RF Signal Capture & Playback
Simple Operation Guide

Signal Analyzer and Built-in Vector Signal Generator Option
MS2690A Series
MS2830A (3.6/6.0/13.5 GHz Model)
MS2840A (3.6/6.0 GHz Model)

This manual explains examples of the Capture & Playback Function using the Signal Analyzer MS2690A series (MS269xA hereafter) and the MS2830A and MS2840A with installed Vector Signal Generator option.

When using the Capture & Playback function, the RF signal captured using the signal analyzer*1 is used to generate an IQ data file (capture hereafter) for generating the waveform pattern using the built-in vector signal generator*2 to output the RF signal (playback hereafter).

For example, it is better to use the Capture & Playback function to generate RF signals from playback from the captured data in the following cases:

✓ Although we want to evaluate actual wireless equipment signals, it is difficult to create and playback waveforms using general-purpose signal generators and software.
✓ When using wireless equipment (golden unit hereafter) as a signal source, fine adjustment of the output level is difficult and the output is unstable.
✓ If many golden units (e.g. base stations) are required, the cost is much higher than using a measuring instrument.

Since this function automatically calculates the average power (rms) when generating the waveform pattern, the output level set at the signal generator after generation equals the average power.

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*1: Signal Analyzer
The MS269xA and MS2840A have a built-in signal analyzer with an Analysis Bandwidth of 31.25 MHz as standard.
The MS2830A can be installed as an option.

*2: Built-in Vector Signal Generator
Option for MS269xA, MS2840A, and MS2830A
This manual introduces examples of operation method for the following sample signal as the Capture & Playback function target.

**Sample Signal**
- Frequency: 400 MHz
- Level: -10 dBm
- Channel spacing: 25 kHz
- Burst Signal Repetition Conditions:
  - Burst Period: 40 ms
  - On Time: 10 ms
  - Off Time: 30 ms
  - Stationary (repeat)

At actual measurement, it is important to pre-confirm the target signal frequency, level, channel spacing, and repetition rate using a spectrum analyzer or signal analyzer. Refer to the procedure on the following page for how to confirm the target signal.
Confirming Signal 1/2
Checking Spectrum: Span Setting

- Use the signal analyzer to check the spectrum of the target signal.

- Switching signal analyzer mode
  > [Application Switch]
  > [F2: Signal Analyzer] *The application button layout may change arbitrarily.

- Executing preset
  > [Preset]
  > [F1: Preset]

- Setting frequency (Example: 400 MHz) *Set to the center frequency of the target signal.
  > [Frequency]
  > [F1: Center] = [400] [F2: MHz]

- Setting span (Example: 100 kHz) *Set to the observed full span of the entire target signal spectrum
  > [Span] = [100] [F3: kHz] *This can be set using the Up and Down keys.

- Setting sub-trace screen *Power vs Time is displayed at the bottom of the screen.
  > [Trace]
  > [F8: Sub Trace Setting]
  > [F1: Trace Mode]
  > [F2: Power vs Time]

- Setting analysis time (Example: 100 ms) *Set a longer time than the target signal burst period. (Example: 40 ms × 2 + margin)
  > [Time/Sweep]
  > [F3: Time Length] = [100] [F2: ms] *This can be set using the Up and Down keys.

- Setting trace (Example: Positive)
  > [Trace]
  > [F7: Time Detection] = Select "Positive" [F7: Set]

- Adjusting reference level
  > [Amplitude]
  > [F1: Reference Level] *Adjust so that the "Level Over" warning dialog is not displayed. *This can be set using the Up and Down keys.
  *Aim to set so there is about one scale of empty space above the spectrum.

- Setting Marker to OFF
  > [Marker]
  > [F5: Off]

When the confirmation target is a burst signal, set Trace to Positive and set the analysis time to longer than the burst period to confirm the spectrum during the On period.

Example of Spectrum Confirmation Screen

Confirm that the Frequency Span setting is about twice the channel width or twice the spectrum waveform. If it is not, adjust Span to the optimum setting.
Confirming Signal 2/2
Checking Power vs Time: Burst Period

- Use the signal analyzer to check the burst period of the target signal.

(Continued)
- Setting main trace screen *Power vs Time settings at screen top
  > [Trace]
  > [F1: Trace Mode]
  > [F2: Power vs Time]
- Setting single sweep (Single)
  > [→]
- Checking burst signal period with markers
  > [Marker]
  > [F2: Marker1] = Shifts marker to first burst signal rise *Fine-adjust using Left/Right keys and rotary knob
  > [F4: Marker2] = Shifts marker to second burst signal rise *Fine-adjust using Left/Right keys and rotary knob
  > Check “⊿(2-1)” at screen top

Example of Power vs Time confirmation Screen

This sample signal has a period of 40 ms per burst that can be also checked with a signal analyzer.

