

DIGITAL MODULATION SIGNAL GENERATOR
MG3681A
 250 kHz to 3 GHz



For Evaluating Next Generation Digital Mobile Communications Systems



The MG3681A uses a wideband vector modulator to output the high-accuracy, high-speed vector modulation signals that are required for R&D and manufacturing of digital mobile communications equipment and related devices. It covers the frequency band of leading mobile communications systems for the frequency range of 250 kHz to 3 GHz. It uses vector modulator to provide excellent frequency response, distortion and S/N ratio. It can perform accurate receiver sensitivity test and transmitter adjacent channel leakage power test for high-speed modulation communications systems. Expansion units such as MU368040A CDMA Modulation Unit for modulation signals generation of W-CDMA communication system can be installed on the seven expansion slots in the MG3681A. Various modulation signals can be generated with the expansion units and associated software. The MG3681A also has analog modulation functions such as AM and FM for testing of analog communications systems. In addition, its excellent signal purity and various functions such as memory and frequency sweep are useful as a general-purpose signal generator.

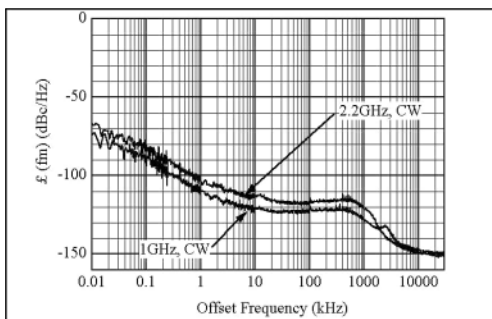
Features

- High-resolution setting of frequency 0.01 Hz and output level 0.01 dB
- 30 MHz wideband and high-accuracy vector modulation
- Excellent adjacent channel leakage power ratio
- Various expansion units

Performance and functions

• Excellent signal purity

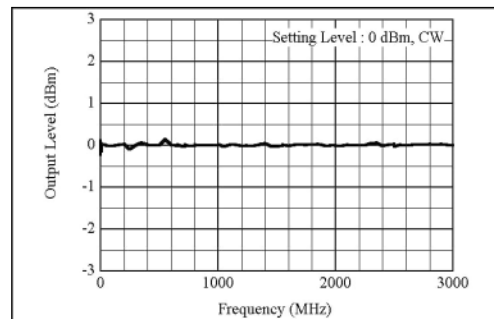
Digital mobile communications evolve into wideband RF frequency bandwidth, and signal generator requires low-noise signal to faraway frequency offset. A unique synthesizer technology achieves low noise floor characteristics of -145 dBc/Hz (typ. at above 5 MHz offset).



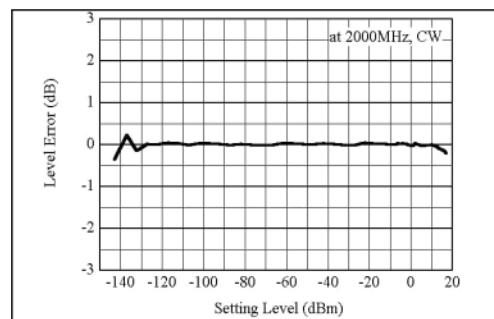
SSB phase noise characteristics

• Excellent level accuracy signal

The frequency response is excellent by calibrating output level across the entire output RF frequency range. Even low level can be output with high-accuracy due to use of a high-precision, high-reliability step attenuator calibrated.



