

Multi-Standard Radio Signal Generation using MG3710A Waveform Combine Function

MG3710A
Vector Signal Generator

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1. Introduction

In recent years, a variety of wireless systems such as GSM, W-CDMA, LTE, etc., have appeared as communications have switched to wireless technologies and transmission speeds have increased. As a result, base stations are handling multiple types of wireless system.

Base stations supporting multiple wireless systems regulated by 3 GPP such as LTE and W-CDMA, are standardized by TS37.104/TS37.141, which regulate the TRx tests for base stations handling multiple wireless systems called Multi-Standard Radio.

The vector signal generator is one measuring instrument used for base station TRx evaluation tests. General-purpose vector signal generators output one specific wireless standard signal from one RF port. However, TS37.104/TS37.141 Multi-Standard Radio TRx tests are expected to require vector signal generators that are also able to handle multiple wireless systems simultaneously. Using a general-purpose vector signal generator, it can be very difficult to generate signals for different wireless systems such as LTE, W-CDMA, GSM, etc., under the following conditions:

- Different sampling rates for communications systems
- Different signal cycle for communications systems

Unlike general-purpose vector signal generators, the MG3710A can generate a combined signal for different wireless systems, such as LTE, W-CDMA, GSM, etc.

This application note explains some of the problems when generating signals for combinations of different wireless systems using a general-purpose vector signal generator. It also explains how to solve these problems using the MG3710A and then introduces an example of how to generate Multi-Standard Radio signals.

2. Problems Combining Different System Signals

Let's consider the problems of outputting a combination of signals for different communications systems from a vector signal generator.

As an example, let's assume output of GSM and W-CDMA signals specified by TS 37.104/TS 37.141 10.5.0 (2011-12) from a vector signal generator.

Figure 1 shows an example of the signals standardized by TS37.104/TS37.141 V10.5.0 (2011-12).

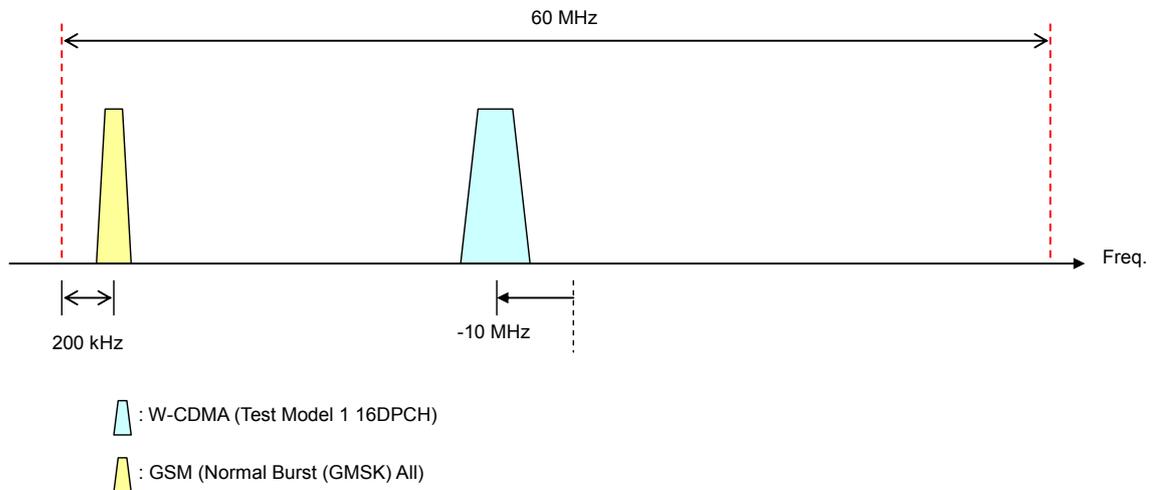


Figure 1. Example of GSM and W-CDMA Signal Combination

There are two methods for outputting these signals from commercial general-purpose vector signal generators:

1. Combine using two vector signal generators.
2. Combine two signals as one waveform pattern.

Let's consider the first method. As shown in Figure 2, using this method, a coupler is required to combine signals from the two vector signal generators. In this configuration, before signal combination at the coupler, it is necessary to adjust each output level from the two vector signal generators. As a consequence, this increases the costs because the system will require provision of jigs as well as assured isolation.

