

# Power Amplifier High-Speed Measurement Solution

**MS2690A/MS2691A/MS2692A**  
Signal Analyzer

# Power Amplifier High-Speed Measurement Solution

for Mobile WiMAX and WLAN

**MS2690A/MS2691A/MS2692A Signal Analyzer**

**MS269xA-020 Vector Signal Generator**

**MX269074A Power Amplifier Measurement Software**

**MX269074A-011 802.11ac (40MHz) Measurement Software**

**MX269074A-012 802.11ac (80MHz) Measurement Software**

**(Version 3.00)**



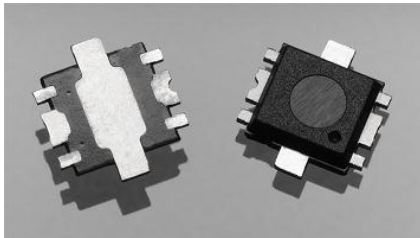
**Anritsu Corporation**

# Background

As mobile terminals and wireless cards for PCs have become multi-band and multi-system there has been a rapid increase in the use of built-in front-end devices.

Users are driving the market towards easy-to-use, compact, low-cost terminals, yet are demanding higher performance at the same time.

When testing front-end devices, the power amplifier is the key component impacting transmitter performance and testing the amplifier is a critical step in front-end development.

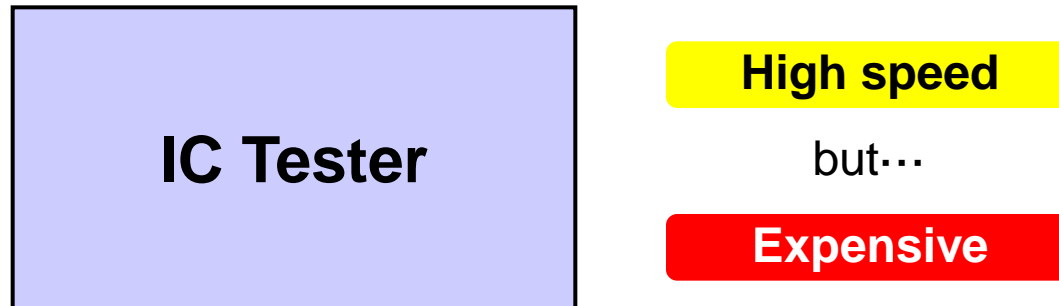


## Measurement items

- EVM
- ACP
- SEM
- Harmonic Distortion
- ⋮

# Background

Although, power amplifier test items can be measured accurately using standalone measuring instruments, such as a signal generators and signal analyzers, measurements using these devices take time. Therefore, large expensive high-speed measuring equipment, such as IC testers, are used.



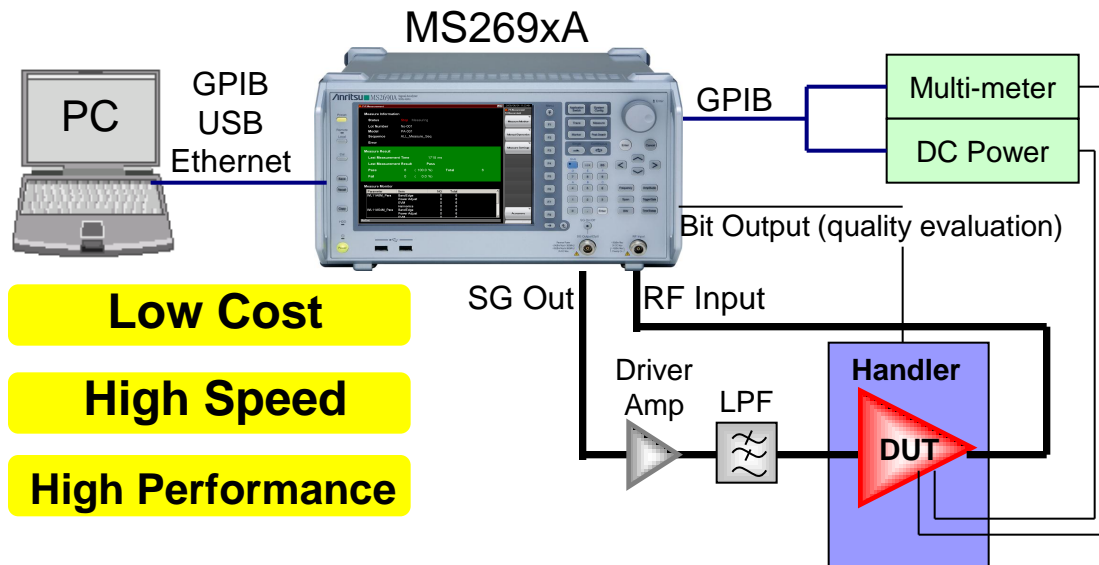
# Anritsu's High-speed Measurement Solution

