Development of high performance Vector Signal Generator “MG3710A”

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[Summary] We developed the MG3710A Vector Signal Generator to support modern wideband wireless systems using more complex modulation methods. The MG3710A has excellent RF performance and a full line of versatile functions. It support two RF outputs, each outputting two signals for a total of four signals. Normally, several vector signal generators are needed to generate complex signals such as Wanted + Interference, Wanted + Delayed, Multi-carrier signals, etc., for testing wireless systems; the MG3710A with two RF ports eliminates the cost of extra vector signal generators.

1 Introduction

Smartphones are becoming increasingly multisystem with functions for supporting multiple mobile systems such as, LTE, 2G/3G (GSM, W-CDMA, etc.). In addition, they also have various other built-in wireless functions, such as ISDB-T digital broadcasting, W-LAN, GPS, etc. Similarly, mobile base-stations are also being developed to support multi-standard radio (MSR), transmitting and receiving several 3GPP Release 9 wireless signals simultaneously for LTE, W-CDMA, GSM, etc. Furthermore, R&D is progressing into LTE Advanced, the next-generation LTE standard supporting new technologies such as Intra-Band and Inter-Band Carrier Aggregation in addition to MIMO, meeting the need for faster communications speeds and now reaching the early deployment stage. Similarly methods for increasing W-LAN speeds are being examined and the latest IEEE802.11ac standard specifies a maximum bandwidth of 160 MHz and 256QAM modulation for achieving faster speeds.

Anritsu released the MG3700A Vector Signal Generator supporting various wireless communications technologies in 2004. The first MG3700A model offered wireless system manufacturers and developers various new unique functions such as the two-signal addition function. However, due to recent advances in wireless technologies, modern vector signal generators now require even higher-level functions and performance. Consequently, Anritsu developed the MG3710A as a test solution meeting the needs of both previous legacy systems as well as emerging next-generation systems.

As well as supporting a modulation bandwidth of 160 MHz, compared to previous vector signal generators, the MG3710A greatly extends the basic vector signal generator performance specifications, such as maximum output level, adjacent leakage power ratio, phase noise performance, and Error Vector Magnitude (EVM) to meet the testing needs of both wideband and narrowband communications systems. As well as having two built-in RF signal sources, each RF port has two independent arbitrary waveform generators (dual baseband), enabling one MG3710A to output up to four signal types. As a result, one MG3710A supports all the tests previously requiring several different signal generators while eliminating the need for external couplers and complex output level adjustments, to simplify setup and operation. Figure 1 shows the front view of the MG3710A.

Figure 1 Front View of MG3710A Vector Signal Generator

2 Development Concepts

The new MG3710A was developed to offer functions and performance supporting wide bandwidth and multi-standard radio requirements based on the following concepts:

(1) High-performance, low-cost design supporting applications ranging from manufacturing to R&D.

(2) Incorporating two RF signal sources and dual basebands for configuring small footprint and simple test system.

(3) Full range of versatile key functions supporting users' operating environments plus Calibration function to minimize measurement error and offer highest performance post-shipment test environment.

(4) Performance matching real-time waveform generation functions with built-in IQproducer™.

2.1 High Performance/Low Cost

The MG3710A design combines the contrasting requirements for high performance at low cost to support applications ranging from R&D and manufacturing with flexibility.

The following performance-related items have been upgraded:

- Better phase noise characteristics for offsets from a few to several tens of kHz required for narrowband communications.
- High output power performance with low distortion for configuring mobile test systems (mainly mobile base-station test systems) without external amplifier

A major redesign of the LO and RF sections was required to achieve the necessary low phase noise, low distortion and high output characteristics.

In addition, we combined the several separate printed circuit boards (PCB) for the LO, RF and Attenuator sections into a single board, helping save space and reducing costs. These design changes enabled incorporation of two RF signal sources in the MG3710A, greatly simplifying test systems for evaluating wireless systems previously requiring several costly measuring instruments.

2.2 Two RF Outputs/Dual Baseband

The MG3710A outputs two types of baseband signal using the two-signal addition function to perform baseband signal processing from one signal source. Moreover, the two built-in RF signal sources can output four signal types. Aditionally, previously unsupported baseband signal clock synchronizing and RF signal phase coherence are possible, supporting evaluation of MIMO systems offering faster data transfer speeds, and improved communications quality, as well as multi-standard radio systems like LTE and W-LAN.

2.3 Full Range of Versatile Functions

2.3.1 Excellent Basic Functions

The MG3710A has been designed with widely upgraded functions compared to its predecessor MG3700A to support a wide range of applications.

In particular, the unique two-signal addition function characterizing the MG3700A has been extended to improve operability. Unlike the predecessor MG3700A which could not perform two-signal addition for signals with different waveform sampling rates, the MG3710A has a built-in rate matching function using baseband signal processing to combine two baseband signals created with different sampling rates. Furthermore, the older model only supported frequency offset at one side of the baseband signal, while the new MG3710A supports frequency offsets independently for each of the two baseband signals. Consequently, at Rx sensitivity tests outputting the wanted + modulation interference signals, the signal arrangement can be adjusted simply on-screen to minimize the impact of carrier leak and image response.