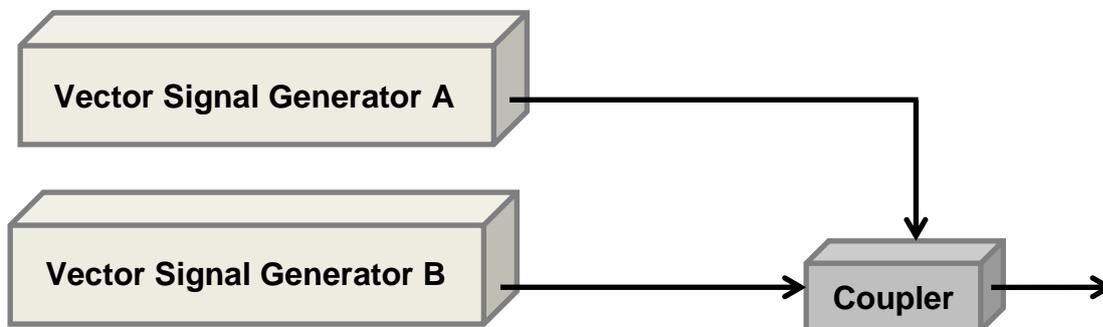


Figure 2. Setup when Combining Outputs from Two Vector Signal Generators

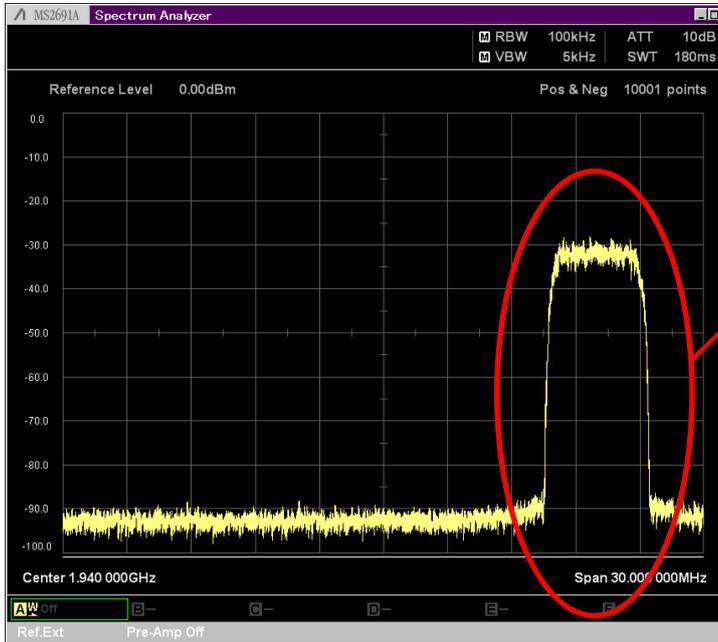
Next, let's consider the second method. Since this method only requires one vector signal generator, the costs are greatly reduced compared to the first method. In addition, it is not necessary to adjust the output levels because the signals are combined by digital processing. However, when combining signals for different communications systems, it is necessary to solve the following two problems.

- Difference in waveform pattern sampling rate
- Difference in waveform pattern cycle

Next, let's consider how each of these impacts the signal after combining.

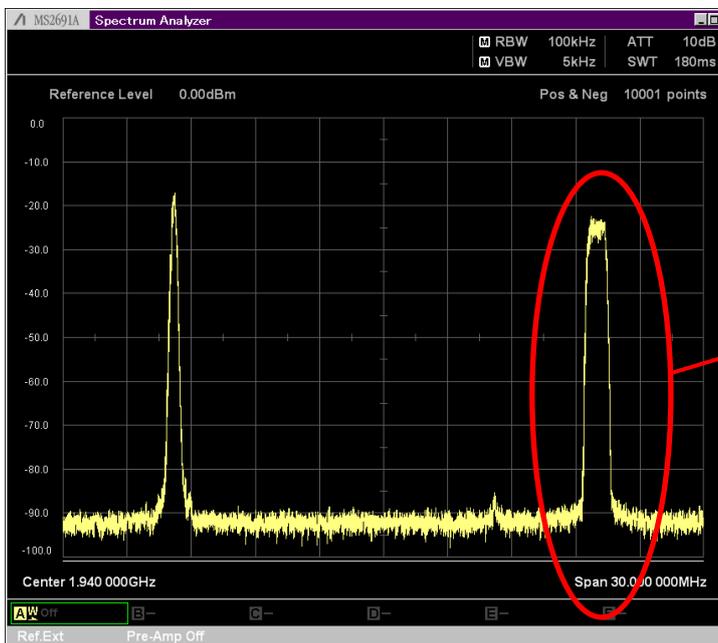
2.1 Difference in Sampling Rates

Usually, two waveform patterns created according to different communications standards are created at different sampling rates. As a consequence, it is necessary to match the sampling rates of the two waveform patterns to be combined. Conversely, when combining waveform patterns with different sampling rates, the correct signal cannot be output because one of the two waveform patterns has a different sampling rate from the required standard. Figure 3 shows an example of when W-CDMA and GSM signals are combined as is with different sampling rates. In this case, the W-CDMA sampling rate is different from the true sampling rate. As a consequence, the W-CDMA signal spectrum is different from the true spectrum.