One-box with Signal Analyzer and Signal Generator.

Faster than an IC Tester.

The MS269xA makes power amplifier measurements quickly with an excellent cost/performance ratio.

## Power Amplifier Manufacturing Line Setup



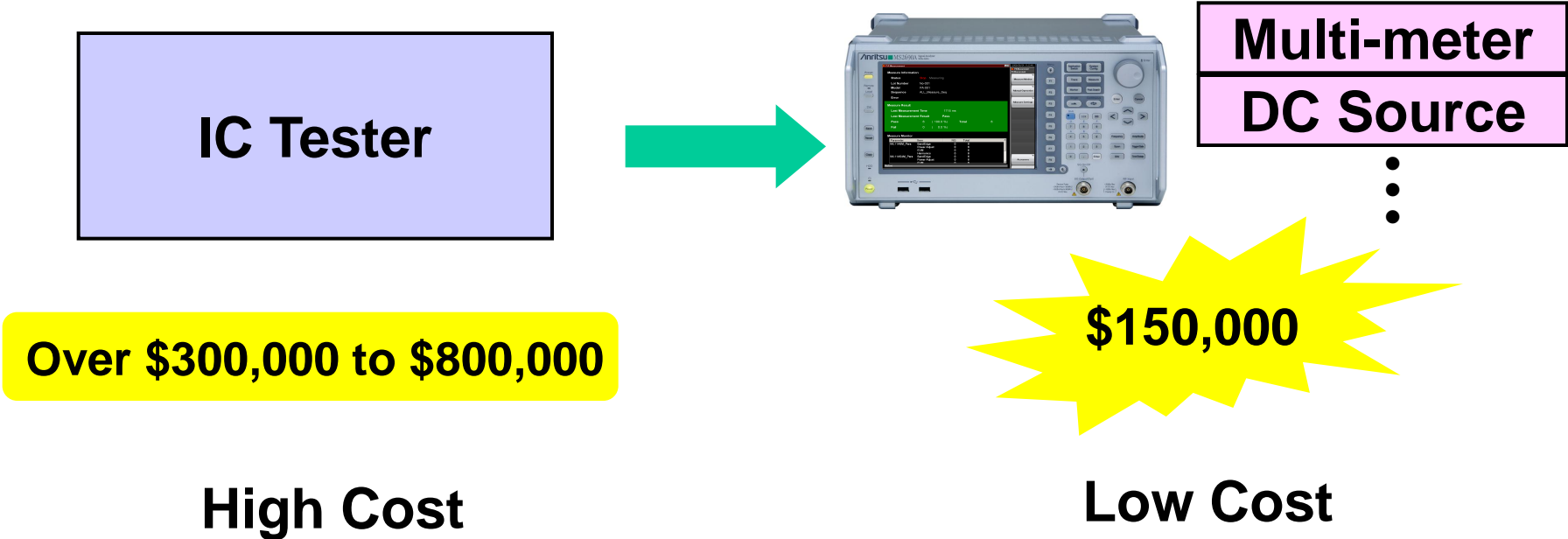
# Features

- ◆ **Cost Advantage**
- ◆ **Excellent Repeatability**
- ◆ **High-Speed Measurement**
- ◆ **Simple Measurement System**

# Cost Advantage

As an example, a WiMAX power amplifier test system price can range from \$300k to \$800k when using an IC tester.