Additionally, the MG3710A supports many functions that are not implemented in the MG3700A. Typical items are listed below:

- Multi-SG Coherent Function for 8 RF Output max. (MIMO)
- AM/FM/øM Modulation
- USB Power Sensor Connection
- Real-time AWGN Generation
- Sweep/List Function
- Support for SCPI Remote Control Command
- Built-in IQproducer™ (Waveform Pattern Generation Software)
- Touch Panel Operation

Although the MG3710A is positioned as the successor to the MG3700A it has been designed to assure compatibility for the items listed below:

- Support for MG3700A Functions

- Remote Control Command Compatibility
- Waveform Pattern File Compatibility

As a result, the MG3710A can be substituted easily for the MG3700A with little disruption to production lines, etc.

2.3.3 Calibration Function

The quadrature modulator used in vector signal generators generates spurious components called carrier leak and image response. The MG3710A has a new I/Q calibration function to reduce the impact of these spurious components. In addition, it supports an Internal Channel Correction function to correct the frequency characteristics response of the internal analog block.

2.4 Built-in IQproducer™

In previous signal generators, IQproducer runs on a external PC and the generated waveform pattern is transferred to the vector signal generator. The MG3710A has a built-in IQproducer and built-in touch panel, so it can generate waveform patterns without an external PC. Additionally, the MG3710A plays waveforms like a real-time waveform generation function.

3 Key Design Points

3.1 LO/RF Section

Figure 2 shows the block diagram for the MG3710A LO/RF section. The LO section uses a newly developed low phase noise Voltage Controlled Oscillator (VCO) to achieve the low phase noise characteristics; the division ratio is reduced by the high output frequency of the reference frequency generator section (Reference Frequency Generator in Figure 2) to obtain the low phase noise characteristics.

The next RF section uses a Direct Conversion Method. The simple block configuration greatly suppresses performance deterioration in the signal path to achieve low distortion. Additionally, installation of a power amplifier (PA) in parallel with the step attenuator at the output side of the output amplifier minimizes losses in the circuit from the PA to the RF output connecrtor, assuring the high output characteristics.

Further, mounting the LO, RF and step attenuator sections on the same board helps minimize cabling between each block while also sharing a common shield case to help achieve the dual RF outputs at low cost and reduced size.

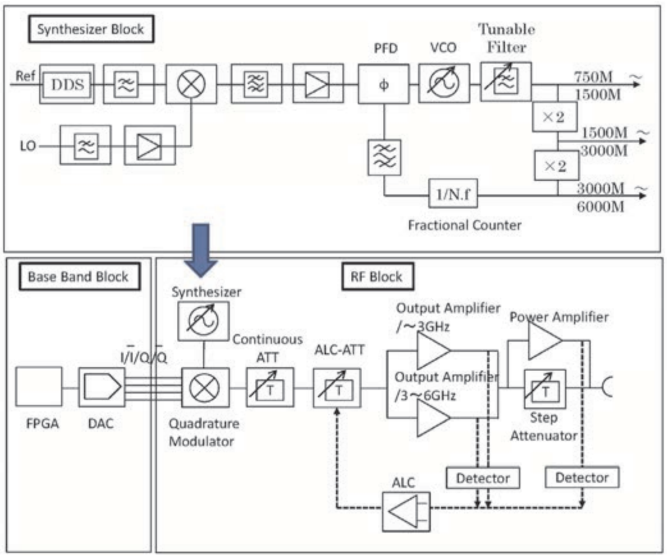


Figure 2 Block Diagram of LO and RF Sections

3.1.1 Low Phase Noise Characteristics

The synthesizer design standards for achieving the low phase noise characteristics are summarized below:

- Use smaller division ratio to reduce in-band noise by using high reference frequency.
- Use fractional counter to reduce spurious and minimize reference frequency variation range.

Lower phase noise characteristics than the conventional Phase Locked Loop (PLL) were achieved by increasing the reference frequency and lowering the PLL division ratio.

Moreover, use of the fractional counter minimized the reference frequency variation range, thereby reducing the impact of spurious generated by changes in the reference frequency.

In addition, an Anritsu developed low SSB phase noise VCO on the PCB offers the dual benefits of high performance at low cost. Figure 3 shows an example of the SSB phase noise characteristics.

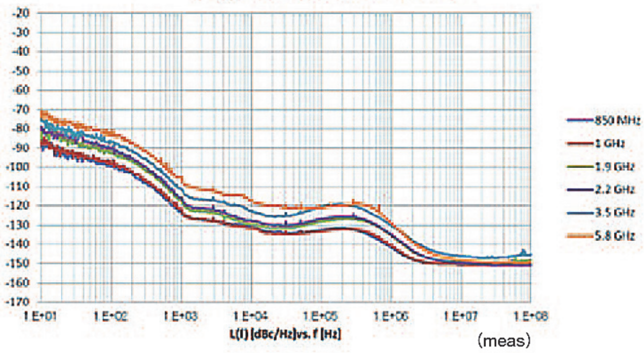


Figure 3 SSB Phase Noise Characteristics†

3.1.2 High Output Power Performance

The maximum output level of the vector signal generator is the maximum output level of the output amplifier (Output Amplifier in Figure 2) minus the loss in the circuit to the RF output connector. To achieve its high output power performance, the MG3710A uses a power amplifier (PA in Figure 2) in parallel with the Step Attenuator at the output amplifier output side, thereby minimizing circuit losses up to the RF output connector and achieving a maximum output level of +23 dBm (400 MHz to 3.0 GHz).