True W-CDMA Signal Spectrum

True spectrum



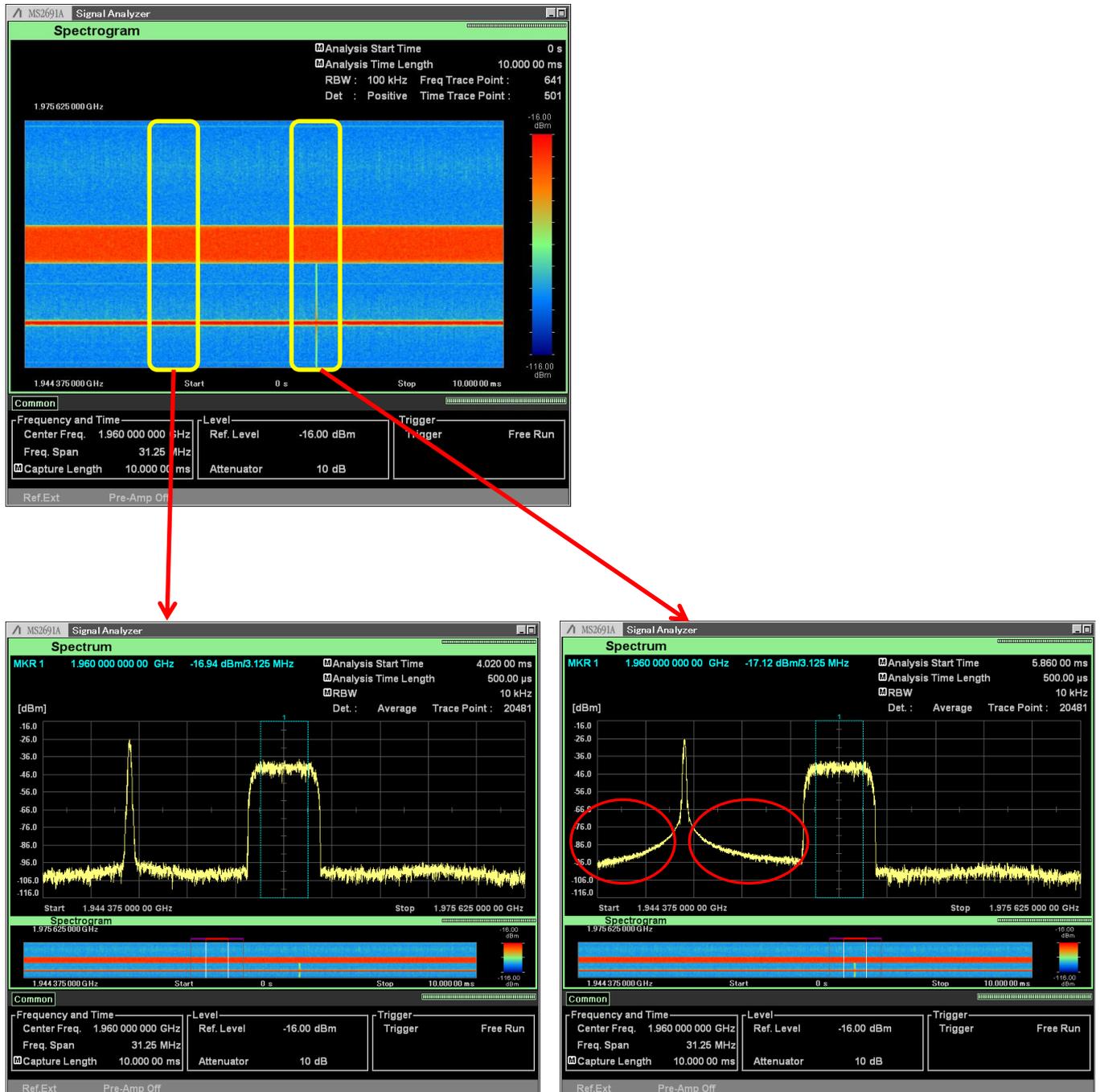
W-CDMA signal spectrum when GSM signal combined

W-CDMA waveform pattern
The true bandwidth is about 3.84 MHz but this bandwidth has been changed to output at the combined GSM waveform pattern sampling rate.