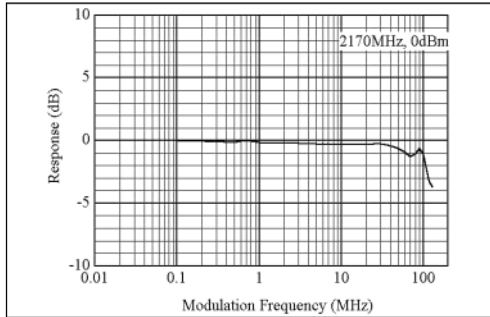
Output level frequency response



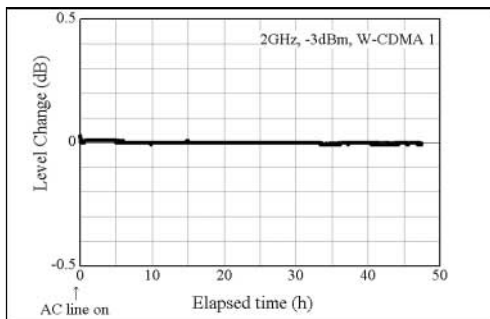
Output level accuracy

• Wideband vector modulation

The modulation frequency response of ± 3 dB at the modulation frequency from DC to 30 MHz is achievable by the high-speed baseband signal processor and wideband vector modulator, permitting wideband vector modulation supporting high-speed data communications including W-CDMA system. Accurate wideband vector modulation is also available by using the external I/Q signals as well as internal modulation using the optional modulation units installed. In addition, a unique Automatic Level Control (ALC) technology assures stable output level at vector modulation.



Vector modulation frequency response



Output level stability at W-CDMA system modulation

• Expansion units for up to seven slots

Seven slots for expansion units have 14 bits high-speed waveform data bus each In-phase and Quadrature signals. The excellent expandable platform covers future communication systems by addition of expansion units.

Note: Some expansion units require installation of dedicated software to enable functionality.

Configuration of communication system software and expansion units

Communication system	Applicable software	Expansion units
PDC	MX368011A PDC Software	MU368010A TDMA Modulation Unit
GSM	MX368012A GSM Device Test Software	
W-CDMA/3GPP (FDD)	MX368041B W-CDMA Software	MU368040A CDMA Modulation Unit
cdmaOne	MX368042A IS-95 Device Test Software	
cdma2000® 1X*1 cdma2000® 1xEV-DO**2 GSM/EDGE*3 PDC*3, NADC*3, PHS*3	MX368031A Device Test Signal Generation Software	MU368030A Universal Modulation Unit
cdma2000® 1xEV-DO	MX368033A cdma2000® 1xEV-DO Signal Generation Software	
PDC packet	MX368034A PDC Packet Software	
PHS	MX368035A PHS Signal Generation Software	
W-CDMA/3GPP cdma2000®	-	MU368060A AWGN Unit

*1: Since coding format of the Reverse is performed, it is utilizable for receiver sensitivity test (RC1 & 3) in base station production.

Since coding format of the Forward is not performed, it is not utilizable for receiver sensitivity test.

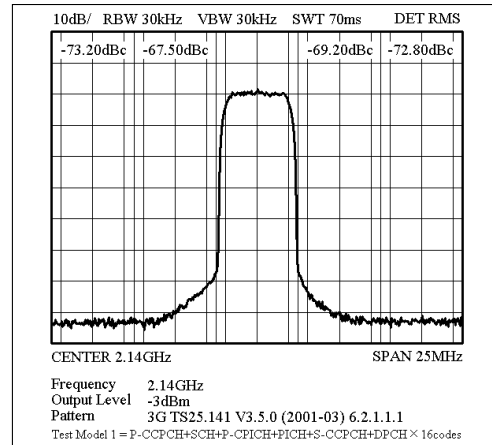
*2: For the Forward, only 16QAM modulation is available, 8PSK and QPSK modulation is not available. Since coding format of the Forward and the Reverse is not performed, it is not utilizable for receiver tests.

*3: It is a continuous modulation signal based on the communication system.

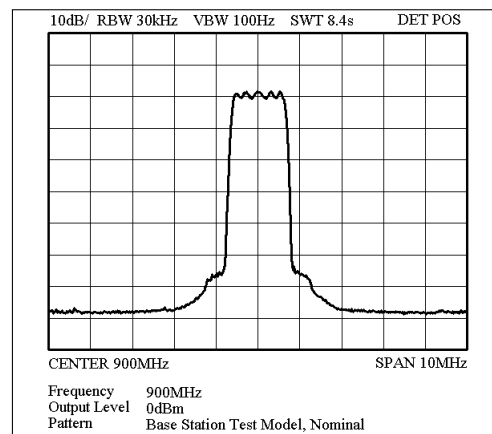
• Excellent adjacent channel leakage power ratio

The adjacent channel leakage power ratio of the digital modulation signal generator is an important factor in distortion testing of device and interference testing of receiver.