3.1.3 Low Distortion Performance

The vector signal generator distortion performance is the sum of the distortion components of the quadrature modulator output and the distortion components generated by each block in the signal path. The result is output as the final RF signal. To optimize the level diagram at each frequency, the MG3710A is calibrated at shipping inspection and, additionally, a low-distortion output amplifier is used to achieve low distortion characteristics (adjacent channel leakage power ratio of –71 dBc) for W-CDMA, TestModel1_64DPCH. Figure 4 shows an example of adjacent channel leakage power ratio measurement.

Figure 4 W-CDMA Measurement Example (Test Model1_64DPCH)

3.1.4 High Level Accuracy

The output signal level of a vector signal generator is controlled by the Automatic Level Control function (ALC). The ALC monitors the output level and feeds back the results to the controller, outputting a signal with a stable level. When a conventional signal generator is connected to a device under test (DUT) with poor reflection characteristics at the RF output connector, the combination of the wave reflected from the RF output and the standing wave forms a signal that is detected by the ALC detector and causes level variation in the vector signal generator signal output. As shown in Figure 5, the MG3710A uses a directional coupler as the signal splitter for the ALC detector to minimize the impact of the reflection wave and improve the level accuracy in actual use.

This improvement simplifies the test setup and procedures for device evaluation measurements requiring accurate level calibration.

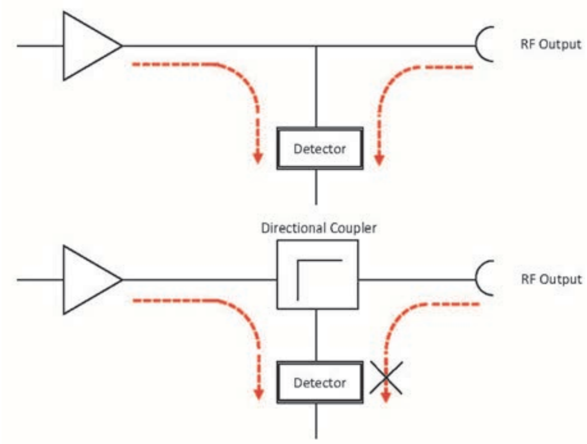


Figure 5 Level Accuracy Improvement Principle

3.1.5 Low Cost/Dual RF Output/Dual Baseband

The MG3710A combines the LO, RF and Step Attenuator sections on the one PCB to achieve a low-cost, space-saving, all-in-one design with two RF outputs and dual basebands. Moreover, the RF phase coherence assembly for splitting the LO signal, and the baseband clock splitter assembly simplify the synchronization system structure. Additionally, the functionality of the MG3710A is easily extended by configuring a synchronization system by connecting several MG3710A units using the splitter I/O as the interface between instruments. A typical synchronization system for evaluating MIMO devices requires multiple measurement systems and the system setup is greatly simplified using the MG3710A because one MG3710A unit has two RF outputs and a dual baseband function.

3.2 Baseband Signal Processing Section

Figure 6 shows the block diagram of the baseband signal processor.

3.2.1 Large Waveform Memory and Fast Signal Processor

The MG3710A has two independent arbitrary waveform memories (ARB Memory A and B) for each RF output. The standard memory size supporting 64 M sample can be optionally expanded to save up to 2048 M sample. This industry-leading ARB memory can be used to save waveform patterns over long periods and saves time when changing waveforms. The waveform data saved in the ARB memories is refreshed on a First In First Out (FIFO) basis (Wave-FIFO in Figure 6) and output to the oversampling DAC by the interpolator composed of resampler, FIR filter, and CIC filter in the baseband signal processing section.

Additionally, a maximum baseband signal processor sampling rate of 200 Msps is achieved using the high-speed FPGA to output signals for the 160 MHz maximum modulation frequency band specified by IEEE802.11ac.

3.2.2 Resampling

To support the Waveform Combine function for different communication systems, the MG3710A has a resampler section in the Waveform Combine function (Resampler in Figure 6).

To support a variety of wireless communications systems, the resampler is composed of a variable FIR filter on the assumptions that it will also be handling high conversion ratios. In such cases, the FIR filter requires steep filter characteristics and the baseband processor requires more logic resources and higher clock frequencies as the filter characteristics become steeper.

The MG3710A uses a polyphase FIR filter that does not use many logic resources and high clock frequencies. The polyphase FIR filter divides the originally required FIR filter into a number of smaller elements and the required filter processing is achieved by combining the results obtained from these elements. Dividing the filter greatly reduces computational load per clock and simultaneous supplement and thinning processing support resample processing for high conversion ratios. This supports efficient use of logic resources as well as various other functions in addition to resample processing.

3.2.3 Analog Modulation using Digital Processing

The MG3710A uses digital processing to support analog modulation functions such as AM/FM. Figure 7 shows the block diagram for the analog modulation using digital processing.

The analog modulator is divided into two blocks for AM and FM (øM); the modulation source is generated for each block from separate AF signal generators.

