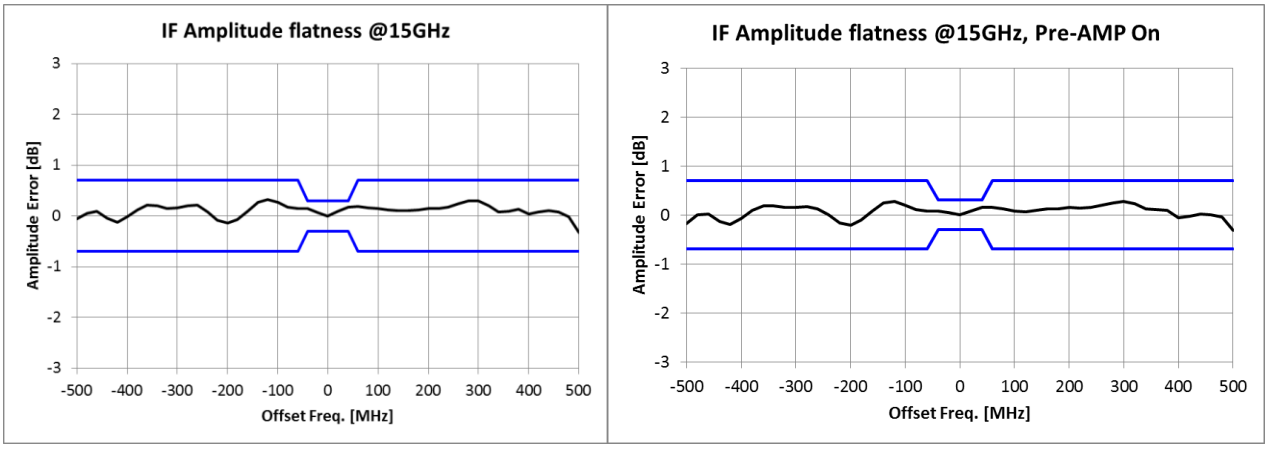

Figure 4.3-1 Amplitude flatness at center frequency: 15 GHz

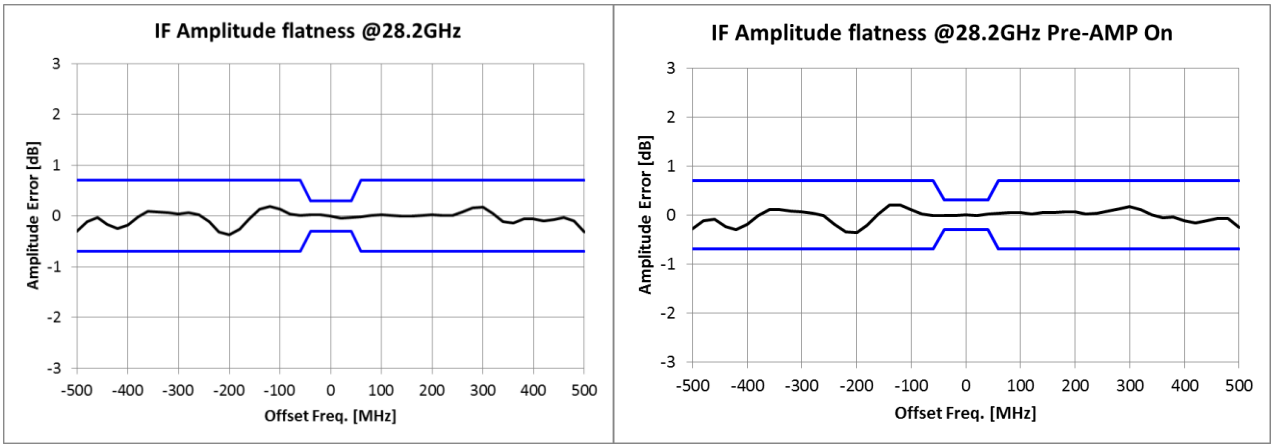

Figure 4.3-2 Amplitude flatness at center frequency: 28.2 GHz

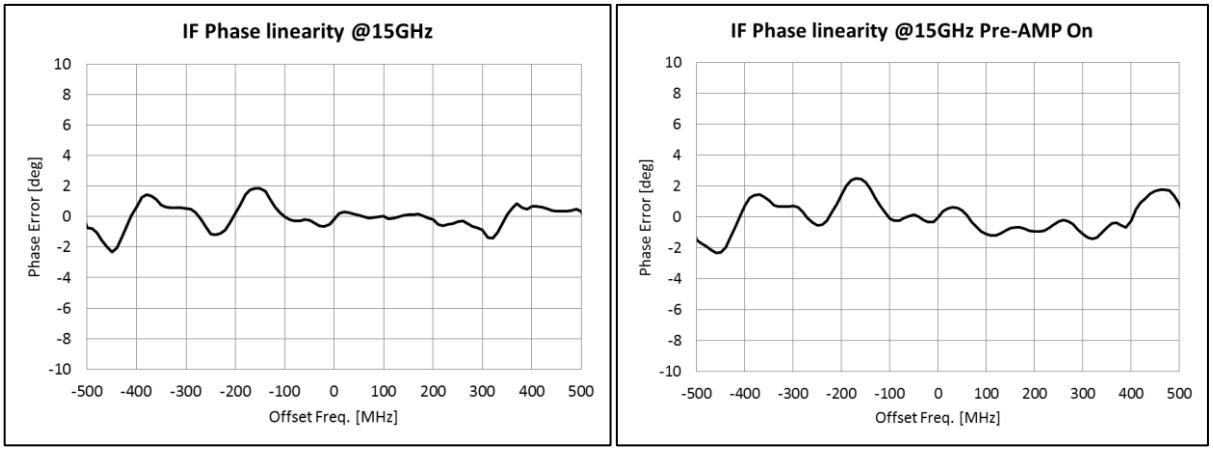

Figure 4.3-3 Phase linearity at center frequency: 15 GHz

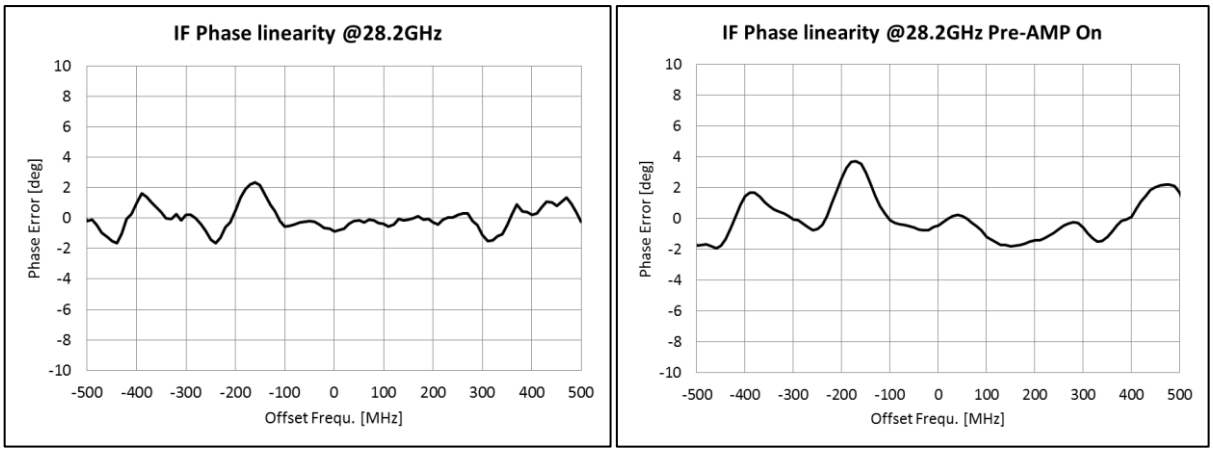

Figure 4.3-4 Phase linearity at center frequency: 28.2 GHz

4.4 Image Signal

Since a superheterodyne signal analyzer uses a mixer for frequency conversion, it has the problem of image signals being generated. Generally, signal analyzers use a preselector to suppress generation of image signals; but at wideband measurement, the preselector must be bypassed due to bandwidth restrictions caused by the preselector pass properties. Doing that, image signals are generated, appearing as unwanted signals that cannot be separated from the real signal to measure. Although the MS2850A bypasses the preselector at center frequencies of more than 4.2 GHz