The MG3681A achieves an excellent adjacent channel leakage power ratio by an optimized circuit design. The typical adjacent channel leakage power ratio for W-CDMA system is -68 dBc/3.84 MHz and the secondary adjacent channel leakage power ratio is -75 dBc/3.84 MHz.



W-CDMA system adjacent channel leakage power ratio at 16 code multiplex



IS-95 system adjacent channel power ratio at 9 code multiplex

Specifications

• MG3681A main frame

Frequency	Range	250 kHz to 3000 MHz, Resolution: 0.01 Hz																											
	Accuracy	Depends on installed reference oscillator, Reference frequency accuracy: \pm (5% of FM setting deviation + 5 Hz) for frequency modulation																											
	Internal reference oscillator	Aging rate: $\pm 1 \times 10^{-6}$ /year, Temperature stability: $\pm 1 \times 10^{-6}$ (0° to 50°C)*1																											
	External reference input	10 MHz/13 MHz auto-switching, ± 10 ppm, ≥ 0.7 V(p-p)/50 Ω (AC coupled), BNC connector (rear panel)																											
	Buffer output	10 MHz, TTL level (DC coupled), BNC connector (rear panel)																											
	Switching time	≤ 20 ms (response time from final command to ± 500 Hz of set frequency on GPIB at CW, ALC on, except when setting frequency is crossing over 600 MHz and 1010 MHz)																											
Output level	Range	-143 to +13 dBm (settable range: -143 to +17 dBm)																											
	Unit	dBm, W, dB μ V, V (dB μ V, V selected terminate/open voltage display)																											
	Resolution	0.01 dB (dBm, dB μ V units), 3 digit (W, V units)																											
	Frequency response	± 1 dB (CW, ALC on, 0 dBm)																											
	Accuracy	CW, ALC on <table border="1" style="margin-left: 20px;"> <thead> <tr> <th rowspan="2">Level</th> <th colspan="2">Frequency</th> </tr> <tr> <th>≤ 1 GHz</th> <th>> 1 GHz</th> </tr> </thead> <tbody> <tr> <td>$\leq +13$ dBm, ≥ -127 dBm</td> <td>± 1 dB</td> <td>± 2 dB</td> </tr> <tr> <td>< -127 dBm</td> <td>± 2 dB</td> <td>± 3 dB</td> </tr> </tbody> </table>			Level	Frequency		≤ 1 GHz	> 1 GHz	$\leq +13$ dBm, ≥ -127 dBm	± 1 dB	± 2 dB	< -127 dBm	± 2 dB	± 3 dB														
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	Output connector	50 Ω , N-type connector (front panel)																											
Switching time	≤ 50 ms (normal mode), ≤ 100 ms (safety mode), ≤ 10 ms (continuous mode) *Response time from final command to ± 0.5 dB of final level on GPIB at CW, ALC on																												
Special setting mode	Continuous mode: Level continuously adjustable in set value range of ± 10 dB (dBm, dB μ V units only) For vector modulation by optional digital modulation unit, continuous mode variance depends on modulation setting Safety mode: Mechanical attenuator decreases level to prevent generation of high-level signal spikes																												
ALC mode	ALC on Usage: Continuous wave or pulse modulation wave (burst wave) with RF On time of 10 μ s or more ALC time constant: Auto, 500 ns, 2.4 μ s, 5 μ s, 24 μ s, 50 μ s, 240 μ s, 500 μ s selectable At Auto, automatically selected depending on frequency, AM and vector modulation [when digital modulation unit (option) is used] The ALC time constant is automatically selected, depending on the set frequency, regardless of the time constant selected on the front panel ALC off Usage: Pulse modulation wave (burst wave) whose RF on time is less than 10 μ s Restrict item: Without AM ALC calibration: Automatic during ALC Calibration operation and at frequency/level setting change																												