When the burst signal period is very short (fast), check the time for a longer period of 10 bursts if there is a risk of error when checking just one burst period.
This explains capture of only one burst of the target signal by the signal analyzer and playback from the signal generator. At playback, the single burst signal is output repeatedly from the signal generator. This can be used for tests that do not require continuous data, such as evaluation of the adjacent channel leakage power at tests of transmitter characteristics, and PER* measurements of receiver characteristics. However, there are some cases where this evaluation cannot be performed due to signal specifications.

- Switching to signal analyzer mode
  > [Application Switch]
  > [F2: Signal Analyzer] *The application button layout may change arbitrarily.
- Executing preset
  > [Preset]
  > [F1: Preset]
- Setting frequency (Example: 400 MHz) *Set to the center frequency of the target signal.
  > [Frequency]
  > [F1: Center] = [400] [F2: MHz]
- Setting span (Example: 100 kHz) *Set to the observed full span of the entire target signal spectrum
  > [Span] = [100] [F3: kHz] *This can be set using the Up and Down keys.
- Setting sub-trace screen *Power vs Time is displayed at the bottom of the screen.
  > [Trace]
  > [F8: Sub Trace Setting]
  > [F1: Trace Mode]
  > [F2: Power vs Time]
- Setting capture time (Example: 40 ms) *Set to burst period of target signal (Example: 40 ms)
  > [Menu]
  > [F7: Capture]
  > [F2: Capture Time Length] = [40] [F2: ms]
- Adjusting reference level
  > [Amplitude]
  > [F1: Reference Level]
  = Adjust so that the “Level Over” warning dialog is not displayed.
*This can be set using the Up and Down keys.
*Aim to set so there is about one scale of empty space above the spectrum.

- Setting trigger
  > [Trigger/Gate]
  > [F1: Trigger Switch] = On
  > [F4: Trigger Level (Video)] = Best Adjustment
  > [F8: Trigger Delay] = [-10] [F2: ms]
- Setting single sweep (Single)
  > [→]

*This completes signal capture.

At signal capture, if the capture start time is set to the burst signal On period, the recorded IQ data becomes discontinuous. (Refer to page 10.) In this example, the period of one burst is 40 ms. Since the capture start time and end time are each set to the burst signal Off period, set –10 ms at Trigger Delay.
*A positive value such as 30 ms can also be set, but the opposite value of –10 ms is set here.
Playing back signal from captured data (Playback)

> [Menu]
> [F7: Capture]
> [F6: Capture & Playback]

Set the following.

- Set waveform pattern package name
  *Default: Playback

- Set waveform pattern pattern name
  *Default: Digitize+YYYYMMDD+_addition number; Example: Digitize20160805_004

- Set burst signal to On
  *Generates waveform pattern as non-signal on Off period.

- Set burst signal Off evaluation level
  *Can only be set at Burst = On

- Set burst signal Off evaluation time
  *Can only be set at Burst = On

Execute Capture & Playback

The following icons are displayed at the top right of the screen during Capture & Playback

- This completes waveform pattern generation.
[Capture & Playback]

Case ①: Capturing One Burst Signal Only 3/3

(Continued)

- Checking waveform pattern selected at signal generator
  > [SG]
  Example: Digitize20160805_004

- Fine-adjust the frequency and level when the pattern is output from the signal generator
[Capture & Playback]

Case ②: Capturing Multiple Burst Signals 1/2

- This explains capture of multiple bursts (511 bursts hereafter) of the target signal by the signal analyzer and playback from the signal generator.
- At playback, the multiple burst signals (waveform pattern) are output repeatedly from the signal generator.
- This can be used for tests requiring continuous data, such as evaluation of Rx BER measurements.*
  
  *(There are some cases where this evaluation cannot be performed due to signal specifications.)*

[Supplementary Explanation]

$2^{9} - 1 = 511$ bits of data are output repeatedly for the PN9 PRBS pattern. Consequently, to maintain the PN9 data continuity, it is necessary to capture 511 burst signals. However, there are different cases depending on the communications system, such as when there are multiple slots in one frame.

- Switching to signal analyzer mode
  > [Application Switch]
  > [F2: Signal Analyzer] *The application button layout may change arbitrarily.