and analysis bandwidths of more than 50 MHz, as shown in Table 4.4-1, it is designed to be unaffected by image responses even at wideband measurement because of a high IF signal. In addition, Fig. 4.4-2 shows where the image signal is generated at input of a 10 GHz signal. The image signal appears at a frequency position that is twice the IF signal. It shows that there is hardly any effect of image signals as the IF increases. However, if the image signal does not disappear completely, it may be necessary to take other countermeasures such as inserting an external BPF.

Table 4.4-1 Digitizer supported by MS2850A

Center frequency	ADC Resolution	Maximum analysis bandwidth	IF frequency
> 4.2 GHz	12 bit	1 GHz	1.95 GHz

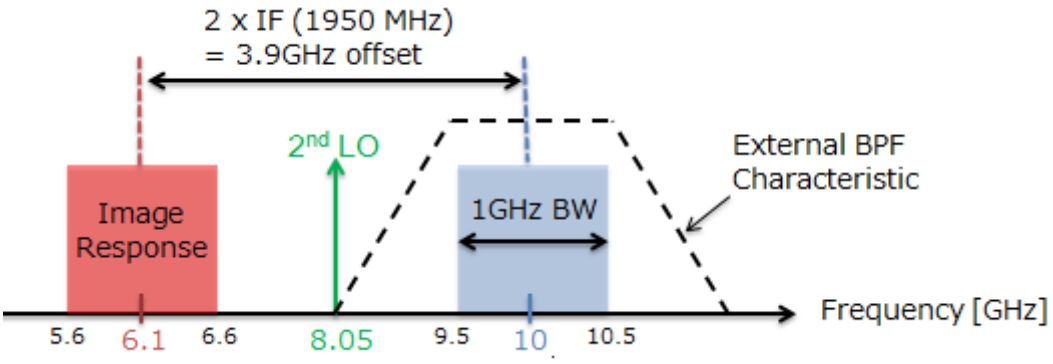

Figure 4.4-2 Image signal at center frequency: 10 GHz

5 Summary

The MS2850A transfers large amounts of digitized data at high speed from the measuring instrument to the external PC using a dedicated data transfer interface. It also has excellent digitizer performance. With these features, the MS2850A contributes to reduction of development and manufacturing time and cost.

6 Ordering Information

Model

Model	Name	Additional Information
MS2850A	Signal Analyzer	Analysis Bandwidth 255 MHz

Standard Option

Model	Name	Additional Information
MS2850A-047	32 GHz Signal Analyzer	Select maximum frequency. Frequency range not upgradable.
MS2850A-046	44.5 GHz Signal Analyzer	
MS2850A-033	Analysis Bandwidth Extension to 510 MHz	
MS2850A-034	Analysis Bandwidth Extension to 1 GHz	Requires MS2850A-033
MS2850A-068	Microwave Preamplifier	
MS2850A-053	External Interface for High Speed Data Transfer PCIe	
MS2850A-054	External Interface for High Speed Data Transfer USB3.0	

Accessories

Model	Name	Additional Information
U0088A	PCIe Host Adapter	
J1749A	PCIe x8 Cable (2 m)	
J1749B	PCIe x8 Cable (5 m)	

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Printed on Recycled Paper

Printed in Japan 2017-11 MG No. MS2850A-E-F-2-(1.00)