MG3700A
Vector Signal Generator
Product Introduction

Anritsu Corporation

MG3700A
Vector Signal Generator

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Contents

- Product Outline 3
- Features
  » Instrument Platform 22
  » Software 95
- Options 148
Product Outline

- Product Outline
- Features
- Options

- Market
- Product Concept
- All-round Applications
Best Value Required

Your vector signal generator requirements have never been tougher, and yet your capital equipment budget has never been tighter. You need the most value you can get in a vector signal generator. You need a vector signal generator that meets today's needs yet can be diverted to satisfy future requirements without shattering your test equipment budget. The MG3700A Vector Signal Generator delivers the best value required today at a reasonable cost:

» Adaptable to next generation markets
» Utilizable to evaluate equipment, baseband chips, and components for broadband wireless communication
Market Trends

• Mobile communication systems are evolving to higher speeds and increased wideband modulation.
  » Cellular phones and WLANs are evolving into new wireless systems using more information.

• Broadcast and information service systems are developing toward digitization.
  » They are changing from analog modulation to digital modulation for advanced information services and frequency-effective utilization.

• A wide variety of new wireless systems, such as last mile and personal communications (WPAN), have appeared.
  » In order to increase cordless mobility, various new wireless systems are being introduced.
Major Vector Signal Generator Applications

- Wanted signal source and interference signal source for receiver testing
  - Receiver sensitivity test needs a wanted signal source. Receiver interference response test also needs interference signal sources.
- Reference signal source for evaluating components and devices
  - For components, such as power amplifiers, filters, mixers, and modulator/demodulators, path performance and distortion (spectral regrowth) are measured using signal generators and signal analyzers.
- Reference signal source for verifying baseband chips
  - Baseband chips are verified their decoding algorithms and processing flows in physical layer during their development phase.
Product Concept

- Wideband modulation capability adaptable up to 4G
- Includes an all-round and high-speed arbitrary waveform (ARB) I/Q baseband generator as standard equipment
- Includes baseband memory and hard disk that store large-volume baseband signal data as standard equipment
- Includes BER analyzer required for receiver sensitivity test as standard equipment
- Fast switching, high reliability, and high level accuracy for ATE
- Ethernet remote operation to make maintenance management easy
- Weight saving to increase mobility
- Ecological design
MG3700A is the diffusion brand with a new concept to realize the various needs of ubiquitous networks.
Wideband Modulation Capability Adaptable Up to 4G

- NTT DoCoMo started development of the next generation mobile communication system for which utilization is expected by 2010.
- High-speed packet data communications with maximum 2.5 Gbps downlink and maximum 20 Mbps uplink were achieved.

<table>
<thead>
<tr>
<th>Wireless technology</th>
<th>Downlink</th>
<th>Uplink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio access scheme</td>
<td>VSF-Spread OFDM &amp; MIMO</td>
<td>VSF-CDMA</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>101.5 MHz</td>
<td>40 MHz</td>
</tr>
<tr>
<td>Number of sub-carrier</td>
<td>768 (131.836 kHz spacing)</td>
<td>2 (20 MHz spacing)</td>
</tr>
<tr>
<td>OFDM symbol length</td>
<td>9.259 ms</td>
<td>-</td>
</tr>
<tr>
<td>Guard interval length</td>
<td>1.674 ms</td>
<td>-</td>
</tr>
<tr>
<td>Frame length</td>
<td>0.5 ms</td>
<td>0.5 ms</td>
</tr>
<tr>
<td>Data modulation scheme</td>
<td>QPSK, 16QAM, 64QAM</td>
<td>QPSK, 16QAM, 64QAM</td>
</tr>
<tr>
<td>Channel coding (Rate)</td>
<td>Turbo coding (1/3 ~ 8/9)</td>
<td>Turbo coding (1/3 ~ 1/16)</td>
</tr>
<tr>
<td>Spreading factor</td>
<td>1 ~ 128</td>
<td>1 ~ 256</td>
</tr>
</tbody>
</table>

100MHz bandwidth is divided into 768 carriers, and it transmits in parallel.

VSF-Spread OFDM: Variable Spreading Factor Spread Orthogonal Frequency Division Multiplexing
MIMO: Multiple-Input-Multiple-Output
Wideband Modulation Capability Adaptable Up to 4G

• Spectrum

Simulation using FFT
Includes an All-round and High-speed ARB I/Q Baseband Generator as Standard Equipment

- Internal I/Q baseband generator generates the amplitude data sequence with which the baseband signals waveform of I channel (in-phase) and Q channel (quadrature-phase) were sampled. The baseband signal sample data are converted using D/A converters.
- I/Q modulation is well suited to generate digital modulation signals but may also be used to generate analog modulation signals.
- Custom I/Q sample data calculated by the PC program (algorithm) are loaded to the baseband memory, and the signal is repeatedly generated.
- Since the simulation signals can be generated arbitrarily, flexibility is very high. But the signal generating capability is limited by the baseband memory length or sample rate.
Includes Baseband Memory and Hard Disk that Store Large-volume Baseband Signal Data as Standard Equipment

- Baseband memory
  - Memory for generating I/Q sample data
  - Dual Baseband memory

- Hard disk drive (HDD)
  - Hard disk for saving the signal pattern files which consist of I/Q sample data files and signal configuration files

- CompactFlash® (CF)
  - Removable media

Max. $2 \times 256$ Msample/channel (with Memory upgrade option)
Includes BER Analyzer Required for Receiver Sensitivity Test as Standard Equipment

- Receiver sensitivity test can measure error rate specified by BER.
  » W-CDMA, GSM, PHS, PDC etc.
- A BERT (Bit Error Rate Tester) installed as standard equipment contributes to easy receiver testing and space saving.
Fast Switching, High Reliability

- Fast testing and high reliability are critical specifications for Auto Test Equipment (ATE).
  - **Fast switching**
    - Original frequency synthesizer technique has balanced cost and performance.
    - Fast switching time employing an electronic step attenuator improves test throughput.
  - **High reliability**
    - MTBF has been improved employing an electronic step attenuator instead of the traditional mechanical step attenuator.
  - **Free application drivers**
    - National Instruments LabView® drivers save time and money in code generation and maintenance.
      - The driver can be downloaded free from the Anritsu MG3700A website.

ME7856A RFIC Tester with three MG3700As
High Level Accuracy

• Output level accuracy leading to the repeatability of measurement data is a critical specification in order to control the uncertainty of measured values.
  – Output level accuracy is derived from the uncertainty of calibrating instruments, repeatability of ALC (Automatic Level Control), repeatability of step attenuator, flatness, and impedance mismatch.
  
  » The new automatic fast-acting internal calibration routine executed quickly achieves high level accuracy $\pm 0.5$ dB. * CW, 23 ±5 °C
  – Level error between I/Q modulation and CW ±0.2 dB

  » The ability to set output level by 0.01 dB resolution in all output level ranges is useful to improve receiver test accuracy and to adjust level little by little.
Ethernet Remote Operation to Make Maintenance Management Easy

- ATE or multiple-instrument deployment can be operated efficiently by management through the network.
  - Remote operation
    - Ethernet control same as GPIB control (Raw Socket interface)
  - File transfer between internal HDD and PC
    - Transfer with FTP using the instrument accessory PC software (2 MB/s)
Weight Saving to Increase Mobility

- Weight saving increases mobility for field test usage and for shared instruments that moves frequently to installation sites.
- 10 kg lighter than traditional instruments
  » Meets new needs

≤ 15 kg
Ecological Design

Excellent Eco Product

- This symbol indicates Anritsu products with industry-leading environmental friendliness, enough transparency to disclose such information, and conformance to environment-friendly criteria uniquely set by Anritsu. Anritsu is now promoting the development of environment-friendly products which impose less burden on the environment throughout their life cycles (procurement of materials, manufacturing, distribution, use, and disposal).

- **Low power consumption**
  - Energy saving: 2/3 of power consumption compared to previous type.
    - \( \leq 200 \text{ VA} \)

- **Standby power consumption virtually zero**
  - Standby state has been abolished by employing a reference oscillator with excellent start-up characteristic.
    - “Main Power” LED lighting only

- **Pb-free soldering**
  - Toxic lead substances are not used.

- **Weight saving**
  - Curtails the use of raw material and improves distribution efficiency.
All-round Applications

- Since standard signal pattern files for major applications are saved to the internal HDD, major signals can be generated immediately after obtaining MG3700A.

Lineup of Standard Signal Pattern files
- WLAN (IEEE802.11a/b/g)
- W-CDMA
- GSM/EDGE
- CDMA2000 1xEV-DO (Rev.0)
- CDMA2000 1X
- PHS
- PDC
- Bluetooth
- GPS
- Digital Broadcast

Option
- TD-SCDMA
All-round Applications

- PC-based Windows simulation software "IQproducer" optimized to specific application can be provided in order to generate signal pattern files, so signal patterns can be customized.

**License option IQproducer**
- HSPA over W-CDMA
- Universal TDMA
- CDMA2000 1xEV-DO (Rev.0)
- Multi-carrier
- Mobile WiMAX
- DVB-T/H
- Fading
- 3GPP LTE

**No license (Standard) IQproducer**
- Limited W-CDMA
- AWGN
All-round Applications

- The file format conversion function of PC software "IQproducer" (MG3700A standard accessory) can convert user-signal-processed and created I/Q sample data from ASCII text CSV file to signal pattern file for MG3700A. This makes it useful for various applications.
  - To R&D for 4G, RFID etc.