FM is achieved by inputting the frequency resource to the Numerical Controlled Oscillator (NCO) and performing complex multiplication of the created data by the I/Q signal. øM is achieved by converting the phase data to frequency data using the differentiator (d/dt in Figure 7) before use by the FM modulator. AM is achieved by multiplying the modulation source by the I/Q signal. In addition, tone squelch evaluation using the internal AF signal and external modulation is supported because input of an external modulation signal is supported.

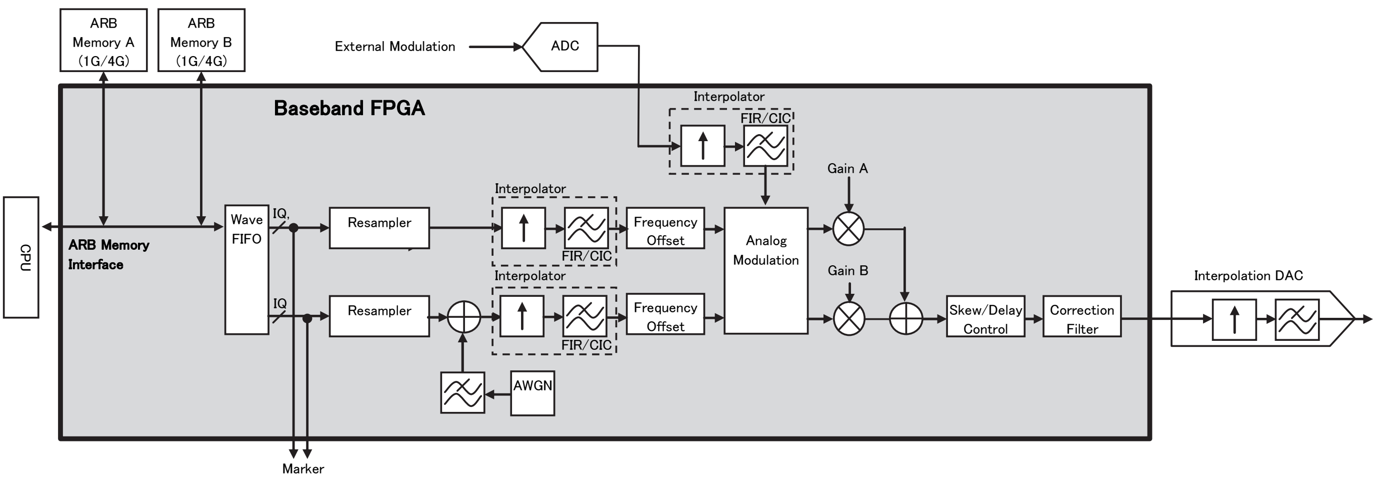


Figure 6 Baseband Signal Processing Section

As a result of the analog modulation function using digital signal processing, it is possible to output an analog signal that is unaffected by the device characteristics and distortion, which cannot be prevented by the conventional vector signal generator.

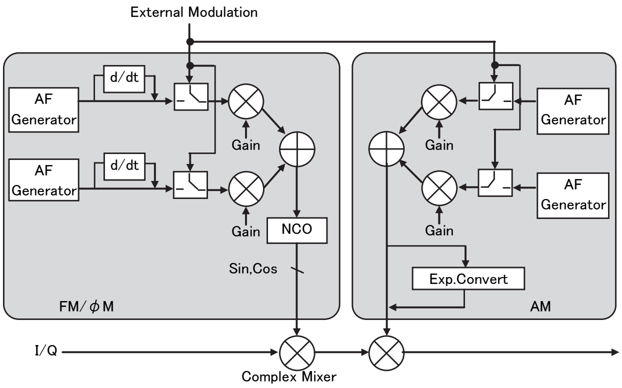


Figure 7 Analog Modulation Section for Digital Signal Processing

3.2.4 Correction Function

The MG3700A compensates for the I/Q signal path only by adjusting the gain balance and phase from the interpolation DAC to the quadrature modulator. Consequently, sometimes the signal quality is degraded by differences in the delay of the I/Q signal path and the signal path frequency response. This is a particular problem when using wideband signals.

To output the maximum 160 MHz modulation band and improve the quality of wideband signals, the MG3710A has an extra block added to the baseband signal processing section for compensating for circuit delays after the Interpolation DAC and frequency response.

3.3 Software Section

The MG3710A has about five times more functions compared to the remote control commands when the MG3700A was first launched. To effectively implement this many functions, we created a unique class library for the MG3710A in pursuit of shared processing.

Use of the Windows® operating system greatly reduced software development for supporting general-purpose PC functions such as USB, LAN, etc. In addition, development efficiency was increased by simulating operability-related parts on a PC.

3.4 IQproducer™

The procedure shown in Figure 8 was required to output waveform patterns because the MG3700A required an external PC to generate waveform patterns. The MG3710A runs IQproducer™ on the built-in Windows OS using a touch panel to meet the needs for a vector signal generator with a real-time waveform generation function. Operability and waveform output are simplified by the new touch panel GUI, coupled with IQproducer™ functions for controlling the MG3710A, loading waveform patterns into memory, and selecting waveform patterns for output.