Signal purity	Spurious	Harmonics: < -30 dBc Non harmonic: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Frequency</th> <th>15 kHz to 300 MHz offset</th> <th>> 300 MHz offset</th> <th>Fixed frequency spurious</th> </tr> </thead> <tbody> <tr> <td>≤ 2500 MHz</td> <td>< -60 dBc</td> <td>< -30 dBc</td> <td>-50 dBc (660, 1320 MHz)</td> </tr> <tr> <td>> 2500 MHz</td> <td colspan="2">< -30 dBc</td> <td>-</td> </tr> </tbody> </table> Those related power: < -40 dBc *CW, ≤ 0 dBm			Frequency	15 kHz to 300 MHz offset	> 300 MHz offset	Fixed frequency spurious	≤ 2500 MHz	< -60 dBc	< -30 dBc	-50 dBc (660, 1320 MHz)	> 2500 MHz	< -30 dBc		-													
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> 2500 MHz	< -30 dBc		-																										
SSB phase noise	< -118 dBc/Hz (≥ 10 MHz, ≤ 1010 MHz), < -112 dBc/Hz (> 1010 MHz) *At CW, 20 kHz offset																												
AM	Range	0 to 100% (cannot set internal/external modulation independently), Resolution: 0.1%																											
	Modulation frequency response	≤ 0 dBm, ALC on, in band of ± 1.5 dB based on modulation frequency of 1 kHz <table border="1" style="margin-left: 20px;"> <thead> <tr> <th rowspan="2">Frequency</th> <th rowspan="2">Lower limit frequency</th> <th colspan="3">Upper limit frequency</th> </tr> <tr> <th colspan="2">Vector modulation and wideband AM off</th> <th>Vector modulation or wideband AM on</th> </tr> <tr> <td>≥ 0.4 MHz, < 2 MHz</td> <td rowspan="3">DC (Internal modulation, External modulation DC coupled), 20 Hz (External modulation AC coupled)</td> <td>AM: 30%</td> <td>AM: 80%</td> <td>AM: 30%</td> </tr> <tr> <td>≥ 2 MHz, < 10 MHz</td> <td>3 kHz</td> <td>1 kHz</td> <td rowspan="2">1 kHz</td> </tr> <tr> <td>≥ 10 MHz</td> <td>10 kHz</td> <td>10 kHz</td> </tr> </thead> <tbody> <tr> <td>≥ 10 MHz</td> <td></td> <td>10 kHz</td> <td>10 kHz</td> <td></td> </tr> </tbody> </table>			Frequency	Lower limit frequency	Upper limit frequency			Vector modulation and wideband AM off		Vector modulation or wideband AM on	≥ 0.4 MHz, < 2 MHz	DC (Internal modulation, External modulation DC coupled), 20 Hz (External modulation AC coupled)	AM: 30%	AM: 80%	AM: 30%	≥ 2 MHz, < 10 MHz	3 kHz	1 kHz	1 kHz	≥ 10 MHz	10 kHz	10 kHz	≥ 10 MHz		10 kHz	10 kHz	
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Internal modulation	Depends on AF synthesizer (Option 21)																												
External modulation	2 V(p-p) approx., 600 Ω , AC/DC coupled switchable, BNC connector (front panel)																												
Modulation signal polarity	Positive/negative switchable																												
FM	Range	0 to 1000 kHz (≥ 10 MHz, ≤ 1010 MHz), 0 to 2000 kHz (> 1010 MHz) *Cannot set internal/external modulation independently.																											
	Resolution	10 Hz (0 to 10 kHz deviation), 100 Hz (10.1 to 100 kHz deviation), 1 kHz (101 to 1000 kHz deviation), 10 kHz (1010 to 2000 kHz deviation)																											
	Modulation frequency response	DC to 20 kHz (internal modulation, external modulation DC coupled), 20 Hz to 20 kHz (external modulation AC coupled) *In band of ± 1 dB based on modulation frequency of 1 kHz																											
	Internal modulation	Depends on AF synthesizer (Option 21)																											
	External modulation	2 V(p-p) approx., 600 Ω , AC/DC coupled switchable, BNC connector (front panel)																											
	Modulation signal polarity	Positive/negative switchable																											