- Creating CSV data files of baseband signals
- Processing (Simulating) signals using C program or EDA tools such as MATLAB
- Converting to signal pattern files for MG3700A
- FTP

Discover What’s Possible™
Features

- Block Diagram
- Connectivity
- High Level Accuracy
- High Spectral Purity
- Wideband I/Q Modulation
- I/Q Adjustment, Differential I/Q Output
- Advanced High-speed I/Q Baseband
- BER Analyzer
- Operability
- Remote Operation
- Radiated Interference Leakage
- Maintainability
Overall Block Diagram

- I/Q Baseband Generator
- D/A
- Burst gate control
- Int/Ext
- I/Q Modulator
- Pulse Modulator
- ALC
- Step Attenuator
- DC offset
- Amplitude
- D/A
- 100 MHz Reference
- 4 GHz
- YTO
- 4.8 ~ 8 GHz
- 250 k ~ 3 GHz
- 3< ~ 6 GHz (Option)
- ×2
- ×8
- Electronic - Mechanical (Option)
Baseband Block Diagram

Sampling rate ≤ 400 MHz (Internal interpolation)

- 8 ~ 8 dB

Calibration source

Gain

Baseband memory A

Gain

Baseband memory B

A/B ≤ ±80 dB

Δf

Δt

∑
or

Sequence

Interpolator

Amplitude

D/A

D/A

to I/Q Modulator

to I/Q Modulator

Sample Clock 20 k ~ 160 MHz

Upsample Clock ≤ 160 MHz

Sample Rate

DDS

×16,8,4,2,1,1/2,1/4,1/8,1/16

INT

EXT

100 MHz Reference

Baseband Reference Clock 20 k ~ 40 MHz

100 kHz

300 kHz

1 MHz

3 MHz

10 MHz

30 MHz

70 MHz

Through

Gain

2× 128 Msample/channel
2× 256 Msample/channel (Option)
Connectivity  Front Panel

- 100Base-TX
- External frame synchronizing trigger
- External I/Q Input
- Sequence controlling trigger
- RF Output (N connector)
Connectivity

External timebase reference
Input: 5MHz/10MHz
Output: 10MHz

Event markers output
Trigger, Gate control, Frame synchronizing pulse marked on baseband signal data

Rear Panel

External baseband reference input

Gate control Input for pulse modulation

Differential I/Q output

100Base-TX
Jumper cable for front panel connection (Standard accessory)

BERT
Input for leveling RF output signal externally using detector or power meter

GPIB

Discover What’s Possible™
High Level Accuracy

- Automatic internal calibration routine
  » The reference source for internal calibration automatically calibrates at high-speed from DAC to ALC Loop.
    - When the change of frequency, output level, and I/Q RMS level (Signal pattern selection)
      » The switching time of frequency and output level includes automatic calibration.
  » The detector performance of ALC Loop was improved.

- Correction at high resolution per unit
  » The frequency response, the linearity error of ALC circuitry, and the attenuation error of the step attenuator are measured using the ML2437A/38A Power Meter and the ML2530A Calibration Receiver with wide dynamic range and high linearity, and then the data is inputted to correction table.

  » ML2530A Calibration Receiver
    • 100 k ~ 3 GHz
    • -140 ~ +20 dBm
Typical Level Accuracy

- Frequency response
  » CW
  - Limits (23 ± 5 °C)
    » ±0.5 dB  * 25 M ~ 3 GHz
    » -120 ~ +6 dBm
    » -120 ~ +10 dBm  * with Option
     Mechanical attenuator

- Linearity
  » CW
  - Relative level accuracy
    Initial power -11 [dBm]
    - Limits (23 ± 5 °C)
      » ±0.2 dB typ.  * 25 M ~ 3 GHz
      » ±0.3 dB typ.  * 3 ~ 6 GHz
      » -120 ~ -11 dBm
      » -120 ~ -7 dBm  * with Option
       Mechanical attenuator
Typical Level Stability

- **Aging**
  - CW (ALC: Active)
    - 1 GHz, -11 dBm
  - Difference \(\leq 0.035\) dB
    - \(-0.063 \sim -0.028\) dB

- **Aging**
  - Level continuous mode, I/Q modulation (ALC: Hold)
    - 1 GHz, -11 dBm, W-CDMA UL RMC 12.2kbps
  - Difference \(\leq 0.21\) dB
    - \(-0.069 \sim 0.141\) dB
Typical Level Stability

- RF off → on (off [on] off [on] ...)
  - CW
  - 2 GHz, -11 dBm

- RF off → on (off [on] off [on] ...)
  - I/Q modulation
  - 2 GHz, -11 dBm, W-CDMA

» Difference ≤ 0.017 dB
-0.007 ~ 0.01 dB

» Difference ≤ 0.022 dB
-0.012 ~ 0.01 dB
Typical Level Stability

- I/Q Modulation → CW (Mod on [off] on [off] ...)
  - 2 GHz, -11 dBm, W-CDMA

- CW → I/Q Modulation (Mod off [on] off [on] off ...)
  - 2 GHz, -11 dBm, W-CDMA

» Difference ≤ 0.017 dB
  -0.009 ~ 0.008 dB

» Difference ≤ 0.023 dB
  -0.011 ~ 0.012 dB
Typical Level Stability

- Random level \([-140 \sim -1 \text{ dBm}] \rightarrow -11 \text{ dBm}\)
  (any level \([-11]\) any level \([-11]\) ...)
  - \(2 \text{ GHz, I/Q Modulation (W-CDMA)}\)

\[\begin{array}{cccc}
-0.05 & -0.04 & -0.03 & -0.02 \\
-0.01 & 0 & 0.01 & 0.02 \\
0.03 & 0.04 & 0.05 & \\
\end{array}\]

\[\begin{array}{cccc}
0 & 50 & 100 & 150 & 200 \\
\end{array}\]

\(\quad\) Difference \(\leq 0.023 \text{ dB}\)
- \(-0.011 \sim 0.012 \text{ dB}\)
Typical Maximum Available Output Level

- **Electronic step attenuator** (Standard): +13 dBm setting
  - E-ATT
- **Mechanical step attenuator** (Option): +19 dBm setting
  - M-ATT
High Spectral Purity

What type of specification are there for spectral purity?
• Spurious
  » Harmonics
    – 2 fc
    – 3 fc
  » Non-harmonics
    – Local Oscillator (LO) leakage: \( f_{LO} \)
    – Image signal: \( f_{img} \)
    – IF signal leakage: \( f_{IF} \)
    – Mixing signal of Harmonic IF and LO: \( 2 f_{IF} - f_{LO} \)
  » Sub-harmonics    None
    – 1/2 fc, 3/2 fc
  » Power line and Fan rotation (Hum)
    – \( fc \pm \) Harmonics of AC frequency (especially 3rd order)
High Spectral Purity

What type of specification are there for spectral purity?

- **SSB** Single Side Band phase noise
  - Phase noise of Reference oscillator (100 MHz) ... (a)
  - Loop bandwidth of PLL Phase Locked Loop ... (b)
  - Phase noise of YTO YIG Tuned Oscillator ... (c)
  - Noise floor ... (d)
• 4.8 - 8 GHz YTO has been employed as LO. And LO, image signal and IF leakage were placed out of the range of output frequency.

\[
\begin{array}{ccc|c}
\text{fc} & \text{LO frequency} & \text{Image frequency} & \text{IF} \\
250 \text{ kHz} \sim & fc + 4.8 \text{ GHz} & fc + 9.6 \text{ GHz} & 4.8 \text{ GHz} \\
3 \text{ GHz} < & fc + 8.8 \text{ GHz} & fc + 17.6 \text{ GHz} & 8.8 \text{ GHz}
\end{array}
\]

Frequency down conversion

Overlap on
2.4 GHz (fc \leq 3 GHz)
4.4 GHz (fc > 3 GHz)

Be careful

Distortion by Mixer
Typical Spurious

- 2 GHz, -1 dBm
  - 2: 2 fc
  - 3: $2f_{IF} - f_{LO}$
  - 4: 3 fc
  - 5: IF

Limits ($\leq -1$ dBm, $\leq +3$ dBm * with Option Mechanical attenuator)

- Harmonics
  - $< -30$ dBc

- Non-harmonics
  - $2f_{IF} - f_{LO}$
    - $< -50$ dBc typ. $< -60$ dBc * 25 M ~ 3 GHz
    - $< -40$ dBc typ. $< -54$ dBc * 3< ~ 5.7 GHz
    - $< -35$ dBc typ. $< -54$ dBc * 5.7< ~ 6 GHz
SSB Phase Noise

In wireless communication, in order to utilize limited radio resources effectively, there is a strong phase noise requirement for signal sources.

» Alternate channel leakage power ratio which spaces one channel from adjacent channel is caused by phase noise.

- Optimization of cost performance
  » The balance between cost and performance was optimized, meeting present needs.
  » A high-speed 14-bit DAC that interpolates internally to a maximum 400 MHz sampling rate has been employed, and the quantization noise leading to residual noise was reduced.
  » A smoothing filter with variable cutoff frequency according to the modulation bandwidth eliminates alias spurious and noise.

- Employed high-purity YTO
  » Although the YTO employed as a LO is expensive, it provides all-round performance by simplifying the circuitry.
Selectable Frequency Switching Time and Phase Noise

- Frequency switching time affects the phase noise.
- The frequency switching time and phase noise profile is changed by switching the loop bandwidth of the PLL synthesizer. It is useful to select it according to the wireless system or the usage.

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency switching time</td>
<td>3 GHz non-cross</td>
<td>3 GHz cross</td>
</tr>
<tr>
<td></td>
<td>3 GHz Non-cross</td>
<td>3 GHz cross</td>
</tr>
<tr>
<td>Δf &lt; 1 GHz</td>
<td>Δf ≥ 1 GHz</td>
<td></td>
</tr>
<tr>
<td>Electronic attenuator</td>
<td>≤ 15 ms</td>
<td>≤ 20 ms</td>
</tr>
<tr>
<td>Mechanical attenuator</td>
<td>≤ 80 ms</td>
<td>≤ 100 ms</td>
</tr>
<tr>
<td>Phase noise</td>
<td>Lower in Offset frequency ≥ 50 kHz</td>
<td>Lower in Offset frequency &lt; 50 kHz</td>
</tr>
</tbody>
</table>

\[ \Delta f < 1 \text{ GHz} \quad \Delta f \geq 1 \text{ GHz} \]

- Electronic attenuator:
  - ≤ 15 ms
  - ≤ 20 ms

- Mechanical attenuator:
  - ≤ 80 ms
  - ≤ 100 ms

Phase noise is lower in Offset frequency ≥ 50 kHz for Normal and Offset frequency < 50 kHz for Fast.
Typical Phase Noise

Normal

Fast
Adjacent Channel Leakage Power Ratio (ACLR)

In wireless communication, in order to utilize limited radio resources effectively, there is a strong ACLR requirement for signal sources.

» It is a critical specification for reference signal sources evaluating transmitter components/devices and for interference signal sources testing receivers.
» Adjacent channel leakage power ratio of modulated signals is caused by intermodulation distortion produced by nonlinear elements in signal generator.