Figure 3. Example of Combining Waveform Patterns with Different Sampling Rates

2.2 Difference in Waveform Pattern Cycle

Communications standards specify the cycle in units such as frame length. When creating a waveform pattern using a vector signal generator, the waveform is created based on the units specified by this communications standard. As a consequence, waveform patterns created by each communications standard have different sample points. When combining two signals it is necessary to consider this difference in sample points. Figure 4 shows an example of how the sample point of one of the waveforms is stopped to match the sample counts when combining waveforms. From this example, we can clearly see that spurious noise is generated at the part where the waveform pattern was stopped. Moreover, this can cause problems at Rx characteristics tests because the stopped part of the waveform pattern cannot be received.



2.2 Difference in Waveform Pattern Cycle (continued)

The following work is required to resolve the above-described problems:

1. Convert sampling rates and match sampling rates of two waveform patterns
2. Using matched sampling rates, generate waveform patterns with least common multiple cycle to match cycles of two waveform patterns

The following describes an example using actual waveform patterns to create one waveform pattern by combining two waveforms. Table 1 shows the sampling rates and sample points of the waveform patterns used in this example.

Table 1. W-CDMA and GSM Signal Specifications

Waveform Pattern	Sampling Rate	Sample Point
W-CDMA	15.36 MHz	153600
GSM	3.25 MHz	7665000

First, sampling rate conversion is performed and then the sampling rates are matched. The sampling rate of both the W-CDMA and GSM signals becomes 19.5 MHz by 3258/256 times multiplication of the W-CDMA sampling rate and by 6 times multiplication of the GSM sampling rate. Table 2 shows the sampling rate and sample point for the W-CDMA and GSM waveform patterns after sampling rate conversion.

Table 2. Specifications of W-CDMA and GSM Signals with Matched Sampling Rates

Waveform Pattern	Sampling Rate	Sample Points
W-CDMA	19.5 MHz	195000
GSM	19.5 MHz	45990000

Next, the sample counts are matched by finding the least common multiple of the sample points of the two waveform patterns. For example, the least common multiple of 195,000 and 45,990,000 is 597,870,000. In other words, combination of the waveform patterns used in this example increases the sampling points to 597,870,000. Increasing the sample count requires the vector signal generator to have a larger waveform memory, making the vector signal generator more expensive; depending on the waveform pattern combination, the waveform memory size can be even larger.

Additionally, combination of two signals may require additional work for frequency offset and level ratio corrections. When combining two waveform patterns, it may be necessary to recreate the waveform patterns each time the frequency offset and level ratio change. As a result, although it may be possible to suppress costs for vector signal generators, other labor costs are incurred by the need to create new waveforms.

As explained above, the following problems occur when using conventional vector signal generators to combine two waveforms for different communications standards:

- Costs of vector signal generators
 - Purchasing two vector signal generators and jigs
 - Complex system equipment
- Costs of creating waveform patterns used for signal combination
- Costs needed to capture large waveform patterns
 - Waveform generation time
 - Cost of larger waveform pattern memory required to recreate larger waveform patterns

3. Combining Signals using MG3710A

The MG3710A supports the following two unique functions, solving the previously described problems of conventional vector signal generators.

- Waveform combine function
- Rate matching function

[Waveform Combine Function]

This function combines two signals by using the digital processing function of the MG3710A main frame. The MG3710A has two baseband memories as shown in Figure 5 that can regenerate each signal. As a result, since it is no longer necessary to combine two waveforms into one waveform pattern, it is also not necessary to match the sample points of the combined waveform patterns.

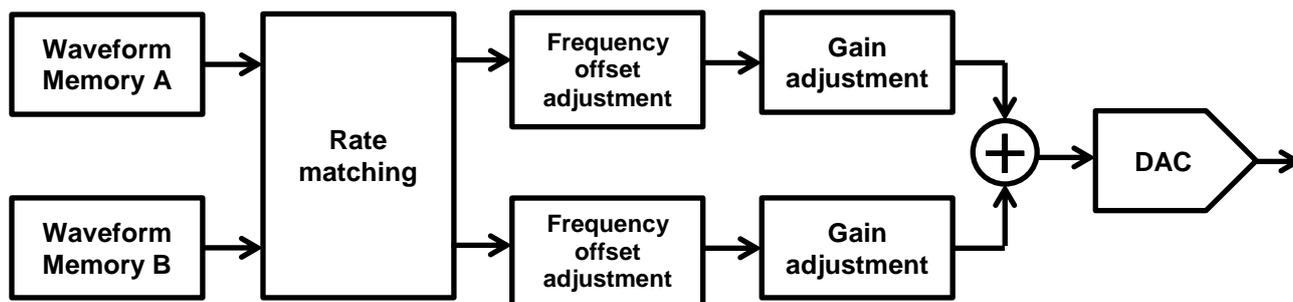


Figure 5. MG3710A Baseband Block

[Rate Matching Function]