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øM	Range	0 to 6.28 rad (≥ 10 MHz, ≤ 1010 MHz), 0 to 12.56 rad (> 1010 MHz) *Cannot set internal/external modulation independently.
	Unit	rad, deg
	Resolution	rad unit: 0.01 rad, deg unit: 1 deg
	Modulation frequency response	DC to 20 kHz (internal modulation, external modulation DC coupled), 20 Hz to 20 kHz (external modulation AC coupled) *In band of ± 1 dB based on modulation frequency of 1 kHz
	Internal modulation	Depends on AF synthesizer (Option 21)
	External modulation	2 V(p-p) approx., 600 Ω , AC/DC coupled switchable, BNC connector (front panel)
	Modulation signal polarity	Positive/negative switchable
Wideband AM	Modulation frequency response	DC to 15 MHz (± 2 dB bandwidth), DC to 30 MHz (± 3 dB bandwidth) *External modulation, input level: 0.9 V(p-p), ≥ 100 MHz, ≤ 0 dBm, modulation frequency of 1 kHz
	Internal modulation	Depends on installed digital modulation unit (option)
	External modulation	≤ 1 V(p-p), 50 Ω , BNC connector (front panel), sensitivity: 1 V(p-p) = 100%
Pulse modulation	On/off ratio	> 60 dB
	Rise/fall time	< 100 ns (external modulation)
	Minimum pulse width	< 500 ns (external modulation)
	Pulse repetition frequency	DC to 1 MHz (external modulation, ALC off)
	Internal modulation	Depends on installed digital modulation unit (option)
	External modulation	TTL level, positive logic, 50 Ω , BNC connector (front panel)
Vector modulation	Modulation frequency response	DC to 15 MHz (± 2 dB bandwidth), DC to 30 MHz (± 3 dB bandwidth) *External modulation, input level: 0.5 V(rms), ≥ 100 MHz, ≤ 0 dBm, modulation frequency of 1 kHz
	Vector error	$\leq 2.5\%$ (rms) *External modulation, input level: 0.5 V(rms), ≥ 100 MHz, ≤ 0 dBm, 3.84 Msps QPSK modulation
	Internal modulation	Depends on installed digital modulation unit (option)
	External modulation	$\sqrt{I^2+Q^2} = 0.5$ V(rms), I/Q = ± 1.5 V(peak), 50 Ω , BNC connector (front panel)
	Quadrature degree adjustment function	Adjustment range: $\geq \pm 1$ deg
I/Q change	I, Q signal changeable (RF spectrum invert)	
Simultaneous modulation	Modulation depth and deviation same for combinations below: AM (internal/external), FM (internal/external), øM (internal/external) Frequency and waveform of modulation signal source same for combinations below: AM (internal)/FM (internal), AM (internal)/øM (internal) Simultaneous modulation impossible as below: FM/øM, wideband AM/vector modulation, vector (internal)/Vector (external) modulation	
AF signal output	Depends on AF synthesizer (Option 21)	
I/Q signal output*2	Output level	Depends on installed digital modulation unit (option)
	Signal source	Depends on installed digital modulation unit (option)
	Output connector	50 Ω , BNC connector (front panel)
Memory function	Basic parameter memory	512 sets of frequency and level
	All parameter memory	All parameters including 100 sets maximum of analog modulation and digital modulation units (option)
Sweep function	Sweep parameter	Basic parameter memory address
	Sweep pattern	Start address \rightarrow stop address
	Sweep time	1 ms to 600 s (per memory; memory recall time restricts lower limit, resolution: 1 ms)
	Sweep mode	Auto (repetition sweep), single (single sweep)
Special display	Relative display	Frequency, output level (dBm, dB μ V units only)
	Offset display	Frequency (offset range: -3 to $+3$ GHz), output level (offset range: -55 to $+55$ dB, dBm, dB μ V units only)
Display	Size	7.2 inch, 480 x 640 dots, color D-STN
	On/off setting	Panel display on/off
Backup function	All items reset at power-on except following: Input data contents, remote condition, contents of GPIB data being transferred, RPP operation condition, screen condition, main function selections	
Panel lock function	Panel lock	Disable operation of all keys except front panel power key, panel lock key, local key and contrast key
	Knob hold	Disable rotary knob on front panel operation
External interface	GPIB	Remote control: All functions except power switch, local key, and contrast key Interfaces: SH1, AH1, T5, L4, TE0, SR1, RL1, DP0, PP0, DC1, DT1, C1, E2 Connector: Rear panel
	RS-232C	Remote control: All functions except power switch, local key, and contrast key Communications method: Async (start-stop), half-duplex Communications control method: X on/off by command Baud rate: 1200, 2400, 4800, 9600, 19200, 38400 bps Data bits; 7 or 8 Parity: Odd, even, none Start bit: 1 Stop bit: 1 or 2 Connector: D-sub 9 pins, rear panel