• ACLR specification
  800 ~ 1000 MHz, 1800 ~ 2400 MHz, 23 ± 5°C, W-CDMA Downlink (Test Model 1 64 DPCH)
  With Option Mechanical attenuator
  » 5 MHz offset: \( \leq -61 \text{ dB} \) \( \leq -62 \text{ dB} \)
    • Output level \( \leq -4 \text{ dBm} \) \( \leq 0 \text{ dBm} \)
  » 10 MHz offset: \( \leq -66 \text{ dB typ.} \) \( \leq -67 \text{ dB typ.} \)
    • Output level \( \leq -1 \text{ dBm} \) \( \leq +3 \text{ dBm} \)
  - Alternate channel leakage power ratio is caused by phase noise.
ACLR
W-CDMA, Downlink (Test Model 1 64 DPCH)

» ≤ -4 dBm

» ≤ 0 dBm * with Option Mechanical attenuator
ACLR
W-CDMA, Uplink (RMC 12.2kbps)

- ≤ -4 dBm
- ≤ 0 dBm * with Option Mechanical attenuator
ACLR
W-CDMA, Downlink (TM1 64DPCH), 4 Carriers

-4 dBm ≥ 0 dBm

* with Option Mechanical attenuator
Spurious Close to Carrier
CDMA2000 1X, Forward (RC1-2)

» \( \leq -4 \text{ dBm} \)

» \( \leq 0 \text{ dBm} \) * with Option Mechanical attenuator
Spurious Close to Carrier
CDMA2000 1X, Forward (RC3-5)

-4 dBm

\( \leq -0 \text{ dBm} \) * with Option Mechanical attenuator
Spurious Close to Carrier CDMA2000 1X, Reverse (RC1-2)

- $\leq -4 \text{ dBm}$
- $\leq 0 \text{ dBm}$ *with Option Mechanical attenuator*
Spurious Close to Carrier
CDMA2000 1X, Reverse (RC3-4)

» ≤ -4 dBm

» ≤ 0 dBm * with Option Mechanical attenuator
Spurious Close to Carrier
CDMA2000 1xEV-DO, Forward (Active Slot)

» ≤ -4 dBm

» ≤ 0 dBm * with Option Mechanical attenuator
Spurious Close to Carrier
CDMA2000 1xEV-DO, Reverse

-4 dBm ≤ » ≤ 0 dBm *

* with Option Mechanical attenuator
ACLR
GSM/EDGE, GMSK

» \( \leq -1 \text{ dBm} \)

» \( \leq +3 \text{ dBm} * \) with Option Mechanical attenuator
ACLR
GSM/EDGE, 8PSK

» \( \leq -1 \text{ dBm} \)

» \( \leq +3 \text{ dBm} \) * with Option Mechanical attenuator
ACLR

PHS

» \( \leq -1 \) dBm

» \( \leq +3 \) dBm * with Option Mechanical attenuator
ACLR PDC

- $\leq -1$ dBm
- $\leq +3$ dBm * with Option Mechanical attenuator
ACLR
WLAN IEEE 802.11a

» \( \leq -4 \text{ dBm} \)

» \( \leq 0 \text{ dBm} \) * with Option Mechanical attenuator
Wideband I/Q Modulation

Modulation bandwidth using internal I/Q

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Flatness ≤ 3 GHz</th>
<th>Flatness &gt; 3 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 MHz (±10 MHz)</td>
<td>&lt; ±0.5 dB (≥0.2 GHz)</td>
<td>&lt; ±1 dB</td>
</tr>
<tr>
<td>120 MHz (±60 MHz)</td>
<td>&lt; ±2 dB (≥1 GHz)</td>
<td>&lt; ±3 dB</td>
</tr>
</tbody>
</table>
Modulation bandwidth using external I/Q

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Flatness ≤ 3GHz</th>
<th>&gt; 3GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 MHz (±10 MHz)</td>
<td>&lt; ±0.5 dB (≥0.2 GHz)</td>
<td>&lt; ±1 dB</td>
</tr>
<tr>
<td>150 MHz (±75 MHz)</td>
<td>&lt; ±3 dB (≥1 GHz)</td>
<td>&lt; ±5 dB</td>
</tr>
<tr>
<td>200 MHz (±100 MHz)</td>
<td>&lt; ±6 dB (≥1 GHz)</td>
<td>&lt; ±9 dB</td>
</tr>
</tbody>
</table>

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**Wideband I/Q Modulation**

Discover What’s Possible™
External I/Q Input

• It is possible to output RF by inputting external I/Q baseband signals.
  » Full scale Input (Optimum level): $\sqrt{I^2 + Q^2} = 0.5 \ V_{rms}$

• Setting

$$V_{rms} = 5.022$$
Carrier Leakage

- The leakage of the carrier inputted into I/Q modulator stays in RF signal.
  - It is quantified by origin offset of signal constellation.
  - It deteriorates quality of the modulation and causes problems for receiver tests.

- Since the leakage adjusted to the minimum level is stable, its subsequent tune-up is unnecessary.
  - $\leq -40$ dBc
I/Q Adjustment and Differential I/Q Output

• In order to test I/Q modulators, I/Q adjustment and differential (balanced) outputs of I, $\bar{I}$, Q, $\bar{Q}$ are required for the signal source.
  » Vector magnitude
    – Amplitude voltage is set as RMS level of I/Q modulator.
  » Drive DC voltage
    – In order to drive I/Q modulator for the single power source, DC offset is set as drive voltage.

• In order to test I/Q modulators and baseband LSI for balanced devices, I, $\bar{I}$, Q, $\bar{Q}$ differential (balanced) outputs are required for the signal source.
  » In I/Q input device, the balanced input has the advantage which can reduce the amplitude error and noise compared with I and Q unbalanced (single-ended) inputs.
    – Reduction of amplitude error by the ground loop
      • The cause is that the grounds of signal source and input device are not equivalent potential.
    – Reduction of signal line noise
      • The cause is that the environmental noise is picked up on the signal line.
I/Q Output

- Differential I/Q signals can be outputted.
  - $\bar{I}$ / $\bar{Q}$ signals which are reverse signals (amplitude is equal and polarity is reverse) of I/Q signals are outputted.
    - D-Sub 15 (Jack), 50 $\Omega$

Setting

J1277 (Optional accessory)
D-Sub>BNC adapter
I/Q Adjustment

- Variable of amplitude voltage of I/Q signals outputs, DC offset
  - Amplitude voltage
    - 0 ~ 120%, Resolution 0.1%
  - DC offset
    - I / I, Q / Q common offset: -1 ~ +3 V, Resolution 10 mV
    - I / I, Q / Q differential offset: -50 ~ +50 mV, Resolution 0.05 mV
  - Amplitude voltage range
    - Amplitude voltage + Common DC offset + Differential DC offset:
      -3.5 ~ +3.5 V
Advanced High-speed I/Q Baseband

- If the baseband sample clock ($f_{ck}$) and the DAC sampling rate ($fs$) are faster, it can generate more wideband signal.
- If the faster $f_{ck}$ is used, the volume of sample data will be larger and the higher capacity baseband memory will be required.

Spectral mechanism of DAC $\rightarrow$ LPF $\rightarrow$ I/Q modulator (by sampling theorem)
High-speed I/Q Baseband

- **Sample rate (Fs)**
  - **20 k ~ 160 MHz, Resolution 0.001 Hz**

- **Upsample clock (f_{\text{ck}})**
  - **f_{\text{ck}} = 2^n \times \text{Fs} \leq 160 MHz (n: maximum integer)**
    - at Fs \leq 20 MHz
  - **Automatic interpolation**
    - Interpolator upsamples the sample clock (f_{\text{ck}}) to the maximum, and f_{\text{ck}} is further kept away from modulated signal frequency.

- **DAC Sampling rate (fs)**
  - **\leq 400 MHz**
    - Since the internal interpolation DAC was employed, alias is further kept away from modulated signal frequency.
  - **Automatic interpolation**
    - 20 < f_{\text{ck}} \leq 50 MHz: 8 \times f_{\text{ck}}
    - 50 < f_{\text{ck}} \leq 100 MHz: 4 \times f_{\text{ck}}
    - 100 < f_{\text{ck}} \leq 160 MHz: 2 \times f_{\text{ck}}
Dual Baseband Memory

- High-capacity baseband memory can generate high-speed signals and long-term signals
  - 2× 128 Msample/channel (1 GB)
  - 2× 256 Msample/channel (2 GB) * with Option Memory upgrade
  - The flash memory had been mainly employed. But since DRAM used for the main memory in PC was employed, the cost was reduced in spite of high-capacity and fast-loading.

Sample data generates in sample time $T_s = 1/F_s$

Maximum of
256,000,000 sample
512,000,000 sample * with Option
Dual Baseband Memory

- Able to generate two signals which mixed digitally the signals of the baseband memories A and B.
  
  » Two signals which mixed the signals of different sample rate (Fs) cannot be generated correctly.
    
    - MX370104A Multi-carrier IQproducer can adjust different Fs.
      
      - e.g. W-CDMA + GSM, IEEE 802.11a/g + 802.11b/g
  
  » Two signals which mixed DL RMC signal for W-CDMA UE receiver test with full SFN count, and interference signal or AWGN cannot be generated.
  