When combining two signals with the MG3710A, this function performs combination by matching the sampling rates of the two baseband memories automatically, eliminating a great deal of time and effort matching the waveform pattern sampling rates before waveform combination.

By using these functions of the MG3710A, it is no longer necessary to perform the previous sampling rate and data point matching work required by conventional vector signal generators.

Moreover, two expensive vector signal generators are no longer required. In addition, since the frequency offset and gain adjustment functions are built into the MG3710A, it is no longer necessary to regenerate the waveform pattern each time the frequency offset and level ratio are changed.

Choosing the MG3710A eliminates one vector signal generator from the equipment costs along with the time consuming and costly work of combining two waveforms, slashing the total costs of combining two waveforms.

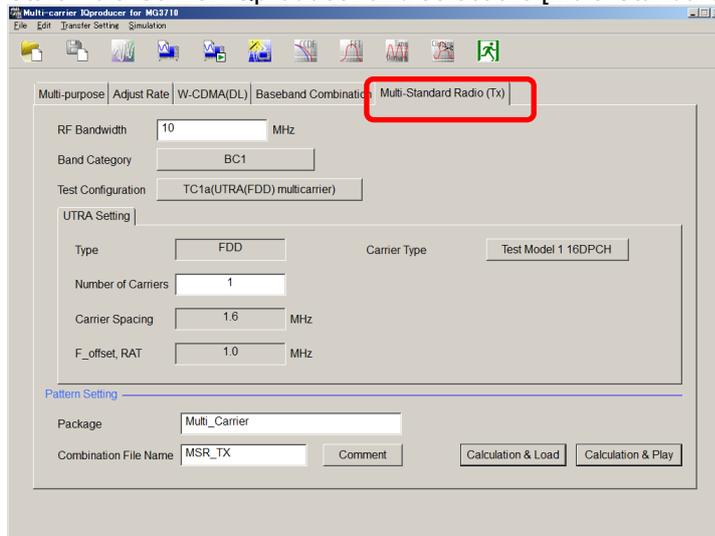


- **Only one vector signal generator required**
- **Eliminates working matching sampling rate and data point**
- Performs combination simply by selecting waveform patterns for combination
- Change frequency offset and adjust gain without needing to regenerate waveform
- Generate waveforms on main unit using touch pane

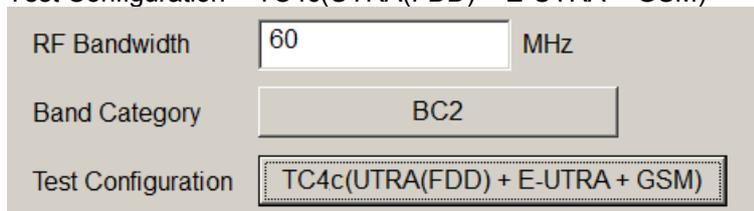
Figure 6. MG3710A with Waveform Combination Function

4.1 Example of Tx Characteristics Test Waveform Pattern Output (continued)

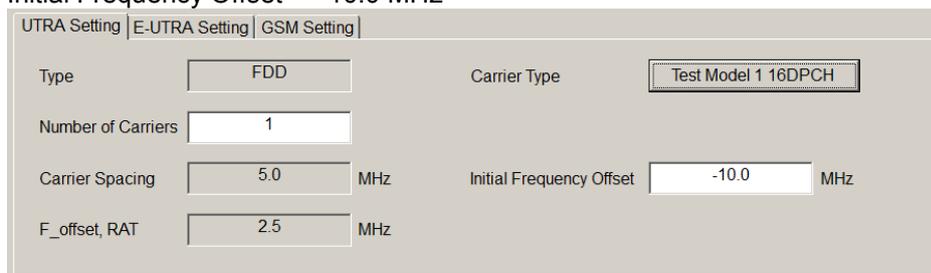
3. Start Multi-Carrier IQproducer and select the [Multi-Standard Radio (Tx)] tab.