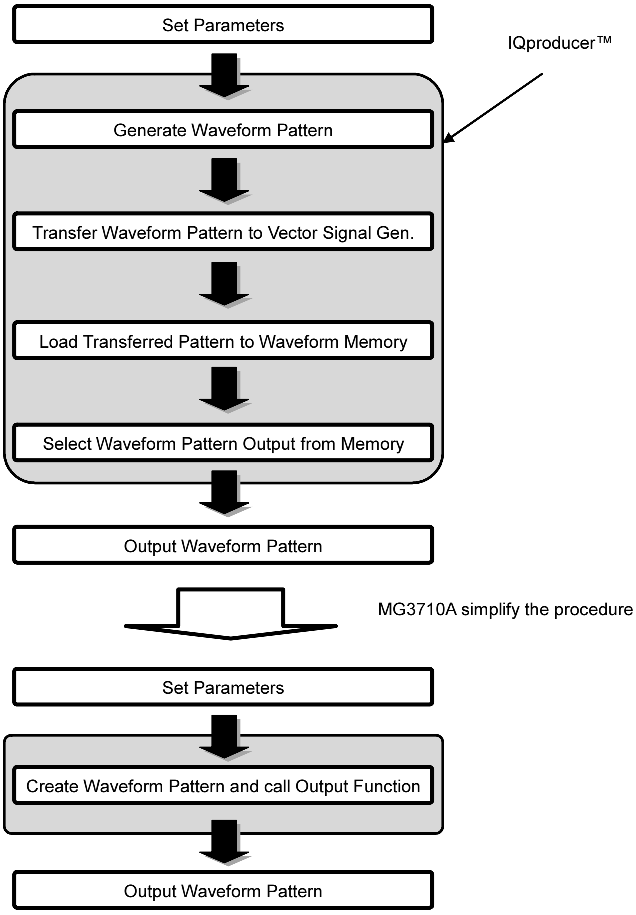


Figure 8 Waveform Pattern Output Procedure

4 Functions

4.1 Waveform Combine Function/Rate Matching Function

4.1.1 Waveform Combine Function

Tests for evaluating Rx characteristics such as ACS, IM, etc., require measurement of characteristics when a modulation interference waveform is added to the wanted waveform. Since only either the wanted wave or the interference wave could be output by one unit of previous signal generators, a test requiring Wanted + Interference signals required two and sometimes three vector signal generators. Furthermore, a coupler was required to combine signals, creating difficulties with setting level ratios for the wanted and interference signals.

The MG3710A inherits the ability of the MG3700A to combine two separate waveform patterns in the baseband block for simultaneous output. Using this function makes it possible to use one MG3710A to perform tests previously requiring two signal generators, greatly simplifying the test setup. Further, synthesis of waveform patterns using digital signal processing for output of signals with a precise power level ratio does not require level adjustment using an external power sensor.

Sometimes, measurement error occurs at tests of Rx characteristics due to level errors and degraded signal quality caused by carrier leak and image response in the vector signal generator. This effect is difficult to suppress in the MG3700A because frequency offset can be applied only to one side of the two baseband signals. With the MG3710A the signals can be arranged to minimize the impact of carrier leak and image response because frequency offset can be set independently for both of the two baseband signals using simple on-screen operations.

4.1.2 Rate Matching Function

3GPP Release 9 defines the TRx tests for MSR base stations simultaneously sending and receiving multi-system radio signals. The waveform data sampling rate is different for each wireless system and outputting an MSR base station signal from the RF output requires matching of signals with different sampling rates.

Creation of signals with different sampling rates as one waveform data set requires complex signal processing, such as rate conversion and adjustment of data cycles. Additionally, the size of the matched waveform data can be excessively large and sometimes cannot be regenerated by the vector signal generator. Prior to the MG3710A, it has been difficult to output a signal matching two signals with different sampling rates from one RF output.

However, the MG3710A has a built-in rate matching functions for outputting two added signals maintaining the sampling rate of each waveform pattern even when the sampling rates are different. The rate matching function performs sampling rate conversion in real time using digital signal processing at the baseband processor. As a result, it is possible to output a signal matching wireless systems with different sampling rates simply by selecting the signals to be matched without considering adjustment of the data cycle and waveform data size.

4.2 Calibration Function

4.2.1 In-band Frequency Response Correction Function

In wideband wireless systems, signal quality is greatly affected by the in-band frequency response. The MG3710A has a correction function for flattening in-band frequency response.

The frequency response of the entire signal path from the Interpolation DAC to the RF output connector can be calibrated by combining the in-band frequency response found from the reference calibration value at shipping with the value found by runtime calibration using the internal detector.

Figure 9 compares the frequency response of the output signal when the correction function is On and Off. With Correction On, the frequency response is improved to within ±0.2 dB in the frequency range of ±50 MHz.†

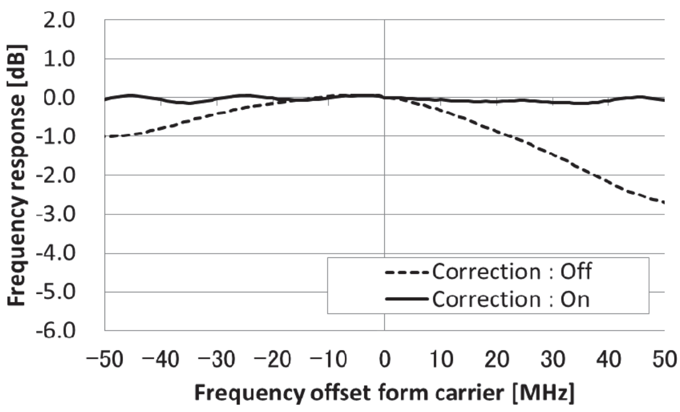


Figure 9 Frequency Response Improved by Correction

4.2.2 I/Q Calibration Function

The vector signal generator has a quadrature modulator block to convert the I/Q signal to the RF signal. Figure 10 shows an example of the I/O signals of the quadrature modulator block.