  » Two signals which mixed DL RMC 12.2 kbps signal for W-CDMA UE receiver test with limited SFN count, and interference signal or AWGN can be generated.
Dual Baseband Memory

- The signals output level of memories A and B can be set as [dBm] and [dB].
  - A/B level ratio: $0 \sim \pm 80$ dB, Resolution 0.01 dB

- Frequency offset ($\Delta f$) is available.
  - Shift the A frequency
    - Carrier leakage stays on the B frequency.
  - $0 \sim \pm (0.8 \times Fs \times 2^n - \text{Bandwidth})/2$
    - at $Fs \leq 20$ MHz
      - $2^n \times Fs \leq 160$ MHz ($n$: maximum integer)
    - at $Fs > 20$ MHz
      - Bandwidth: Modulation rate[cps, sps] = $Fs/Oversampling$ ratio
      - Example of W-CDMA: $\pm (0.8 \times 4 \times 3.84$ MHz $\times 2^3 - 3.84$ MHz)/2 = $\pm 47.232$ MHz
  - Resolution 1 Hz

- Timing offset ($\Delta t$) is available.
  - $0 \sim (\text{Total sample of A} - 1) \leq 9,999,999$, Resolution 1 sample
    - Shift the B start timing
      - It is useful to the signals with same A and B, such as multipath and TX diversity.
Dual Baseband Memory

- Mixing on the same frequency
  - Wanted signal + AWGN
  - 2-path fading
  - TX diversity

![Dual Baseband Memory Diagram]

<table>
<thead>
<tr>
<th>A/B Set</th>
<th>A level</th>
<th>B level</th>
<th>RF level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Variable</td>
<td>Static</td>
<td>Coupled</td>
</tr>
<tr>
<td>B</td>
<td>Static</td>
<td>Variable</td>
<td>Coupled</td>
</tr>
<tr>
<td>Constant</td>
<td>Variable</td>
<td>Variable</td>
<td>Static</td>
</tr>
</tbody>
</table>
Dual Baseband Memory

- Mixing on different frequency
  - Wanted signal + Interference signal or CW
  - AWGN + AWGN

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</tr>
<tr>
<td>Constant</td>
<td>Variable</td>
<td>Variable</td>
<td>Static</td>
</tr>
</tbody>
</table>
• Baseband memories A and B load the I/Q sample data in the saved signal pattern files from HDD in advance.
  » Loading time: 14 MB/s (7 MS/s)
  » Maximum package/baseband memory: 100
  » Maximum pattern/package: 100
  » Maximum pattern/baseband memory: 4,096
  » Minimum sample/pattern: 1,000

• Baseband memories A and B output I/Q sample data of the selected signal pattern.
Dual Baseband Memory

- When outputting long term signals with larger capacity than baseband memory A, the memories of A and B are combined automatically.
  - Simulated signal pattern of fading
  - Real signal pattern for receiving video and voice test

- W-CDMA 16.66 s (1,666 frame)
  - Sample rate (Fs): 4× 3.84 Mcps
- VSF-Spread OFDM roughly 4 s * with Memory upgrade option
Dual Baseband Memory

- When a long term signal is loaded to a baseband memory, all the memorized patterns are deleted.
  - Maximum pattern/baseband memories A+B: 1
    - The message is displayed when downloading in a baseband memory (A).
Sequence/Combination of Signal Patterns

- The signal pattern sequence can be generated.
  - Useful to protocol emulation
  - Available for digital sweep of output level

- Shortcut operation is served.
  - Simplification of operation for combination output
  - Management of utilized pattern files in custom packages

- The combination files can be created/defined by PC software "IQ producer" (standard accessory).
Sequence of Signal Patterns

- Example of protocol emulation
  » Play Mode: Auto
  - The sequence based on a scenario of the combination file works.
    Scenario:
    - The repeat count and output level per element are already defined.
Sequence of Signal Patterns

- Example of protocol emulation
  - Play Mode: Manual
    - Pattern Trigger input executes Next Pattern [F1] operation.
Sequence of Signal Patterns

- Example of digital sweep of output level
  » Dynamic range ≤ 80 dB
Combination of Signal Patterns

- Example of shortcut operation
Variable Smoothing Filter

- Much cutoff frequency $f_{LPF}$ can be changed according to usage.
  - **Auto**
    - The filter is chosen according to sample rate ($Fs$).
      
      | $f_{LPF}$   | Single   | Dual (Used baseband memory) |
      |------------|----------|-----------------------------|
      | 100 kHz    | 70 MHz   | $20 < Fs \leq 312.5$ kHz    |
      | 300 kHz    | 70 MHz   | $0.3125 < Fs \leq 1.25$ MHz |
      | 1 MHz      | 70 MHz   | $1.25 < Fs \leq 2.5$ MHz    |
      | 3 MHz      | 70 MHz   | $2.5 < Fs \leq 5$ MHz       |
      | 10 MHz     | 70 MHz   | $5 < Fs \leq 20$ MHz        |
      | 70 MHz     | 70 MHz   | $20 < Fs \leq 150$ MHz      |
      | 100 MHz    | 100 MHz  | $150 < Fs \leq 160$ MHz     |
  - **100kHz, 300kHz, 1MHz**
    - 4th-order Butterworth filter
  - **3MHz, 10MHz, 30MHz, 70MHz, 100MHz(Through)**
    - 5th-order Butterworth filter

- Smoothing filter removes the aliasing noise of DAC output waveform.
  - Smoothing filter is LPF.
  - Aliasing noise appears as alias on the frequency domain.
Behavior of Variable Smoothing Filter

• Although the smoothing filter can be used in order to reduce the spurious and ACLR, it affects EVM.
  » Trade-off of the performance
    – If $f_{\text{LPF}}$ is set lower in order to reduce ACLR, EVM performance will degrade.

• Please select best $f_{\text{LPF}}$ according to signal bandwidth, in the case of the signal generating that prioritizes ACLR performance.
  For example
  » W-CDMA: 3 MHz
  » CDMA2000: 1 MHz
  » GSM/EDGE: 300 kHz
  » PHS: 300 kHz
Tunable Baseband Amplitude

- I/Q amplitude (RMS) of DAC output level i.e. I/Q modulator input level is tunable.
  \[ \sqrt{I^2 + Q^2} \]
  -8 ~ +8 dB, Resolution 0.01 dB
Behavior of Tunable Baseband Amplitude

- I/Q modulator input level affects EVM, origin offset, ACLR, and noise floor.
  - Trade-off of the performance
    - If the level is gained in order to improve the performance of origin offset and noise floor, the spectral regrowth will be caused, and then ACLR and EVM will degrade.
- Try to decrease RMS level, in the case of the signal generating that prioritizes the adjacent channel leakage power ratio performance and intermodulation distortion performance.
- Try to increase RMS level, in the case of the signal generating that prioritizes the alternate channel leakage power ratio performance.
  - RMS level tuning changes the performance guarantee range of the output level.
    - If RMS level is increased, the lower limits of output level go up the increases.
      - For example 1 GHz, RMS +3 dB
        - Upper limits of output level: +2 dBm
        - Lower limits of output level: -140 dBm + 3 dB = -137 dBm
    - If RMS level is decreased, the upper limits of output level go down the decreases.
      - For example 1 GHz, RMS -3 dB
        - Upper limits of output level: +2 dBm - 3 dB = -1 dBm
        - Lower limits of output level: -140 dBm

Note: RMS level is not initialized to 0 dB, even if the signal pattern is changed.
Behavior of Tunable Baseband Amplitude

Typ. ACLR of W-CDMA, Downlink Test Model 1 64 DPCH

- "Unleveled" indicates out of range for performance guarantee

Output level: RMS

- +3 dBm: -2 ~ -8 dB
- 0 dBm: -5 ~ -8 dB
- -3 dBm: -8 dB

with Option Mechanical attenuator

MS2781A Signature

2140 MHz

RMS Value Tuning [dB]

ACLR [dB]

-3 dBm ADJ
-3 dBm ALT
-6 dBm ADJ
-6 dBm ALT

Discover What’s Possible™
One MG3700A performs the receiver tests.

» Until now a BER analyzer and an interference signal source in addition to the wanted signal source were required.
- Cost was reduced by employing LSI designed for BER analysis, and BER analyzer was included as standard equipment.

- **Clock rate**
  » 1 k ~ 20 MHz * Standard
  » 100 ~ 120 Mbps * Option

- **Data pattern**
  » PN9, 11, 15, 20, 23, ALL0, ALL1, Alternate 01
  » PN fixed pattern, Custom pattern * Option only

- **Measuring bit/time (after synchronization)**
  » 1,000 ~ 4,294,967,295 ($2^{23}$-1) bits
  » 0.1 ~ 359,999 s (99 h 59 m 59 s), Resolution 0.1 s * Standard only
  » 1 ~ 2,147,483,647 ($2^{31}$-1) error bits * Option only
BER Analyzer

- Real-time display
  - Elapsed time
  - Progress rate
    - Automatic re-synchronization (Auto Resync)
      - On: Sync Loss monitoring per 10 ms
        - If 6 error bits in 64 bits occurs, Sync Loss will be displayed and measurement will stop.
      - Off: Sync Loss detection ignore
    - Measure mode
      - Single, Continuous, Endless
- BER
  - Floating point \((\times.\times\times\times \times \pm \times \times)\)
  - Fixed point \((\times.\times\times \times \times \%\)
- Error-bit-count
- Bit count
- Log save
  - Comparison with previous BER is available.
  - Data for BER curve can be saved.
- Save media: HD, CF
- Maximum number of logs: 100
Operability

- Function keys
- Editing menu keys
  » Frequency
  » Output level
  » Baseband
  » Utility
    - Internal memory management
      » Save/Recall the setting status
    - BERT
    - System
      » Remote operation interface
      » Network setting
      » Activity log
      » Configuration/Version
      » Firmware upgrade
- Cursor/Edit keys
- Large-screen color LCD
  » 8.4 inch TFT
  » bmp file save (HD, CF)
    » 640 x 480 pixel
- Modulation On/Off
- RF output On/Off
Operability

• Panel key layout
  » Operability has been improved by using the rotary knob to move the cursor, as a result of considering smooth operation flow:
    [Selecting function]→[Moving cursor]→[Editing(select/input)]→[Enter].

• Operation guidance display
  » Panel operations include the parameter settings such as item selection, data input and character input. Available key types are displayed as guidance in pop-up window during parameter setting to enable operation without confusion.
    • Example of Output level setting

  ! [Level Value](image)
  
  Current : -1.00 dBm
  Range : -140.00 dBm to 13.00 dBm

  Rotary knob, Step keys, ten keys, Resolution keys

• CF slot on front panel
  » Linking with a PC is easy in environments without a LAN by using CompactFlash® as removable media.
Operability

- Frequency channel setting
  - If assignment of the channel number is defined as frequency, frequency will change only by setting the channel number.
    - Selectable: Frequency display only, Frequency and Channel display, Channel display only
  - The groups up to 19 are edited/saved in the channel table file.
    - Save to HD, CF

In case of secret frequency
Operability

- Internal memory management
  - All setting parameters can be saved in up to 100 files.
    - File name up to 30 characters can be inputted for easy confirmation.
    - Save to HD, CF
Remote Operation

Both GPIB and Ethernet links are provided for remote interfaces.