4. Set the RF Bandwidth, Band Category and Test Configuration items as shown below:
RF Bandwidth = 60 MHz
Band Category = BC2
Test Configuration = TC4c(UTRA(FDD) + E-UTRA + GSM)



5. Select the [UTRA Setting] tab and set as shown below:
Carrier Type = Test Model 1 16DPCH
Number of Carriers = 1
Initial Frequency Offset = -10.0 MHz



4.1 Example of Tx Characteristics Test Waveform Pattern Output (continued)

- Next, select the [E-UTRA Setting] tab and set as shown below:
Frame Type = FDD
Bandwidth = 5 MHz
Carrier Type = Test Model 1.1
Number of Carriers = 1
Initial Frequency Offset = +10.0 MHz

The screenshot shows the 'E-UTRA Setting' tab with the following parameters:

Frame Type	FDD	Bandwidth	5MHz	Carrier Type	Test Model 1.1
Number of Carriers	1				
Carrier Spacing	5.0	MHz	Initial Frequency Offset	+10.0	MHz
F_offset, RAT	2.5	MHz			

- Select the [GSM Setting] tab and set as shown below:
Carrier Type = Normal Burst(GMSK) All
Number of Carriers = 1

The screenshot shows the 'GSM Setting' tab with the following parameters:

Carrier Type	Normal Burst(GMSK) All				
Number of Carriers	1				
Carrier Spacing	600	kHz	F_offset, RAT	200	kHz

- Next, set the Package and Combination File Name. Click the [Calculation & Play button] to finish setting.

The screenshot shows the 'Multi-Standard Radio (Tx)' window with the following parameters:

RF Bandwidth	60	MHz			
Band Category	BC2				
Test Configuration	TC4a(UTRA(FDD) + E-UTRA + GSM)				
Carrier Type	Normal Burst(GMSK) All				
Number of Carriers	1				
Carrier Spacing	600	kHz	F_offset, RAT	200	kHz
Package	Multi_Carrier				
Combination File Name	MSR_TX				

Buttons: Calculation & Load, Calculation & Play (indicated by a red arrow)

4.1 Example of Tx Characteristics Test Waveform Pattern Output (continued)

Making the above settings outputs the signal with the spectrum shown in Figure 8 from the MG3710A. We can see that it is a combination of the W-CDMA, LTE, and GSM signals.