When a 1-MHz baseband signal (I/Q signal) and a 1000-MHz LO signal are input to the quadrature modulator block, a modulation signal of 1001 MHz is output. However, as shown in the figure, there are also actually signal components at the 1000 and 999 MHz positions. These are spurious signals caused by the characteristics of the quadrature modulator block and they are called the carrier leak and image response.

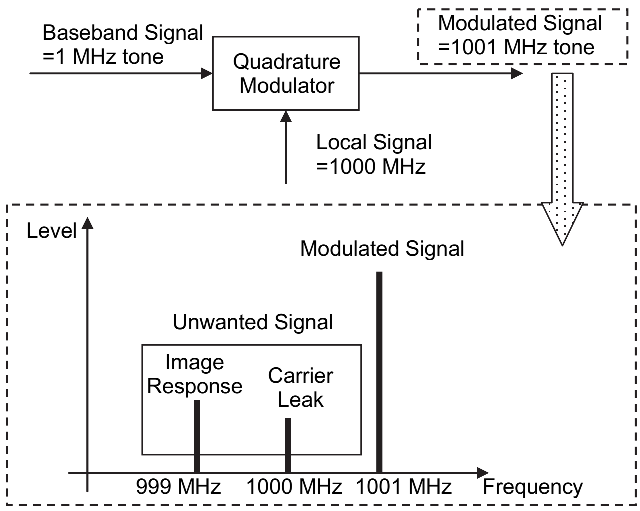


Figure 10 Quadrature Modulator Input-and-Output Signals

Conventional vector signal generators guarantee constant performance by adjusting the quadrature modulator block at the shipping inspection but this method does not account for changes in characteristics due to changes in ambient temperature. However, the MG3710A has an I/Q calibration function for simple built-in adjustment of the quadrature modulator block.

Adjustment requires a precheck of the quadrature modulator block characteristics. A commonly used method outputs a calibration signal from the vector signal generator for measurement by an external instrument, such as a spectrum analyzer but this method requires external test instruments for every adjustment. Using the MG3710A internal ALC detector for signal analysis eliminates the need for external instruments, such as spectrum analyzers and power meters, supporting a quadrature modulator block calibration function using the all-in-one MG3710A.

Figure 11 shows graphs of how the carrier leak and image response change with I/Q calibration. Calibration improves carrier leak by about –70 to –60 dB, and image response by about –60 dB.†

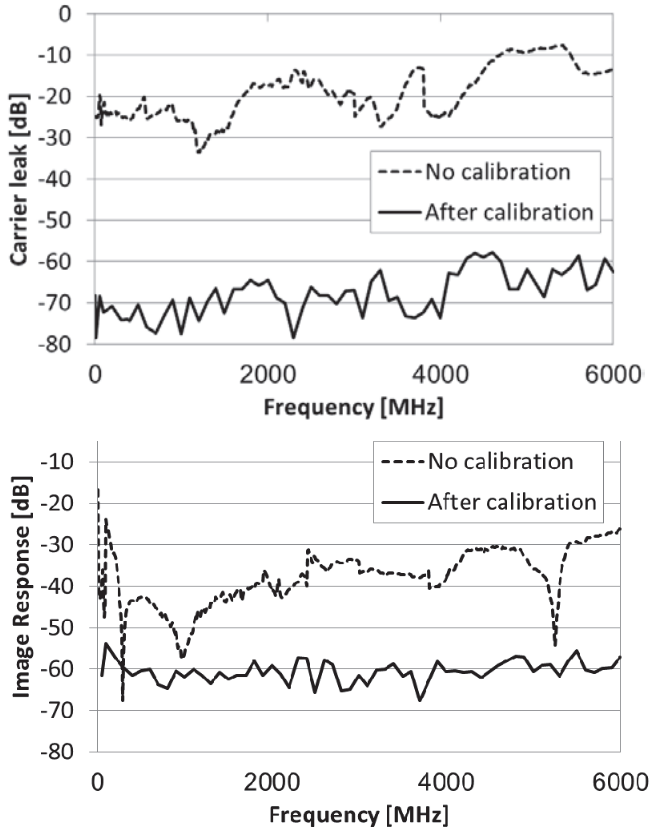
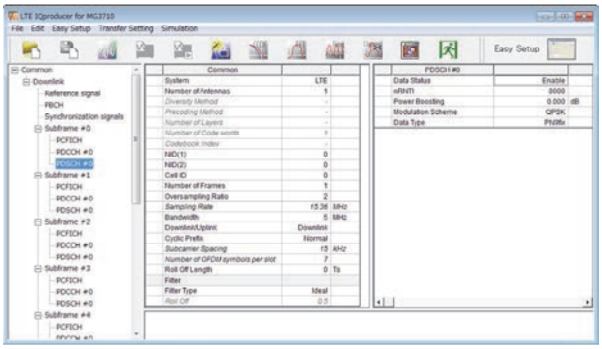