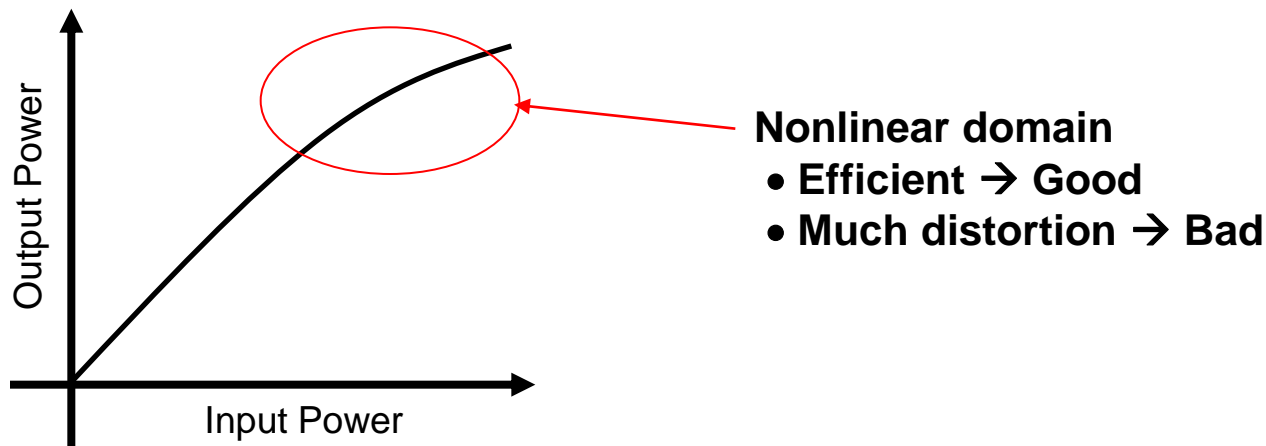
The general configuration of the MS269xA (including the multi-meter and the DC source prices out at about \$150k.



# Excellent Repeatability

One key goal of power amplifier design is to maximize the mobile terminal battery life. Generally, power consumption is suppressed by transmitting in the nonlinear domain but this domain suffers from distortion, which can impact measured values such as EVM, ACP, etc.

At inspection, it is necessary to make a highly accurate power adjustment for each measurement item. **However, measurement repeatability of EVM and ACP may be poor because the repeatability of the power adjustment was poor.**





# Excellent Repeatability

The table below shows some actual examples of dispersion in measured values due to differences in repeatability. Repeatability is expressed as the measured EVM, ACP, and 2HD values at power adjustment ranges of 0.14, 0.05, and 0.03 dB as the target output power for the power amplifier 1 dB gain compression.

Power Adjust Range	Repeatability			
	EVM	ACP upper	ACP lower	2HD
0.14 dB	1.96 dB	1.14 dB	1.12 dB	1.12 dB
0.05 dB	0.44 dB	0.89 dB	0.88 dB	0.72 dB
0.03 dB	0.27 dB	0.27 dB	0.54 dB	0.40 dB

**The measurement repeatability improves as the power adjustment range becomes narrower.**

# Excellent Repeatability

Power adjustment is a key element in power amplifier tests. However, modulated signals have wide level changes and an IC tester typically supports a power adjustment of 0.1 dB.

The MS269xA achieves a  **$\sigma$  value of  $\leq 0.015$  dB (typ.) after adjustment** using unique SA and SG high-speed control technology.

## Power Amplifier Measurement Examples

	Power Adjust [dBm]	EVM [dB]	Mask [dBm]	ACP [dBm]	Current [A]
1	3.02	-49.64	-79.51	-60.10	1.375149
2	3.00	-49.73	-79.35	-60.14	1.375783
3	3.00	-49.65	-79.35	-60.15	1.376175
4	3.02	-49.73	-79.29	-60.12	1.376541
5	3.00	-49.80	-79.07	-60.10	1.376464
6	3.01	-49.67	-79.61	-60.10	1.376685
7	3.01	-49.83	-78.91	-60.10	1.376703
8	3.02	-49.76	-79.52	-60.12	1.376887
9	3.00	-49.76	-79.62	-60.09	1.376964
10	2.98	-49.74	-79.34	-60.13	1.376876
$\sigma$	0.01265	0.06226	0.22857	0.02014	0.00057

\* The KEITHLEY 2430 Pulse Source Meter is used to measure current.