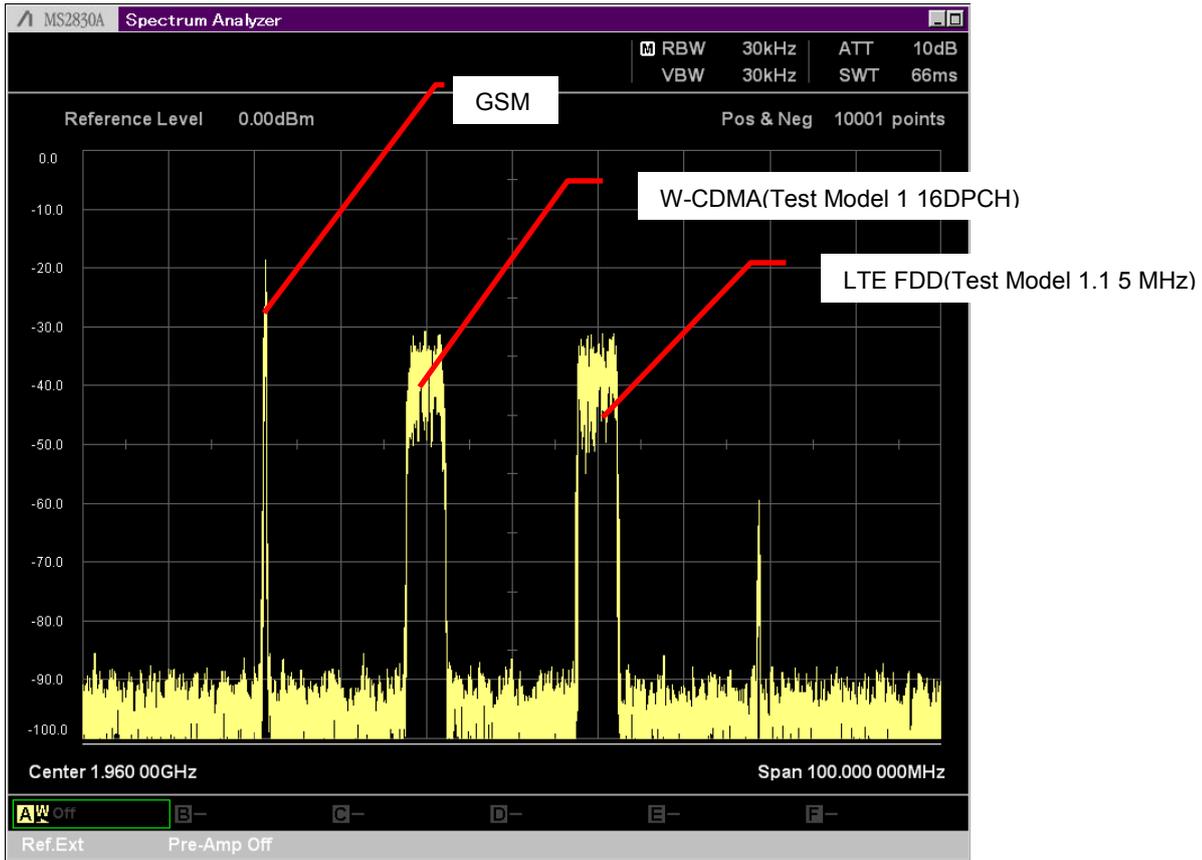
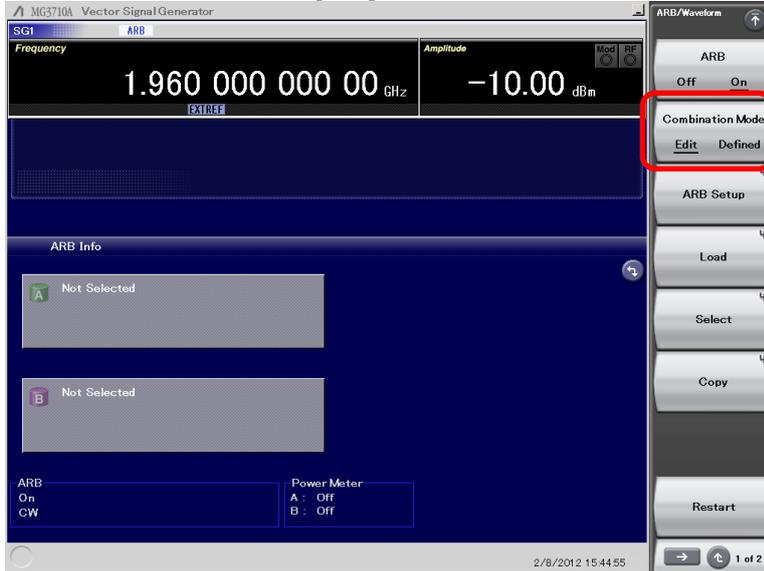


Figure 8. Example of Tx Characteristics Test Signal Output from MG3710A

4.2 Example of Rx Characteristics Test Waveform Pattern Output

This example shows the combined E-UTRA FDD (LTE FDD) and GSM signal output for testing Rx characteristics standardized by the Multi-Standard Radio TC5b regulation.

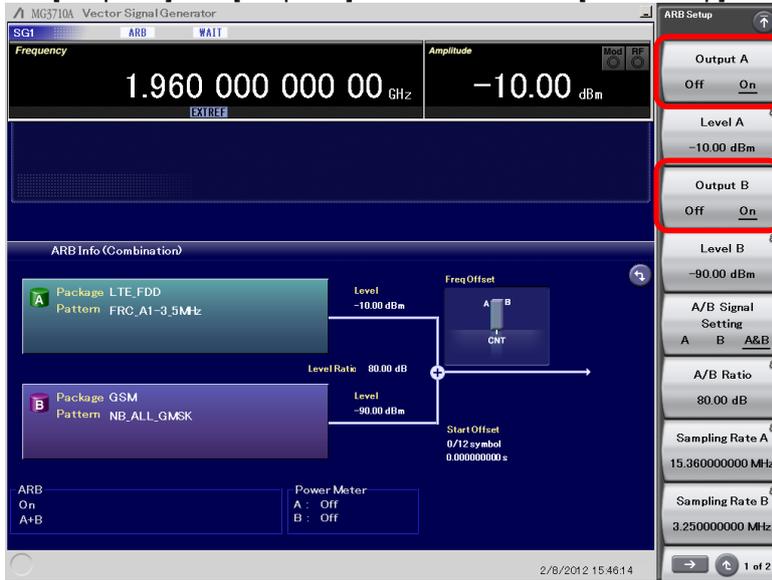
1. The provided LTE FDD and GSM signals are loaded into Memory A and Memory B, respectively. Here, the FRC A1-3 5 MHz signal created by MX370108A LTE IQproducer is used as the LTE signal. In addition, this time, the NB_ALL_GMSK standard waveform pattern is used as the GSM signal.
2. Set Combination Mode to [Edit] to combine the waveforms.