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External interface	PC card	Memory card (memory backup, screen hard copy) Connector: JEIDA Ver 4/4.1 PCMCIA Rel 2.0, 1 slot (rear panel)
	Trigger	Executes item specified by command-input signals (3 bits) from following items: Frequency step-up/step-down, output level step-up/step-down, basic parameter recall address up/down, output level on/off Interface: TTL level Connector: D-sub 9-pin, female (rear panel)
Reverse power protection	≤ 50 W (≤ 1 GHz), ≤ 25 W (> 1 GHz), ± 50 V (DC)	
Power	AC 100 to 120/200 to 240 V ($-15/+10\%$, 250 V max, automatic selection), 47.5 to 63 Hz, ≤ 300 VA	
Temperature	Operating: 0° to 50° C, Storage: -20° to 60° C	
Dimensions and mass	426 (W) x 177 (H) x 451 (D) mm, ≤ 25 kg (excluding option)	
EMC	EN61326: 1997/A1: 1998 (Class A) EN61000-3-2: 1995/A2: 1998 (Class A) EN61326: 1997/A1: 1998 (Annex A)	
LVD	EN61010-1: 1993/A2: 1995 (Installation Category II, Pollution degree 2)	

*1: Aging rates down to 5×10^{-10} /day are available as reference crystal oscillator (MG3681A Option 01/02).

*2: Possible to expand the function with MG3681A Option 11

• Options

Option 01 (Reference crystal oscillator)	Frequency: 10 MHz Aging rate: $\pm 5 \times 10^{-9}$ /day Start-up characteristics: 1×10^{-7} (After 10 min, compared to frequency after 24 h warm-up) Temperature stability: $\pm 3 \times 10^{-8}$ (0° to 50° C)
Option 02 (Reference crystal oscillator)	Frequency: 10 MHz Aging rate: $\pm 5 \times 10^{-10}$ /day Start-up characteristics: 1×10^{-7} (After 10 min, compared to frequency after 24 h warm-up) Temperature stability: $\pm 5 \times 10^{-9}$ (0° to 50° C)
Option 11 (Additional function of I/Q output)	Functions: Adds level, offset setting, and differential output functions to I/Q output Level Range: 80 to 120% of nominal level, Resolution: 0.1% *2 sets of I/\bar{I} and Q/\bar{Q} set independently, 50 Ω termination Offset Range: -0.5 to $+1.5$ V, Resolution: 0.5 mV *4 sets of I, \bar{I}, Q, \bar{Q} set independently, 50 Ω termination Quadrature degree variable function Range: ± 5 deg, Resolution: 0.5 deg Differential output: I, Q signals (Using front I/Q input connector) Signal source: Depends on installed digital modulation unit (option) Output connector: 50 Ω , BNC connector (front panel)
Option 21 (AF synthesizer)	Frequency: 0.01 Hz to 400 kHz, Resolution: 0.01 Hz, Accuracy: same as reference oscillator Waveform: Sine, triangular, square, sawtooth Frequency response: ± 1 dB [sine wave, level: 2 V(p-p), offset: 0 V, 600 Ω termination, reference to 1 kHz, 10 Hz to 100 kHz] Harmonics: ≤ -50 dB [sine wave, level: 2 V(p-p), offset: 0 V, 600 Ω termination, 1 kHz] Level Range: 0 to 4 V(p-p), Resolution: 1 mV(p-p), Accuracy: $\pm [8\%$ of set level + 2 mV(p-p)] *600 Ω termination Offset Range: -2 to $+2$ V, Resolution: 1 mV, Accuracy: $\pm (8\%$ of set level + 2 mV) *600 Ω termination Output connector: 600 Ω , BNC connector (front panel)
Option 42 (RF high level output)	Functions: 8 dB gain of maximum output level in W-CDMA band Frequency: 1900 to 2200 MHz Gain: 8 ± 1 dB (from -3 dBm, RF high level output off, 2.1 GHz) Gain frequency response: ± 1 dB (at $+5$ dBm, referenced to 2.1 GHz)

• Expansion units and software

Refer to the individual catalogs for the expansion units and software.