» 100Base-TX connectors are on the front panel and rear panel, and either can be used.

• **End-to-end connection**

![Diagram showing end-to-end connection](image)

J1261D (Optional accessory)
Ethernet cross cable

• **Network connection**

![Diagram showing network connection](image)

J1261B (Optional accessory)
Ethernet straight cable

Network hub (100Base)
Remote Operation

Network interface settings

- **Ethernet**
  - Socket Port Number: TCP/IP port number 49152 ~ 65535

- **TCP/IP**
  - Host name \( \leq 30 \) character
  - Domain name \( \leq 30 \) character
  - assigned from DHCP server
  - DHCP
    - Off: IP address
    - Subnet mask
    - Default gateway
  - On:
    - DNS server (DHCP use): On, Off
    - DNS address Primary, Secondary
      - at DHCP: Off or DNS server: Off
  - Ping IP address

- **FTP access key using IQproducer**
  - User ID \( \leq 8 \) character
  - Password \( \leq 8 \) character
Radiated Interference Leakage

The signal generator shield is important in minimizing the signal generator’s radiated interference leakage, which interferes with the receiver in low level receiver sensitivity tests.

- Although MG3700A is lighter, the shielding performance of the circuitry units has been improved.
- Shielding has been devised for the front panel CF port.
- The display has been equipped with a shielding net.
Maintainability

Shortening of downtime

- Exchange of internal HDD
  The signal cannot be outputted if internal HDD breaks down.
  » If the HDD breaks down, the user can exchange it on-site via the rear panel.
    - MTBF of internal HDD: 20,000 Hours
  - Periodical backup of custom files is recommended using "IQproducer" of standard accessory.
  » If the MG3700A breaks down, the HDD for the failed MG3700A can be installed in a MG3700A loaner.
    - Resetting is unnecessary.
  » Confidential setting can be preserved.
    - Pull out when shipping for repair.

G0141 (Optional accessory)
HDD ASSY assembly
- 2.5 inch for notebook PC
- The files at MG3700A delivery is saved.

Be careful not to damage the connection pins when inserting HDD.
Maintainability

Reliable usage for ATE

- Automatic check for useful life of mechanical step attenuator and mechanical switch
  - Warning is released when useful life is exceeded after switching 5 million times.

- Self-check
  - Automatic alarm at emergence of trouble
    - Output level ALC trouble
    - Temperature trouble (Internal temperature > 70 °C)
  - Alarm log file
    - It can be saved to HD or CF for troubleshooting.
Maintainability

The users can upgrade the firmware.

- The user can visit the Anritsu "Software Download" website to download the latest firmware and operation manuals (PDF) for free.
  - User registration is required to use the download service.

http://www.anritsu.com/
Features

- IQproducer
- Standard Signal Pattern Files
  Optional Signal Pattern Files

IQproducer and standard signal pattern files are MG3700A standard accessory.
- IQproducer is stored in CD together with Operation Manuals (PDF).
- Standard signal pattern files are saved in HDD.
IQproducer

- Windows software utility operating on PC
  - User-friendly graphical user interface (GUI)
- Creates pattern files for internal I/Q baseband generator
  - Sets signal parameters flexibly
    - User-friendly GUIs focused on specific signal formats
  - Links to EDA tools
    - Importable ASCII text CSV files of I/Q sample data to the signal pattern files for MG3700A
  - Creates arbitrary AWGN patterns
  - Applies peak clipping and bandlimiting filter to pattern file
  - Edits scenario for sequence and combination of signal patterns
- Plots simulation of CCDF, FFT spectrum, and time domain
- FTP connection to MG3700A internal HDD
  - FTP between internal HDD and PC
- Remote operation for signal generation
  - Loads the pattern files from internal HDD to baseband memory
  - Selects the pattern to generate
Hardware Requirements

Personal computer

- **OS:** Windows® 2000, XP
- **Memory:** ≥ 512 MB recommendation
- **Display:** ≥ 1,024 x 768 pixel
Creates Pattern Files: Sets Signal Parameters Flexibly

- Since these are recorded on CD of MG3700A standard accessories, the user can try the functionality before purchase.

License option

- MX370101A   HSDPA/HSUPA IQproducer
  - Focuses on DL/UL RMC formats for HSPA/W-CDMA
- MX370102A   TDMA IQproducer
  - Focuses on universal TDMA formats for ASK, FSK, PSK, QAM
- MX370103A   CDMA2000 1xEV-DO IQproducer
  - Focuses on Forward/Reverse signal formats for CDMA2000 1xEV-DO (Rev.0)
- MX370104A   Multi-carrier IQproducer
  - Focuses on multi-carrier with any signal formats and Test Model formats for HSDPA/W-CDMA
- MX370105A   Mobile WiMAX IQproducer
  - Focuses on OFDMA formats for IEEE802.16e

* The other datasheets and literatures show the more information.
Creates Pattern Files: Sets Signal Parameters Flexibly

• Since these are recorded on CD of MG3700A standard accessories, the user can try the functionality before purchase.

License option

» MX370106A  DVB-T/H IQproducer
  • Focuses on OFDM broadcast for DVB-T/H

» MX370107A  Fading IQproducer
  • Focuses on universal fading channels containing MIMO

» MX370108A  LTE IQproducer
  • Focuses on DL/UL signal formats for 3GPP LTE

* The other datasheets and literatures show the more information.
Creates Pattern Files: Sets Signal Parameters Flexibly

- Non-license
  » Limited W-CDMA IQproducer
  - Focuses on DL/UL RMC formats for W-CDMA
    - Limited version for parameter editing of HSDPA/HSUPA IQproducer

* The other datasheets and literatures show the more information.
License Key for MX3701xx IQproducer

- If MX3701xx IQproducer is purchased, CD containing the license key file on MG3700A serial number will be provided.
  - The same IQproducer as standard accessory and Operation Manual (PDF) are also contained in CD.
- In order to download the signal pattern file created using the MX3701xx IQproducer to baseband memory, installing the license key file per MG3700A is required.
  - When MX3701xx IQproducer is purchased together with MG3700A, the license key file is already installed in MG3700A.

![Image of software interface]

Appear on the additional line

Appeard on the additional line
EDA tools such as "MATLAB" and "Microwave Office" can save IQ simulation data to ASCII text CSV files.

» It is made easy to compare simulation data and the measured data.

- Importable ASCII text CSV files to the signal pattern files for MG3700A
  » ASCII text CSV files
    - I channel data
    - Q channel data
    - Markers data (3 event markers and RF gate flag)

Import ↓

» Signal pattern files for MG3700A
  - .wvi text file (Header file)
    • The configuration information of the signal patterns is saved.
  - .wvd binary file (IQ sample data file)
    • The data of I channel, Q channel, markers is saved.
Convertible Files

- **Importable file into MG3700A**
  - ASCII text files
    - CSV format in which data is saved to **one file**
      - I channel, Q channel, Event markers
    - CSV format in which data is saved to **two files**
      - I channel, Q channel
    - CSV format in which data is saved to **three files**
      - I channel, Q channel, Event markers
  - MS2690 digitized file
  - Signal pattern file for MS2690-20 (VSG)

- **Exportable signal pattern files for MG3700A into MS2690-20 (VSG)**
  - Signal pattern files for MG3700A
    - .wvi text file (Header file)
  - Signal pattern files for MS2690-20
    - .wvi text file (Header file)
Import

- **Sampling Rate (Fs)**
  - Number of I/Q waveform samples per second (expressed in Hz and equal to reciprocal of sampling interval)

- **Normalizing**
  - Setting RMS Value to 1634

- **RMS Value**
  - Tunable baseband amplitude at Normalizing Off
    - 651 ~ 1634 I/Q DAC RMS $I/Q$
      - Performance guarantee is covered within RMS Value 1157 ~ 1634.
      - Set RMS Value as "1157" in the case of the signal with the higher crest factor like CDMA and OFDM.

- **Low pass filter**
  - Variable smoothing filter

- **Over Sampling**
  - 1 ~ 999 oversampling ratio (OSR) = Fs/Modulation rate (Bandwidth)
    - The more OSR, the better S/N of a signal and the wider dynamic range. ($2 \times$ OSR improves S/N 3 dB.)

- **Unit Symbol**
  - Modulation point for Modulation rate
    - sample, symbol, chip, none
Burst Setting
- Definition of frame length in use of input frame trigger
- Saving of the baseband memory in the case of a burst signal because burst-off period doesn’t need sample data.

» Frame Length
- Frame samples
  - Real frame length = Frame Length + Gap Length

» Gap Length
- Burst gap samples
  - This period holds the final sample data including event markers and RF gate flag in Frame Length.
**Slide 106**

**Import**

RF Gate
- This optimizes RF gate flag to scale I/Q data within burst signal for MS2690 digitized file at **MS269x Digitizer**.

» RF On/Off Threshold
- Threshold level for automatic detection of no signal and active/inactive (On/Off) definition of RF gate flag
  - 0 ~ 100%
    - 100% reference level: Peak $\sqrt{I_n^2 + Q_n^2}$

» Minimum RF Gate Length
- Minimum consecutive samples for automatic detection of no signal and inactive (Off) definition of RF gate flag
  - 0 ~ 100000 samples
Effect of RF Gate

- **Blue trace**
  - Data with RF Gate
  - \( \text{RMS}_{I/Q} \) (0 dB) is calculated from burst I/Q data.

- **Red trace**
  - Data without RF Gate
  - \( \text{RMS}_{I/Q} \) (0 dB) is calculated from all I/Q data.

- **Peak level** (+12.9892 dB)
- **RF On/Off Threshold** 1% (-40 dB)
- **Minimum RF Gate Length** \( \geq 100 \) samples

- **Crest Factor** 12.9892 dB
Creates Pattern Files: Creates Arbitrary AWGN Patterns

- AWGN pattern file suitable for arbitrary wireless systems can be created easily.

- **Coupled Pattern File**
  - The configuration information of the wanted signal to mix is read.