- Executing preset
  > [Preset]
  > [F1: Preset]

- Setting frequency (Example: 400 MHz) *Set to the center frequency of the target signal.
  > [Frequency]
  > [F1: Center] = [400] [F2: MHz]

- Setting span (Example: 100 kHz) *Set to the observed full span of the entire target signal spectrum
  > [Span] = [100] [F3: kHz] *This can be set using the Up and Down keys.

- Setting sub-trace screen *Power vs Time is displayed at the bottom of the screen.
  > [Trace]
  > [F8: Sub Trace Setting]
  > [F1: Trace Mode]
  > [F2: Power vs Time]

First, set the capture time to 40 ms and set the capture start time to the Off period.

- Setting capture time (Example: 40 ms)
  *Set to burst period of target signal (Example: 40 ms)
  > [Menu]
  > [F7: Capture]
  > [F2: Capture Time Length] = [40] [F2: ms]

- Adjusting reference level
  > [Amplitude]
  > [F1: Reference Level]
  = Adjust so that the “Level Over” warning dialog is not displayed.
*This can be set using the Up and Down keys.
*Aim to set so there is about one scale of empty space spectrum.

- Setting trigger
  > [Trigger/Gate]
  > [F1: Trigger Switch] = On
  > [F4: Trigger Level (Video)] = Best Adjustment
  > [F8: Trigger Delay] = [-10] [F2: ms]

(Continued)
Set the total time for capture over again.

- Setting capture time
  *Set time for 511 bursts of target signal
  Example: $40 \times 511 = 20440$ ms
  > [Menu]
  > [F7: Capture]
  > [F2: Capture Time Length] = [20440] [F2: ms]

- Setting single sweep (Single)
  > [→]

  *This completes signal capture.

The procedure from here is the same as for case 1.
See pages 6 to 7 for details.

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**Maximum Signal Analyzer Capture Function Capture Times**

The maximum capture time differs with the Span setting. Refer to the table on the right for details.

For example, the maximum capture time is 500 s when the span is 100 kHz.

In addition, the upper limit of the frequency span that can be set for the MS269xA, MS2830A, and MS2840A differs with the installed Analysis Bandwidth option.
[Supplementary Explanation]

Capture & Playback of Continuous Signal 1/2

When capturing a continuous signal, the capture start time cannot be set in the signal Off period. The capture start must always be in the On period. Consequently, at playback (output from the signal generator), the IQ data is discontinuous at the point where it returns from the end of the waveform pattern to the start. This discontinuous IQ data causes the following phenomena.

[Phenomena]

- **Distortion over a wide spectrum range; at Tx evaluation, the adjacent channel leakage power and modulation accuracy suffer large deterioration.**
- **Errors or sync loss may occur at Rx evaluations, such as BER measurement, due to the discontinuous signal data.**

Signal Before Capture & Playback

The IQ data is discontinuous at the point where it returns from the end of the waveform pattern to the start, causing distortion over a wide spectrum range.

Signal After Capture & Playback

Example of Spectrogram Measurement Screen

Example of Spectrum Measurement Screen

Example of Spectrum Measurement Screen

Example of Spectrum Measurement Screen
[Supplementary Explanation]

Capture & Playback of Continuous Signal 2/2

[Workaround Case 1] Setting analysis range (time) to avoid distortion timing

Any analysis range (time) can be set using the signal analyzer functions. For example, at adjacent channel leakage power measurement, the timing performance with distortion (lower left figure) is greatly degraded whereas the timing performance without distortion (lower right figure) shows almost no degradation.

[Workaround Case 2] Setting longer capture time

As an example, sometimes setting a capture time with a sufficiently longer margin than the required time at the DUT (wireless equipment) and then playing back is used for sensitivity measurements, such as BER. In this case, sometimes it is necessary to set the DUT to the standby status for Rx evaluation and output the signal (waveform pattern) only once instead of repeatedly to perform BER measurement in this period.

Refer to page 9 for the maximum capture times of the signal analyzer capture function.

The function for outputting this signal (waveform pattern) once only is set at the vector signal generator option for the MS2830A/MS2840A. It cannot be set using the MS269xA. Refer to the following operation manual for more details.

- MS2830A/MS2840A Operation Manual
  Vector Signal Generator Operation
  2.6.2 Setting Start/Frame trigger

Note: Even using these workarounds, it is not possible to capture issues where the IQ data is discontinuous at the point of return from the end of the waveform pattern to the start. When wanting to evaluate a signal with stable quality, consider using the waveform pattern and waveform generation software (IQproducer) for vector signal generator.
This section explains an example of playback of the waveform pattern generated using the Capture & Playback function.