Ordering information

Please specify model/order number, name, and quantity when ordering.

Model/Order No.	Name
MG3681A	Main frame Digital Modulation Signal Generator
	Standard accessories
	Power cord, 2.6 m: 1 pc
B0325	GPIB connector shield cap: 1 pc
F0014	Fuse, 6.3 A: 2 pcs
W1708AE	MG3681A operation manual: 1 copy
	Options
MG3681A-01	Reference oscillator (aging rate: 5 x 10 ⁻⁹ /day)
MG3681A-02	Reference oscillator (aging rate: 5 x 10 ⁻¹⁰ /day)
MG3681A-11	Additional function of I/Q output (level and offset setting, differential output)
MG3681A-21	AF synthesizer (0.01 Hz to 400 kHz, resolution: 0.01 Hz)
MG3681A-42	RF high level output (for W-CDMA, 8 dB gain)
	Maintenance service
MG3681A-90	Extended three years warranty service
MG3681A-91	Extended five years warranty service
	Expansion units
MU368010A	TDMA Modulation Unit*1,*2
MU368030A	Universal Modulation Unit*1,*2
MU368040A	CDMA Modulation Unit*1,*2
MU368060A	AWGN Unit*1
	Standard accessories
W1835AE	MU368010A operation manual: 1 copy
W1973AE	MU368030A operation manual: 1 copy
W1758AE	MU368040A operation manual: 1 copy
W1955AE	MU368060A operation manual: 1 copy
	Maintenance service
MU368010A-90	Extended three years warranty service
MU368010A-91	Extended five years warranty service
MU368030A-90	Extended three years warranty service
MU368030A-91	Extended five years warranty service
MU368040A-90	Extended three years warranty service
MU368040A-91	Extended five years warranty service
MU368060A-90	Extended three years warranty service
MU368060A-91	Extended five years warranty service

*1: Refer to the individual catalogs for the expansion units, software and band pass filter.

*2: When using the MU368010A, MU368030A and MU368040A, dedicated software must be installed.

Model/Order No.	Name
	Softwares*1
MX368011A	PDC Software (for MU368010A)
MX368012A	GSM Device Test Software (for MU368010A)
MX368031A	Device Test Signal Generation Software (for MU368030A)
MX368033A	cdma2000® 1xEV-DO Signal Generation Software (for MU368030A)
MX368034A	PDC Packet Software (for MU368030A)
MX368035A	PHS Signal Generation Software (for MU368030A)
MX368041B	W-CDMA Software (for MU368040A)
MX368041B-10	3GPP Release 5 signal pattern
MX368042A	IS-95 Device Test Software (for MU368040A)
	Standard accessories
W1836AE	MX368011A operation manual: 1 copy
W1837AE	MX368012A operation manual: 1 copy
W1974AE	MX368031A operation manual: 1 copy
W2072AE	MX368033A operation manual: 1 copy
W2073AE	MX368034A operation manual: 1 copy
W2167AE	MX368035A operation manual: 1 copy
W2089AE	MX368041B operation manual: 1 copy
W1838AE	MX368042A operation manual: 1 copy
	Optional accessories
J0576B	Coaxial cord (N-P · 5D-2W · N-P), 1 m
J0576D	Coaxial cord (N-P · 5D-2W · N-P), 2 m
J0127C	Coaxial cord (BNC-P · RG-58A/U · BNC-P), 0.5 m
J0127A	Coaxial cord (BNC-P · RG-58A/U · BNC-P), 1 m
J0007	GPIB cable, 1 m
J0008	GPIB cable, 2 m
B0329C	Front cover (1MW4U)
B0331C	Front handle (2 pcs/set)
B0332	Joint plate (4 pcs/set)
B0333C	Rack mount kit
B0334C	Carrying case (Hard type, with front cover and casters)
MA2512A	Band Pass Filter*1 (for W-CDMA, pass band: 1.92 to 2.17 GHz)