- **AWGN BW (B) / Wanted Signal BW (A)**
  - 1, 1.5, 2, 2.5 ratio

- **Sampling Rate**
  - Sample rate (Fs) corresponding to the wanted signal to mix

- **AWGN BW (B)**
  - Calculated from Wanted Signal BW (A) and AWGN BW (B) / Wanted Signal BW (A)
    - \( \text{BW (B)} \leq \frac{\text{Fs}}{2} \) at \( \text{BW (B)} = 0.001 \sim 20 \text{ MHz} \)
    - \( \text{BW (B)} \leq \text{Fs} \) at \( \text{BW (B)} = 20.001 \sim 120 \text{ MHz} \)
creates pattern files: applies peak clipping and bandlimiting filter to pattern file

- peak clipping affects spectral regrowth and EVM because of lower PAR.
  - It improves the spectral regrowth, but it worsens the EVM.
- Filtering affects spectrum and EVM because of spectral shaping filter on baseband.
  - It shapes up the spectrum, but it worsens the EVM.
Creates Pattern Files: Applies Peak Clipping and Bandlimiting Filter to Pattern File

- **Peak clipping**
  - **Threshold Level**
    - 0 ~ 20 dB, Resolution 0.1 dB
      - 0 dB reference level: Recomputed $RMS_{IQ}$ power
      $$ RMS_{IQ} = \sqrt{\frac{\sum_{n=1}^{N} (I_n^2 + Q_n^2)}{N}} $$
      $n$: Data with RF gate flag active (On)
  - **Repetition**
    - 0 ~ 20 repeat count

- **Filtering**
  - **Type**
  - **Bandwidth**
    - $2 \times$ Cutoff frequency
      - Min(Sampling rate/1000, 1 kHz) ~ Sampling rate, Resolution 0.01 Hz
Ideal Filter

- Ideal filter is available to reduce out-of-band noises.
  - Example of frequency response with bandwidth/sampling rate = 1/2

Frequency [Hz] = Normalized frequency * Sampling rate

14-bit DAC S/N = 86.04 dB = 6.02 * 14 + 1.76
Ideal Filter

Flat 0 dB gain: 95% of bandwidth

Cutoff frequency

Passband zoom

Slope zoom

Normalized Frequency [\(x2\pi\) rad/sample]

Gain [dB]

Normalized Frequency [\(x2\pi\) rad/sample]

Gain [dB]
Effect of Peak Clipping and Filtering

» Example of OFDM signal
  - Blue trace
    • Source data
  - Red trace
    • Data with 10 dB clipping and ideal filtering
Creates Pattern Files: Edits Scenario for Sequence and Combination

- Combination file .wvc text file
  - The setting status is saved.

- Sequence for protocol emulation
  - Repeat Count
    - 1 ~ 65,535 / \(\infty\) (endless)
Creates Pattern Files: Edits Scenario for Sequence and Combination

- Sequence for digital sweep of output level
  - Level
    - -80 ~ 0 dB
      - 0 dB reference level: MG3700A setting RF level

- Combination
  - Add Pattern
    - Pattern for baseband memory B

Opening of the existing combination file
Plots Simulation of CCDF, FFT Spectrum, Time Domain

- **CCDF** (Complementary Cumulative Distribution Function) curve
  - Plots the cumulative distribution of instantaneous power/mean power
    - If PAR (Peak to Average power Ratio) or Crest Factor of the signal is higher, the nonlinear elements will cause the spectral regrowth, and will affect ACLR.

- **FFT** (Fast Fourier Transform) Spectrum
  - Plots the frequency spectrum
    - Converting time-based signal into frequency domain

- **Time domain**
  - Plots the I/Q waveform, markers activity and power trace into time domain
    - Available to reconfigure markers data
CCDF

- Plots the signal patterns up to 8
- Plots the gaussian trace
- Adds or deletes CCDF curve
- Plots in conjunction with IQproducer under System menu
- Operation of the mouse dragging on graph area
  - Cursor motion
  - Zoom of the scope of selection

Discover What’s Possible™
FFT

Plots the signal patterns up to 4 on same sampling rate

Adds or deletes spectrum
Select lower value than Data Length
Range of the sample data to compute

Plots in conjunction with IQproducer under System menu

Operation of the mouse dragging on graph area
- Cursor motion
- Zoom of the scope of selection
Time Domain

I/Q waveform

- Plots the signal patterns up to 4
- Adds or deletes trace
- Trace range

Power

Reconfigurable markers data

Operation of the mouse dragging on graph area
- Cursor motion
- Zoom of the scope of selection

Plots in conjunction with IQproducer under System menu
Marker Edit

Marker Edit

Marker 1
- Name: Frame Clock
- Data Edit: Start Point 0, Width 0, Period 0

Marker 2
- Name: RF Gate
- Data Edit: Start Point 0, Width 0, Period 0

Marker 3
- Name: -
- Data Edit: Start Point 0, Width 0, Period 0

Create Close

New pattern file

Start Point

Marker Edit

Slide 120
MG3700A-E-I-1
FTP Connection to Internal HDD

- **Transfer & Setting Panel**
  - Files transfer to multi-MG3700A internal HDD, and backup of HD
    - Signal pattern files
    - Parameter files
    - Channel table files
    - BER log files
    - Alarm log files
    - Screen copy files
    - Firmware updated files
  - Remote operation for signal generation

- **Transfer & Setting Wizard**
  - Step-by-step operation for a pattern file transfer and generating
    - Step 1: FTP connection to one MG3700A
    - Step 2: Selection of a package for a pattern file to transfer to MG3700A internal HDD
    - Step 3: Remote operation for selection and generation of the pattern file
FTP Connection

- **Transfer & Setting Panel**
  - Server based network connection
    - Enter the host name of MG3700A.
    - Enter the IP address of MG3700A, when the domain name is not defined.
  - End-to-end connection
    - Enter the IP address of MG3700A.
    - PC has different IP address with MG3700A.

- **Transfer & Setting Wizard**
FTP Connection

- Toolbar
- Folder address
- PC side
- SG(MG3700A) side

Saved package (folder)
MG3700A status bar
Free space / Full capacity
Internal HDD, Baseband memory
Transfer, Remote Operation

- **Copy**: SG to PC
- **Download to baseband memory**: PC to SG, PC to All SG
- **Delete from baseband memory**: A, B: for signal pattern files (.wvi); C: for combination files (.wvc)
- **Generate the selected pattern**

**Under generating**

**FTP log**
Transfer Wizard

Select the package to copy PC to SG

Select one pattern file to copy

Download to baseband memory

Generate the selected Pattern file

Discover What’s Possible™
Release Version Check

• The user can visit the Anritsu "Software Download" website to download the latest IQproducer and operation manuals (PDF) for free.
  – User registration is required to use the download service.

http://www.anritsu.com/
Standard Signal Pattern Files

- Standard signal pattern files are the signal formats based on the receiver/transmitter test specifications for base stations and terminals of the major wireless systems.
- Easy operation just selects the signal pattern saved to high-capacity HDD, without setting the troublesome signal parameters for a wireless system.
- Useful for production and installation/maintenance application

Lineup
- WLAN (IEEE802.11a/b/g)
- W-CDMA
- GSM/EDGE
- CDMA2000 1xEV-DO (Rev.0)
- CDMA2000 1X
- PHS
- PDC
- Bluetooth®
- GPS
- Digital Broadcast (BS, CS, CATV, ISDB-T)

* The other datasheets show the more information.
WLAN Outline

- AP/STA transmitter test
- AP/STA receiver test
  - IEEE802.11a/g OFDM 6 ~ 54 Mbps
    - 40 MS/s, 16.6 MHz bandwidth
  - IEEE802.11b/g DSSS 1, 2 Mbps
    - 44 MS/s, 22 MHz bandwidth
  - IEEE802.11g (Optional) DSSS-OFDM 6 ~ 54 Mbps
    - 40 MS/s, 16.6 MHz bandwidth
• BS transmitter test
  » Test Model 1 ~ 5
  » Multi-carrier
    • 4× Test Model 1 64DPCH
    • 3× Test Model 1 64DPCH
    • 2× Test Model 1 64DPCH

  – Scrambling Code $0_H$, $10_H^{(+5\ MHz)}$, $20_H^{(+10\ MHz)}$, $30_H^{(+15\ MHz)}$
    – Oversampling $4 \times 3.84\ Mcps = 15.36\ MS/s$
W-CDMA Outline

- BS receiver test
  - UL RMC 12.2 ~ 384 kbps
  - UL AMR
  - UL ISDN
  - UL Packet 64 kbps
    - Scrambling Code $0_H$
      - Oversampling $3 \times 3.84 \text{ Mcps} = 11.52 \text{ MS/s}$
      - UL RMC 12.2 kbps also has Oversampling $4 \times 3.84 \text{ Mcps} = 15.36 \text{ MS/s}$.
  - UL Interferer
    - Scrambling Code $1_H$
      - Oversampling $3 \times 3.84 \text{ Mcps} = 11.52 \text{ MS/s}$
        - Maximum frequency offset ($\Delta f$): ±34.944 MHz
      - Oversampling $4 \times 3.84 \text{ Mcps} = 15.36 \text{ MS/s}$
        - Maximum frequency offset ($\Delta f$): ±47.232 MHz
W-CDMA Outline

- **UE transmitter test**
  - UL RMC 12.2 kbps
    - Scrambling Code $0_H$
    - Oversampling $3 \times 3.84$ Mcps = 11.52 MS/s

- **UE receiver test**
  - DL RMC 12.2 ~ 384 kbps *
  - DL AMR *
  - DL ISDN *
  - DL Packet 384 kbps *
    - Scrambling Code $80_H$
  - DL Interferer
    - Scrambling Code $0_H$
    - Oversampling $4 \times 3.84$ Mcps = 15.36 MS/s

*: To mix P-CCPCH (4096 frames) with full SFN 11 bit count (0 ~ 2047)
GSM/EDGE Outline

- BS/MS transmitter test
  - No timeslot format PN9 (And also for interference signal)
  - No burst format TN0

<table>
<thead>
<tr>
<th>GMSK</th>
<th>PN 148</th>
<th>G 8.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>8PSK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- No channel coding NB Normal burst TN0, TN0 ~ 7 (All slots)

<table>
<thead>
<tr>
<th>GMSK</th>
<th>PN 444</th>
<th>G 24.75</th>
</tr>
</thead>
<tbody>
<tr>
<td>8PSK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- BS/MS receiver test
  - TCH/FS Full rate Speech TCH TN0
  - CS-1, CS-4 GPRS PDTCH TN0
  - MCS-1, MCS-5 EGPRS PDTCH TN0
  - MCS-9 EGPRS PDTCH TN0, TN0 ~ 3