# Excellent Repeatability

Using a sync trigger also improves the repeatability of current measurements.

When using a burst signal such as WiMAX, measurement accuracy is improved by 1 to 2 orders of magnitude.

## Power Amplifier Measurement Examples

	Power Adjust [dBm]	EVM [dB]	Mask [dBm]	ACP [dBm]	Current [A]
1	3.02	-49.64	-79.51	-60.10	1.375149
2	3.00	-49.73	-79.35	-60.14	1.375783
3	3.00	-49.65	-79.35	-60.15	1.376175
4	3.02	-49.73	-79.29	-60.12	1.376541
5	3.00	-49.80	-79.07	-60.10	1.376464
6	3.01	-49.67	-79.61	-60.10	1.376685
7	3.01	-49.83	-78.91	-60.10	1.376703
8	3.02	-49.76	-79.52	-60.12	1.376887
9	3.00	-49.76	-79.62	-60.09	1.376964
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$\sigma$	0.01265	0.06226	0.22857	0.02014	0.00057

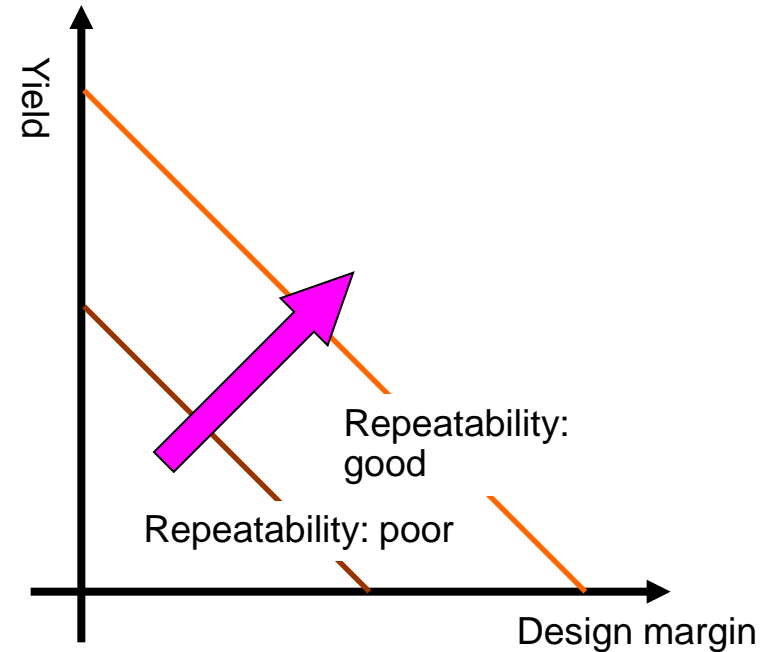
\* The KEITHLEY 2430 Pulse Source Meter is used to measure current.

# Excellent Repeatability

## Why is repeatability important?

Poor repeatability lowers design margin to maintain yield.

Poor repeatability lowers yield to maintain design margin.



Improving the repeatability provides good effects to both yield and design margin.