Figure 11 Carrier Leak and Image Response Improved by Calibration

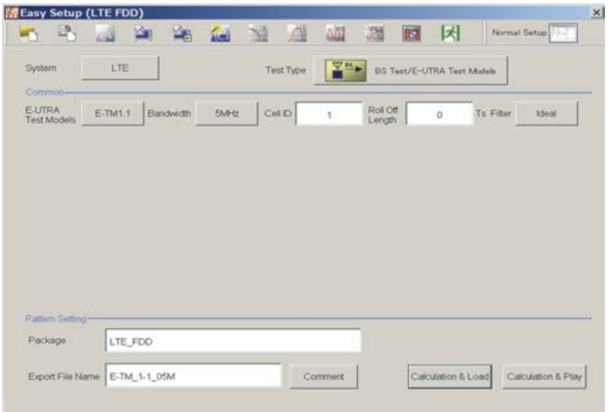
4.3 IQproducer™

4.3.1 Waveform Pattern Generation at MG3710A

The previous version of IQproducer assumed operation using an external PC. Figure 12a shows an example of the GUI on a PC. Since this GUI assumes operation by mouse and keyboard, it is hard to use with a touch panel like that on the MG3710A. Consequently, we created a new GUI design optimized for the MG3710A touch panel like that shown in Figure 12b. Minimizing the number of setting parameters has simplified the GUI layout compared to the legacy GUI used for PC operation.



a: LTE IQproducer Running on PC



b: LTE IQproducer Running on MG3710A

Figure 12 Screens of IQproducer™ running on PC and MG3710A

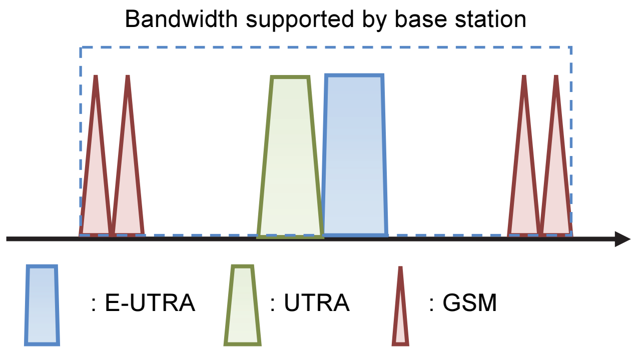
In addition, two new functions have been added to match the real-time waveform generation functions: a Calculation & Load function for not only generating the waveform pattern data but also loading it into waveform memory; and a Calculation & Play function for selecting the waveform pattern loaded into waveform memory. By using the added functions, the all-in-one MG3710A makes it easy to both create and output waveform patterns. For example, the signals required for the LTE base station Tx test can be output simply by using the Calculation & Play function to select the Tx test signal type and bandwidth, greatly simplifying operations from waveform pattern generation to output. Operability matching a real-time waveform generation function is achieved using the touch panel with greatly simplified new GUI.

4.3.2 MSR Support

Multi-system radio terminals are entering recent widespread use and more base stations must each support multiple wireless systems. The 3GPP specifications define the TRx test standards for base stations supporting different wireless systems, such as UTRA, E-UTRA, and GSM/EDGE (defined as MSR in TS37.104/TS37.141).

As shown in Figure 13, MSR is standardized as a combination of multicarrier signals for three different communications standards in the bandwidth supported by base stations for Tx tests. However, combining signals for different communications standards causes problems with different sampling rates. As a result, using conventional vector signal generators for waveform pattern generation results in long generation times and large differences in generated waveform pattern size. Consequently, combining signals for different communications standards is difficult. However, the MG3710A solves this problem using the Resampler function incorporated in the baseband FPGA.

Rather than generating waveform patterns using IQproducer™, the MSR waveform pattern generation function is used in combination with the Resampler processing function using the MG3710A baseband FPGA to generate and output MSR signals that are hard to generate using conventional vector signal generators.



Multi-Standard Radio Signal Arrangement

Multi-Standard Radio Signal Spectrum

Figure 13 Multi-Standard Radio Signal Example

5 Main Specifications

Table 1 lists the main specifications of the MG3710A.

6 Summary

We have developed the MG3710A Vector Signal Generator to support increasingly wideband and complex wireless systems. In addition to supporting cellular systems like LTE FDD/TDD, W-CDMA, GSM, etc., the MG3710A also supports many other wireless standards, including short-range wireless like W-LAN, Bluetooth, etc., and GPS, mobile wireless and more. Its expandability assures continued flexible support as the best measurement solution for development and manufacturing of evolving wireless technologies.