  - Oversampling $8 \times 270.833 \text{ ksp} = 2,166.7 \text{ kS/s}$

*TN: Timeslot Number
CDMA2000 1xEV-DO Outline

- AN/AT transmitter test
- AN/AT receiver test
  - Forward 38.4 ~ 2,457.6 kbps (Active slot), Idle slot
  - Reverse 9.6 ~ 153.6 kbps
    - Long Code Mask (42 bits)
      - MI: 3FF00000000H
      - MQ: 3FF00000001H
    - Oversampling 4× 1.2288 Mcps = 4.9152 MS/s
CDMA2000 1X Outline

- BS/MS transmitter test
- BS receiver test
  » Forward RC 1/2 (6× FCH 19.2 ksps)
    RC 3/4/5 (6× FCH 38.4 ksps)
      - No coding
  » Reverse RC 1  FCH 9.6 kbps
    RC 2  FCH 14.4 kbps
    RC 3  PICH + FCH 9.6 kbps
          PICH + FCH 9.6 kbps + SCH 9.6 kbps
          PICH + DCCH 9.6 kbps
    RC 4  PICH + FCH 14.4 kbps
      - Long Code Mask (42 bits) 000000000000H
        - Oversampling 4× 1.2288 Mcps = 4.9152 MS/s
PHS
• CS/PS transmitter test
  » No $\pi$/4DQPSK slot format PN9, All’0’
• CS/PS receiver test
  » $\pi$/4DQPSK TCH Slot 1
  » No $\pi$/4DQPSK slot format PN15
    – Oversampling $8 \times 192$ ksp = 1,536 kS/s

PDC
• BS/MS transmitter test
  » No slot format PN9
• BS/MS receiver test
  » TCH full rate Slot 0
  » TCH half rate Slot 0
  » PDC-P Slot 0, Slot 0/1 *Downlink, Slot 0/1/2 *Downlink
  » No slot format PN15
    – Oversampling $8 \times 21$ ksp = 168 kS/s
Bluetooth®

Outline

• Transmitter test
• Receiver test
  » No packet format  PN9, PN15  GFSK, π/4DQPSK, 8DPSK
  » DH1, DH3, DH5  Basic Rate  GFSK Payload
  » 2-DH1, 2-DH3, 2-DH5  EDR  π/4DQPSK Payload
  » 3-DH1, 3-DH3, 3-DH5  EDR  8DPSK Payload
  » POLL  System packet for functionality test  π/4DQPSK, 8DPSK Payload
  » 2/3-DH1/3/5 dirty signals  EDR

– Oversampling 12× 1 Msp = 12 MS/s

<table>
<thead>
<tr>
<th>Transmission Packets</th>
<th>Carrier Offset Frequency</th>
<th>Symbol Timing Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 Packets</td>
<td>0 kHz</td>
</tr>
<tr>
<td>2</td>
<td>20 Packets</td>
<td>+65 kHz</td>
</tr>
<tr>
<td>3</td>
<td>20 Packets</td>
<td>-65 kHz</td>
</tr>
</tbody>
</table>

Burst slots map
GPS Outline

- GPS receiver test
  - No subframe format  PN9
  - Subframe for parity detection  PARITY
    - Subframe ID 1
  - Subframe for sensitivity test  TLM
    - Subframe ID 1
  - Frame for sensitivity test  TLM_PARITY
    - Subframe ID 1 ~ 5

  - Oversampling $4 \times 1.023 \text{ Mcps} = 4.092 \text{ MS/s}$
  - Trigger delay setting ability 244 ns $\approx 1/4.092 \text{ us}$

- Satellite ID 1
GPS Outline

• A-GPS receiver test
  » Subframe for time calibration  
    SYNC_ADJ
    It is used when synchronizing with PP2S.
    – Subframe ID 1

    – Oversampling $100 \times 1.023 \text{Mcps} = 102.3 \text{MS/s}$
      Trigger delay setting ability $9.8 \text{ns} \approx 1/102.3 \text{us}$

• Satellite ID 1

![Diagram showing GPS receiver setup and signal patterns](image-url)
Digital Broadcast Outline

- Transmitter test
  - Digital BS (ISDB-S)  QPSK  Roll-off 0.35
    - 144.3 MS/s, 34.5 MHz bandwidth
  - Digital CS  QPSK  Roll-off 0.35
    - 147.672 MS/s, 27 MHz bandwidth
  - CATV (ITU-T J83 Annex C)  64QAM  Roll-off 0.13
    - 42.192 MS/s, 6 MHz bandwidth
  - ISDB-T  $TSP_A$ (13 segments)  $64QAM$
    $TSP_A$ (1 segment) QPSK + $TSP_B$ (12 segments)  $64QAM$
    - Mode 3, GI 1/8
      - 16.253968 254 MS/s, 5.572 MHz bandwidth
ISDB-T receiver test

- **TSP_A** (1 segment) QPSK 2/3 + **TSP_B** (12 segments) 64QAM 3/4 or 7/8
  - **TSP_A/TSP_B** Payload: Video + Audio
  - 40 frames length (9.3 s)
- **TSP_A** (1 segment) QPSK 2/3 or 1/2, 16QAM 1/2
  + **TSP_B** (12 segments) 64QAM 3/4 or 7/8
  - **TSP_A/TSP_B** Payload: PN23 initialized at start of 4 frames
  - 4 frames length (0.9 s)

- Mode 3, GI 1/8
  - 16.253968 254 MS/s, 5.572 MHz bandwidth
Digital Broadcast Outline

- ISDB-Tsb receiver test
  - TSP_A (1 segment) QPSK 1/2 + TSP_B (2 segments) QPSK 1/2
    - TSP_A/TSP_B Payload: Video + Audio
    - 68 frames length (15.7 s)
  - TSP_A (1 segment) QPSK 1/2 or 2/3, 16QAM 1/2
    + TSP_B (2 segments) 16QAM 1/2
    - TSP_A/TSP_B Payload: PN23 initialized at start of 4 frames
    - 4 frames length (0.9 s)
  - Mode 3, GI 1/8
    - 8.126984 17 MS/s, 3.429563 49 MHz bandwidth
For W-CDMA
  » 1.5× 3.84 MHz = 5.76 MHz bandwidth
  » 2× 3.84 MHz = 7.68 MHz bandwidth
    – Oversampling 3× 3.84 Mcps = 11.52 MS/s

For CDMA2000
  » 1.5× 1.2288 MHz = 1.8432 MHz bandwidth
  » 2× 1.2288 MHz = 2.4576 MHz bandwidth
    – Oversampling 4× 1.2288 Mcps = 4.9152 MS/s
Optional Signal Pattern Files

• Optional signal pattern files are the signal formats based on the receiver/transmitter test specifications for base stations and terminals of specific wireless systems.

• License option
  » MX370001A TD-SCDMA waveform pattern
    – DL/UL RMC of 3GPP TS 25.142/102 1.28 Mcps TDD option
      • DVD stored together with Operation Manual (PDF) is provided.

* The other datasheets show the more information.
License Key for Optional Signal Pattern Files

- If optional signal pattern files are purchased, CD (DVD) containing the license key file on MG3700A serial number will be provided.
- In order to download the optional signal pattern files to baseband memory, installing the license key file per MG3700A is required.
  - When optional signal pattern files are purchased together with MG3700A, the license key file is already installed in MG3700A.
TD-SCDMA Outline

• BS transmitter test
  » DL 1 DPCH, 8 DPCH, 10 DPCH, P-CCPCH
    – Scrambling Code $0_H$

• BS receiver test/ UE transmitter test
  » UL RMC 12.2 ~ 384 kbps
    – Scrambling Code $0_H$

• UE receiver test
  » DL RMC 12.2 ~ 384 kbps
    – Scrambling Code $0_H$
    – Oversampling $4 \times 1.28$ Mcps = 5.12 MS/s
Updated Signal Pattern Files

- The user can visit the Anritsu "Software Download" website to download the updated latest pattern files and operation manuals (PDF) for free.
  - User registration is required to use the download service.
  - The pattern files are deleted two months after an announcement due to bulk files.

- All the latest pattern files are provided by DVD for a fee.
  - Z0777 (optional accessory)
    Standard waveform pattern upgrade kit

http://www.anritsu.com/
Option

- Product Outline
- Features
- Options

- MG3700A-002 (102)
  » Mechanical Attenuator
- MG3700A-011 (111)
  » Upper Frequency 6 GHz
- MG3700A-021 (121)
  » ARB Memory Upgrade
    512 Msample/channel
- MG3700A-031 (131)
  » High-speed BER Test function

- MG3700A-0xx: Initial order
- MG3700A-1xx: Retrofit order

- Key optional accessories list 160
MG3700A-002 Mechanical Attenuator

- In order to change the RF output level widely, the step attenuator controls the output level.
- There are two types of step attenuators. An electronic attenuator is provided as standard. Please determine needs according to usage, since there are trade-off relationships regarding advantages.