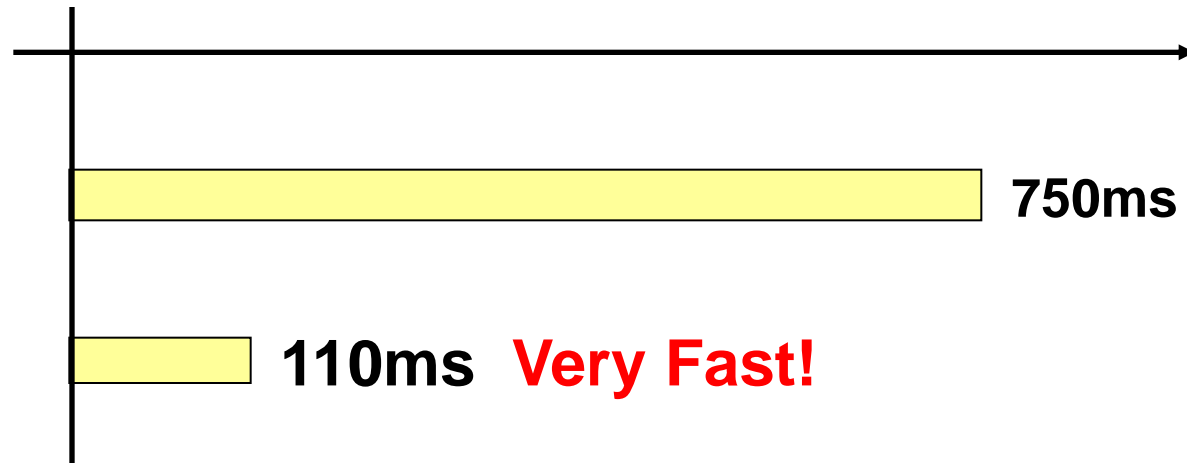
Boost your yield, best your competition!

# High-Speed Measurement

By using the all-in-one MS269xA, **a power adjustment time of about 30 ms (typ.)** is achieved when using a modulated signal for testing.

In one customer's case, **the measurement time has improved it from 750ms to 110ms** by changing from the IC tester to the MS260xA. (power adjustment and EVM)

IC Tester



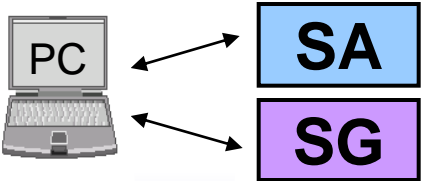
# High-Speed Measurement

Normally, measurements are made by sending remote settings and reading commands one-by-one to the SA and SG. These remote command exchanges take a lot of the total measurement time.

**With the MS269xA, the pre-set measurement sequence is executed by sending just one remote command, cutting measurement times.**

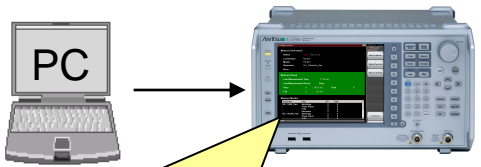
Send one command per solution

[Conventional]



Measurement using Sequence Measurement function

[MS269xA]



**Cuts remote TRX time**

Sequence examples

Setting	SG modulation On
Setting	Change SG frequency
Setting	Change SA frequency (Carrier frequency)
Meas.	Power adjustment (SG level control + SPA meas.)
Setting	EVM measurement setting
Meas.	EVM measurement
Setting	SEM measurement setting
Meas.	SEM measurement
Setting	ACP measurement setting
Meas.	ACP measurement
Setting	SG modulation Off (CW)
Setting	Harmonic measurement setting
Setting	Change SA frequency (second)
Meas.	Harmonic measurement (second)
Setting	Change SA frequency (third)
Meas.	Harmonic measurement (third_