**Equipment Setup**

(1) First, output the following modulation signal from the vector signal generator option installed in the Signal Analyzer MS2830A and confirm the level and modulation accuracy (EVM) at the MS2830A.

- **Frequency**: 400 MHz
- **Level**: -10 dBm
- **Channel spacing**: 25 kHz
- **Burst Signal Repetition Conditions**:
  - Burst Period 40 ms
  - On Time 10 ms
  - Off Time 30 ms
  - Stationary (repeat)

(2) Second, confirm the level and modulation accuracy (EVM) at the MS2830A for the modulation signal played back using the Capture & Playback function.

**Confirmation Items**

- **Level** Refer to page 13.
- **Modulation Accuracy (EVM)** Refer to page 14.
First, output an unmodulated signal from the signal generator and adjust the offset for cable loss, etc.

Check that the signal generator level setting and the signal analyzer level (power) measurement result are about the same.

Next, output the modulation signal to be captured from the signal generator. Check that the signal generator level setting and the signal analyzer measurement result are about the same.

*Measure the average power of burst signal On period with the signal analyzer.
*The signal generator level setting at this sample signal is the average power of burst signal On period.

Finally, output the modulation signal generated by the Capture & Playback function from the signal generator. Check that the signal generator level setting and the signal analyzer measurement result are about the same.

Since the average power of burst signal On period of the waveform pattern generated by the Capture & Playback function like this is the same as the signal generator setting, it can be used for evaluation while fine-adjusting the output level.
Before Capture & Playback, output the modulation signal to be captured from the signal generator.

\[
\begin{array}{|l|l|l|}
\hline
\text{Numeric} & \text{Avg / Max} \\
\hline
\text{Tx Power} & -10.07 / -10.06 \text{ dBm} \\
\text{Frequency Error} & 0.05 / 0.04 \text{ Hz} \\
\text{EVM(rms)} & 0.30 / 0.33 \% \\
\text{EVM(peak)} & 0.50 / 0.64 \% \\
\text{Phase Error(rms)} & 0.12 / 0.13 \text{ deg.} \\
\text{Phase Error(peak)} & -0.06 / -0.29 \text{ deg.} \\
\text{Mag. Error(rms)} & 0.22 / 0.23 \% \\
\text{Mag. Error(peak)} & 0.08 / 0.54 \% \\
\text{Origin Offset} & -63.48 / -62.91 \text{ dB} \\
\text{IQ Gain Imbalance} & 0.00 / 0.01 \text{ dB} \\
\text{Quadrature Error} & 0.13 / 0.33 \text{ deg.} \\
\hline
\end{array}
\]

Then, output the modulation signal generated by the Capture & Playback function from the signal generator.

\[
\begin{array}{|l|l|l|}
\hline
\text{Numeric} & \text{Avg / Max} \\
\hline
\text{Tx Power} & -9.94 / -9.94 \text{ dBm} \\
\text{Frequency Error} & 0.08 / 0.09 \text{ Hz} \\
\text{EVM(rms)} & 0.51 / 0.52 \% \\
\text{EVM(peak)} & 0.74 / 0.76 \% \\
\text{Phase Error(rms)} & 0.21 / 0.21 \text{ deg.} \\
\text{Phase Error(peak)} & -0.30 / -0.40 \text{ deg.} \\
\text{Mag. Error(rms)} & 0.37 / 0.37 \% \\
\text{Mag. Error(peak)} & -0.67 / -0.66 \% \\
\text{Origin Offset} & -62.40 / -62.17 \text{ dB} \\
\text{IQ Gain Imbalance} & -0.04 / -0.04 \text{ dB} \\
\text{Quadrature Error} & 0.51 / 0.51 \text{ deg.} \\
\hline
\end{array}
\]

Waveform patterns generated using Capture & Playback like this are slightly degraded by the effect of sampling processing at capture. However, playback is possible with a modulation accuracy close to that of the original signal.

Note: When the frequency, level and modulation of the signal to be captured are unstable, the Capture & Playback function may not be able to playback a signal with the same quality as above. When wanting to evaluate a signal with stable quality, please consider using our waveform pattern and waveform generation software (IQproducer) for vector signal generator.
For details of functions and specifications not described in this User Guide, refer to the following documents.
The latest version of the operation manual can be downloaded from the Anritsu website at http://www.anritsu.com.
*To search, input the function name using the Search function at the top right of the web page.

Refer to Chapter 5 Digitize Function.

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