  - Electronic step attenuator  **Standard**
    - Switches the attenuation elements using a semiconductor switch
    - 5 dB step, 135 dB range
    - Advantage: high-speed, long life, no wear
      *Better for ATE*

  - Mechanical step attenuator  **Option**
    - Switches the contacts of a multi-fixed attenuator of different values and through paths using a mechanical switch
    - 2 dB step, 142 dB range, Switching useful life ≥ 5 million times
    - Advantage: low loss, no variation of temperature
      *Better for high power output, high C/N, field site use*
### Different Attenuator Specifications

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Switching time</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Frequency switching = Normal:</td>
<td></td>
<td>≤ 15 ms (3 GHz non-cross, Δf &lt; 1 GHz)</td>
<td>≤ 80 ms (3 GHz non-cross)</td>
<td>≤ 20 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 20 ms (3 GHz non-cross, Δf ≥ 1 GHz)</td>
<td>≤ 100 ms (3 GHz cross)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 40 ms (3 GHz cross)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Frequency switching = Fast:</td>
<td></td>
<td>≤ 10 ms (3 GHz non-cross)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 40 ms (3 GHz cross)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output level</th>
<th>Settable range</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency switching = Normal:</td>
<td>-140 ~ +13 dBm</td>
<td>-140 ~ +19 dBm</td>
<td>-143 ~ +17 dBm</td>
<td></td>
</tr>
<tr>
<td>Frequency switching = Fast:</td>
<td>-140 ~ +13 dBm</td>
<td>-140 ~ +19 dBm</td>
<td>-143 ~ +17 dBm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW, 23 ±5 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switching time</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 10 ms (≥ 25 MHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 15 ms (&lt; 25 MHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 80 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 50 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VSWR</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3 (≤ 3 GHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.55 (&gt; 3 GHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.25 (≤ 3 GHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.35 (&gt; 3 GHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vector mod.</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/Q mod.</td>
<td>W-CDMA</td>
<td>Test Model 1 64DPCH</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACLR 5 MHz Offset</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>-61 dBc/3.84 MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-63 dBc/3.84 MHz typ.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACLR 10 MHz Offset</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>-66 dBc/3.84 MHz typ.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACLR 10 MHz Offset</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>-67 dBc/3.84 MHz typ.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACLR 10 MHz Offset</th>
<th>Electronic attenuator</th>
<th>Mechanical attenuator</th>
<th>MG3681A Mechanical attenuator for reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>-67 dBc/3.84 MHz typ.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MG3700A-011 Upper Frequency 6 GHz

• Upper frequency reaches 6 GHz by mounting RF unit for 3 GHz < frequency ≤ 6 GHz

<table>
<thead>
<tr>
<th>Standard</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range 250 k ~ 3 GHz</td>
<td>250 k ~ 6 GHz</td>
</tr>
</tbody>
</table>

• The frequency switch between RF unit for frequency ≤ 3 GHz and RF unit for 3 GHz < frequency ≤ 6 GHz is made using a mechanical switch.
  » Switching useful life ≥ 5 million times
MG3700A-021 ARB Memory Upgrade
512 Msample/channel

- Upgradable baseband memory capacity
  - Doubles the I/Q sample data sequence length
  - Increases the loadable number of signal patterns
    - Although the data loading speed from HDD to baseband memory is 14 MB/s, the change of the signal pattern within the memory is the instant.

*Better for W-CDMA and broadcast receiver test*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory capacity</td>
<td>2× 128 M (1 GB)</td>
</tr>
</tbody>
</table>
### MG3700A-031 High-speed BER Test Function

- Upgradable features by mounting PCB for Faster BER analyzer

<table>
<thead>
<tr>
<th>Feature</th>
<th>Standard</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data rate</td>
<td>1 k ~ 20 Mbps</td>
<td>100 ~ 120 Mbps</td>
</tr>
<tr>
<td>Data pattern</td>
<td>PN9, 11, 15, 20, 23, ALL0, ALL1, Alternate 01</td>
<td>PN fixed pattern, Custom pattern</td>
</tr>
<tr>
<td>Measuring bit * after synchronization</td>
<td>1,000 ~ 4,294,967,295 (2^{23}-1)</td>
<td></td>
</tr>
<tr>
<td>Measuring time * after synchronization</td>
<td>0.1 ~ 359,999 s (99 h 59 m 59 s)</td>
<td></td>
</tr>
<tr>
<td>Measuring error bit * after synchronization</td>
<td></td>
<td>1 ~ 2,147,483,647 (2^{31}-1)</td>
</tr>
<tr>
<td>Automatic re-synchronization (Auto Resync)</td>
<td>On: Sync Loss monitoring per 10 ms</td>
<td>Re-synchronization (Sync Loss count)</td>
</tr>
<tr>
<td>Sync Loss behavior</td>
<td>Measurement stop (Sync Loss error)</td>
<td>1 ~ Error bits for half of bits</td>
</tr>
<tr>
<td>Sync Loss threshold</td>
<td>6 error bits</td>
<td>500 or 5,000 or 50,000 bits</td>
</tr>
<tr>
<td>64 bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input level</td>
<td>TTL</td>
<td>0 ~ 5 V</td>
</tr>
<tr>
<td>Input threshold</td>
<td>0.8 ~ 2.4 V for TTL</td>
<td>0.2 ~ 3 V Resolution 0.05 V</td>
</tr>
<tr>
<td>Input impedance</td>
<td>High impedance</td>
<td>High impedance, 50 Ω</td>
</tr>
<tr>
<td>Input timing adjustment</td>
<td>High impedance</td>
<td>Data, Enable: -1 ~ +15 clock</td>
</tr>
</tbody>
</table>
Advanced BER Analyzer

Auto Resync described later

PN fixed pattern
Custom pattern described later
PN Fixed Pattern

- The PN in PN sequence stands for pseudo noise, which is just another name for PRBS.
  - PRBS: Pseudorandom binary (bit) sequence
- Pseudorandom sequences are generated using a binary shift register.
  - PN(n) sequences are $2^n-1$ bits period
    - PN9: 511 bits period
    - PN11: 2,047 bits period
    - PN15: 32,767 bits period
    - PN20: 1,048,575 bits period
    - PN23: 8,388,607 bits period

The signal pattern file created with these bits periods for BER test will be a large file.

↓ In order to reduce the pattern file size
PN Fixed Pattern

- PN fixed pattern is a data pattern initialized at the start of the frame etc.

- PN signal is continuous.
- PN signal is discontinuous.

```
<table>
<thead>
<tr>
<th>A: Fixed bit (10 bits)</th>
<th>B: Communication channel (1000 bits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN6 (511 bits)</td>
<td>PN9 (22 bits)</td>
</tr>
<tr>
<td>PN9 (489 bits)</td>
<td>PN9 signal returns to the head.</td>
</tr>
</tbody>
</table>

1 frame
```

Waveform pattern period = 2 frames

- Repetition of PNx N times (N = 0, 1, 2, ...)

- PNx ($2^x - 1$ bits)
- PNx ($2^x - 1$ bits)
- Incomplete PNx (y bits)

PN Fix Pattern Length = ($2^x - 1$) x N + y bits

x: PN stage count
N: PNx repetition times

Discover What's Possible™
Custom Pattern

- Arbitrary data patterns can be defined on PC.
  » 8 ~ 1,024 bits period

Text file
00000000
11111111
01010101
00001111

Ethernet

![Image of custom pattern setup and output]

[Text file content]
00000000
11111111
01010101
00001111

[Output on equipment]

Discover What's Possible™

Anritsu
Automatic Re-synchronization (Auto Resync)

- **On**
  - The error bits more than threshold occurred after synchronization is judged to Sync Loss, and then the data pattern is re-synchronized.

- **Off**
  - Sync Loss is not detected.

**Recommended setting**

<table>
<thead>
<tr>
<th>Error rate</th>
<th>Auto Resync On</th>
<th>Auto Resync Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 0.3 %</td>
<td>Threshold 50/500</td>
<td>Optimum</td>
</tr>
<tr>
<td>&lt; 0.3 %</td>
<td>Optimum</td>
<td>Applicable</td>
</tr>
</tbody>
</table>

**Threshold of other models**
- MP1201C 200/512
- MD6420A default 200/512
- MT8820A (W-CDMA) 23/64

**Flowchart**

- Start of BER measurement
- Display
- Synchronizing
- Measuring
- Continuous
- Measure Mode?
- Single
- Endless
- Stop
- Stop of count
- Yes
- No
- Stop?
Synchronization

Standard

- Conditions
  - Error-free bits detection

<table>
<thead>
<tr>
<th>PN(n)</th>
<th>50 + n bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL0, ALL1, Alternate 01</td>
<td>48 bits</td>
</tr>
</tbody>
</table>

- Probability
  - Probability that Error-free (50 + n) bits occur

<table>
<thead>
<tr>
<th>Error rate</th>
<th>PN9</th>
<th>PN15</th>
<th>PN23</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 %</td>
<td>0.22 %</td>
<td>0.11 %</td>
<td>0.046 %</td>
</tr>
<tr>
<td>3 %</td>
<td>17.1 %</td>
<td>13.8 %</td>
<td>10.8 %</td>
</tr>
<tr>
<td>1 %</td>
<td>55.8 %</td>
<td>52 %</td>
<td>48 %</td>
</tr>
<tr>
<td>0.1 %</td>
<td>94.4 %</td>
<td>93.7 %</td>
<td>93 %</td>
</tr>
</tbody>
</table>

| Probability that Error-free (2 × n) bits occur

<table>
<thead>
<tr>
<th>Error rate</th>
<th>PN9</th>
<th>PN15</th>
<th>PN23</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 %</td>
<td>15 %</td>
<td>4.2 %</td>
<td>0.79 %</td>
</tr>
<tr>
<td>3 %</td>
<td>57.8 %</td>
<td>40.1 %</td>
<td>24.6 %</td>
</tr>
<tr>
<td>1 %</td>
<td>83.5 %</td>
<td>74 %</td>
<td>63 %</td>
</tr>
<tr>
<td>0.1 %</td>
<td>98.2 %</td>
<td>97 %</td>
<td>95.5 %</td>
</tr>
</tbody>
</table>

Option

<table>
<thead>
<tr>
<th>PN(n)</th>
<th>2 × n bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL0, ALL1, Alternate 01</td>
<td>10 bits</td>
</tr>
<tr>
<td>PN fixed pattern</td>
<td>2 × n bits &gt;&gt; Last bit &gt;&gt; First n bits</td>
</tr>
<tr>
<td>Custom pattern</td>
<td>≥ 8 bits customer-defined</td>
</tr>
</tbody>
</table>

In PN(n) sequence with random error bits.
Key Optional Accessories List

- Various operation manuals (booklet)
  - PDF files are stored in CDs for MG3700A standard accessories and option software.

- J1277 IQ output adapter
  - D-Sub/BNC

- G0141 HDD ASSY
  - for internal HDD exchange

- J1261B Ethernet cable (shield type)
  - Straight, 3 m

- J1261D Ethernet cable (shield type)
  - Cross, 3 m

- B0329C Front cover

- B0331C Front panel handle kit

- B0333C Rack mount kit

- MA1612A Four-port junction pad
  - 5 M ~ 3 GHz

- MP752A Termination
  - DC ~ 12.4 GHz, 50 Ω

- MA2512A Band Pass Filter
  - 1.92 ~ 2.17 GHz