† Actual randomly selected MG3710A measurement data but not assured performance

References

1) H. Noda, N. Akiyama, H. Watanabe, Y. Kishi, N. Watanabe: "Development of MG3700A for Ubiquitous Networks", Anritsu Technical, No. 83, pp.10-18 (2006.09)

2) 3GPP TS 37.104
3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
E-UTRA, UTRA and GSM/EDGE;
Multi-Standard Radio (MSR) Base Station (BS)
radio transmission and reception

3) 3GPP TS 37.141
3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
E-UTRA, UTRA and GSM/EDGE;
Multi-Standard Radio (MSR) Base Station (BS)
conformance testing

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Table 1 Main Specifications of MG3710A Vector Signal Generator

<table>
<tr><td rowspan="4">Frequency</td><td>Setting Range</td><td></td></tr>
<tr><td>1st SG</td><td>9 kHz to 2.7 GHz (MG3710A-032)
9 kHz to 4 GHz (MG3710A-034)
9 kHz to 6 GHz (MG3710A-036)</td></tr>
<tr><td>2nd SG</td><td>9 kHz to 2.7 GHz (MG3710A-062)
9 kHz to 4 GHz (MG3710A-064)
9 kHz to 6 GHz (MG3710A-066)</td></tr>
<tr><td>Resolution</td><td>0.01 Hz</td></tr>
<tr><td rowspan="3">Output Level</td><td rowspan="2">Setting Range</td><td>1st SG: without MG3710A-043/143
2nd SG: without MG3710A-073/173</td></tr>
<tr><td>1st SG: with MG3710A-041/141 and 042/142
2nd SG: with MG3710A-071/171 and 072/172
–144 dBm to +30 dBm</td></tr>
<tr><td>Accuracy</td><td>
<table>
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<tr><th>50 MHz≤, <400 MHz</th><th>400 MHz≤, ≤3 GHz</th></tr>
<tr><td>+20 dBm<, ≤+23 dBm</td><td></td><td>±0.6 dB</td></tr>
<tr><td>+17 dBm<, ≤+20 dBm</td><td></td><td>±0.6 dB</td></tr>
<tr><td>+10 dBm<, ≤+17 dBm</td><td>±0.6 dB</td><td>±0.6 dB</td></tr>
<tr><td>–2 dBm≤, ≤+10 dBm</td><td>±0.6 dB</td><td>±0.5 dB</td></tr>
<tr><td>–40 dBm<, <–2 dBm</td><td>±0.5 dB</td><td>±0.5 dB</td></tr>
<tr><td>–110 dBm<, ≤–40 dBm</td><td>±0.5 dB</td><td>±0.5 dB</td></tr>
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</table>
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<tr><td rowspan="2">Signal Purity</td><td>Non-harmonic spurious</td><td>–30 dBm ≤ Output Level ≤ +5 dBm, CW, >10 Hz Offset from output frequency:
<–62 dBc (–70 dBc typ.) (100 kHz≤Frequency≤187.5 MHz)
<–68 dBc (–76 dBc typ.) (187.5 MHz<Frequency≤750 MHz)
<–62 dBc (–76 dBc typ.) (750 MHz<Frequency≤1.5 GHz)
<–56 dBc (–70 dBc typ.) (1.5 GHz<Frequency≤3 GHz)
<–50 dBc (–64 dBc typ.) (3 GHz<Frequency≤6 GHz)</td></tr>
<tr><td>SSB Phase Noise</td><td>Phase Noise Opt.: <200 kHz, CW, 20 kHz Offset
<–140 dBc/Hz (nominal) (100 MHz)
<–131 dBc/Hz typ. (1 GHz)
<–125 dBc/Hz typ. (2 GHz)</td></tr>
</table>

Vector Modulation	Vector Accuracy	After CAL Without MG3710A-043/143 W-CDMA (Test Model 4) Modulation Output Frequency: 800 MHz to 900 MHz, 1800 MHz to 2200 MHz, Output Level ≤+7 dBm (without MG3710A-041/141) Output Level ≤+13 dBm (without MG3710A-041/141) ≤0.6% (rms) typ. GSM Modulation Output Frequency: 800 MHz to 900 MHz, 1800 MHz to 1900 MHz, Output Level ≤+7 dBm (without MG3710A-041/141) Output Level ≤+13 dBm (with MG3710A-041/141) ≤0.8° (rms) typ. EDGE Modulation Output Frequency: 800 MHz to 900 MHz, 1800 MHz to 1900 MHz, Output Level ≤+7 dBm (without MG3710A-041/141) Output Level ≤+13 dBm (with MG3710A-041/141) ≤0.8% (rms) typ. LTE (20 MHz Test Model 3.1) Modulation Output Frequency: 600 MHz to 2700 MHz, Output Level ≤+7 dBm (without MG3710A-041/141) Output Level ≤+13 dBm (with MG3710A-041/141) ≤0.8% (rms) typ.
	ACLR	1.8 GHz ≤ Output Frequency < 2.2 GHz, Output Level ≤–2 dBm (without MG3710A-041/141) Output Level ≤+5 dBm (with MG3710A-041/141) 5 MHz offset: ≤–71 dBc/3.84 MHz (W-CDMA TestModel1_64DPCH) 10 MHz offset: ≤–71 dBc/3.84 MHz (W-CDMA TestModel1_64DPCH)
General	Dimensions	177 (H) × 426 (W) × 390 (D) mm (excluding projections)
	Mass	≤13.7 kg (with MG3710A-032, -034 or -036 options, excluding other options)
	Power Consumption	≤350 VA (including all options) 180 VA (nominal) (with MG3710A-032, -034 or -036, and -041, -042 options, excluding other options) 260 VA (nominal) (with MG3710A-032, -034 or -036, and -041, -042 options, plus MG3710A-062, -064 or -066, and -071, -072 options, excluding other options) 280 VA (nominal) (with MG3710A-032, -034 or -036, and -041, -042 options, plus MG3710A-062, -064 or -066, and -071, -072 options, plus -001, -021 options, excluding other options)