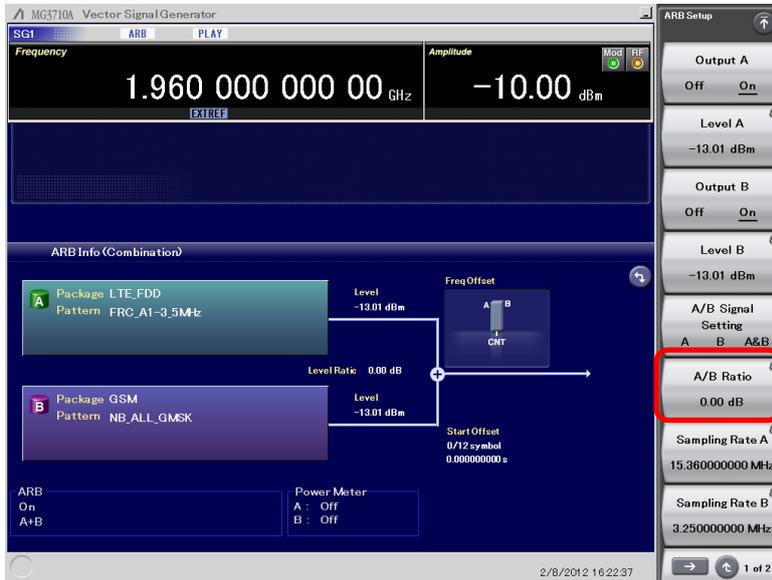
3. Click [Select] or Memory A, B shown on the screen to select the waveform pattern loaded into the waveform memory in step 1.



4. Set [Output A] and [Output B] shown in Mode at [ARB Setup] to output both waveform memories A and B.



5. Set the level ratio of waveform memory A and B using [A/B Ratio] displayed by setting Mode to [ARB Setup]. In this example, this is 0 dB because no level ratio is appended. Set an appropriate level ratio matching the test contents.



- Apply frequency offset to the memory-A and -B waveform patterns by setting [Freq Offset A] and [Freq Offset B] displayed on page 2 by setting Mode to [ARB Setup]. In this example, Freq Offset A is set to 27.5 MHz and Freq Offset B is set to -29.8 MHz.

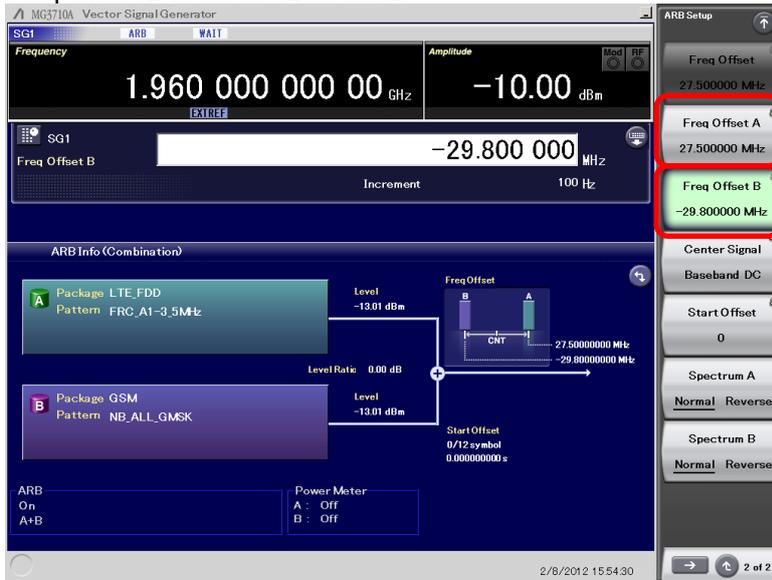


Figure 9 shows the spectrum of the signal output from the MG3710 by making the above settings. We can see that the output combines the GSM and LTE FDD (FRC A1-3 5 MHz) signals.



Figure 9. Example of Tx Characteristics Test Signals Output from MG3710A

5. Summary

The spread of new communications standards will require future support for base stations managing multiple communications standards. At that time, vector signal generators used for testing Tx and Rx characteristics will also be required to support multiple communications standard simultaneously. To meet this need, Anritsu has designed the MG3710A with both two-signal combine and rate matching functions. Using the MG3710A, not only are costs of generating Multi-Standard Radio test signals greatly decreased but also combinations of signals for different communications standards can be output easily—a difficult procedure using conventional vector signal generators.

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