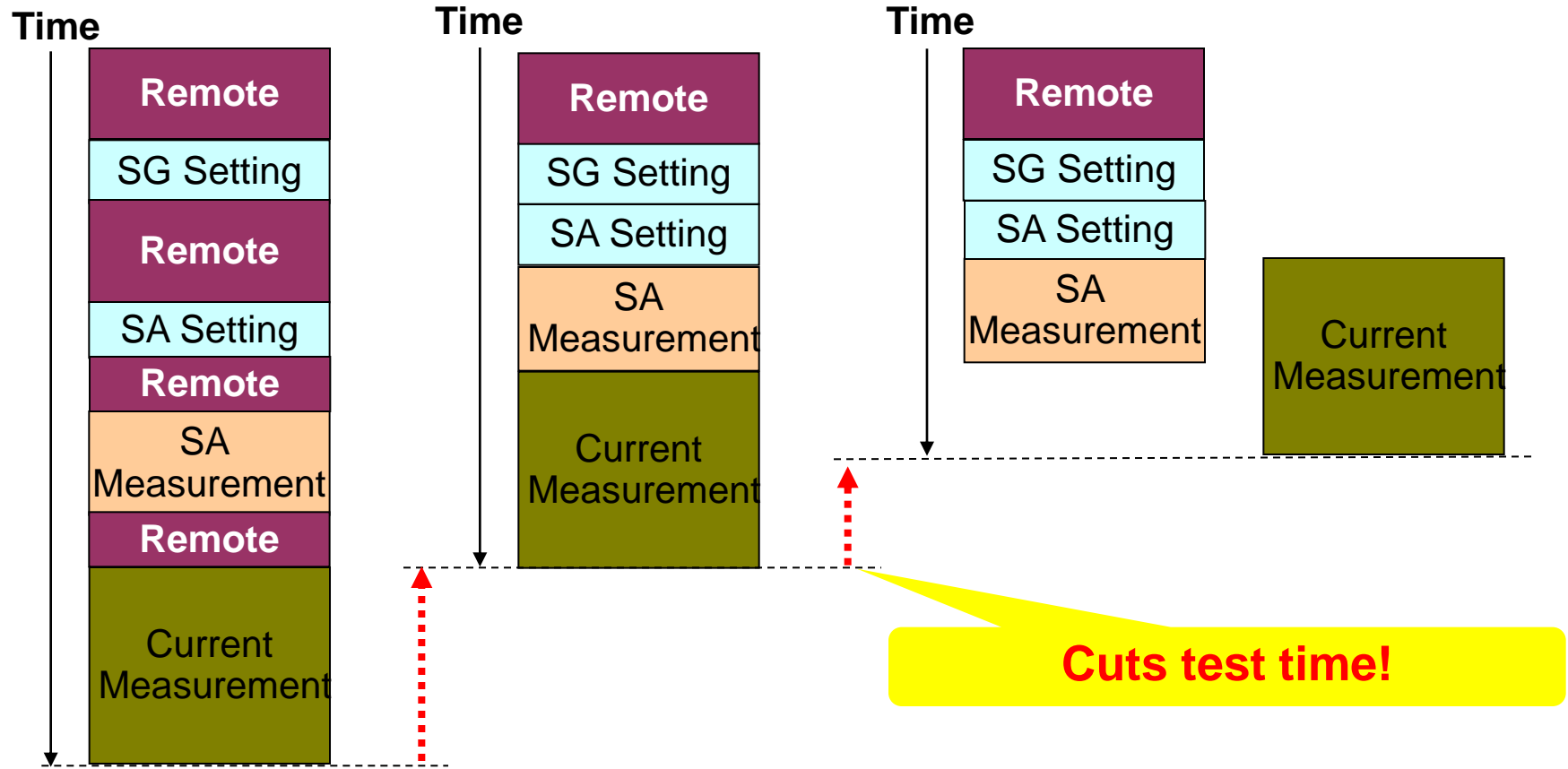
# High-Speed Measurement

By integrating the control of the multi-meters, test time is reduced because the measurements are done in parallel.

## (1) Conventional

## (2) Batch Control

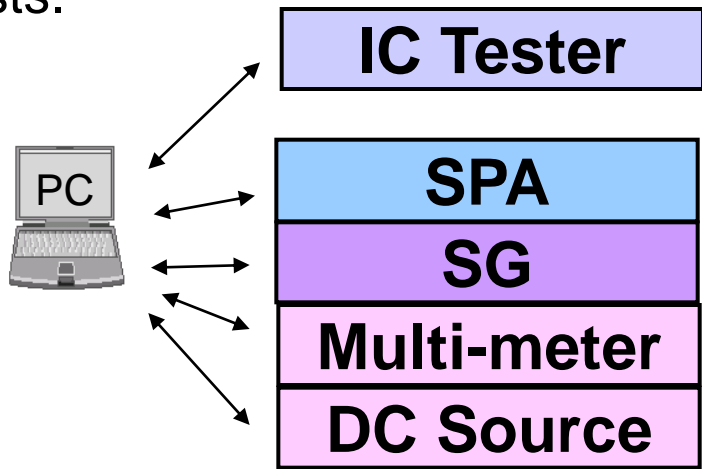
## (3) Parallel Control



# Simple Measurement System

A conventional measurement system **requires control of each measuring instrument by a PC controller**, increasing system installation and maintenance costs.

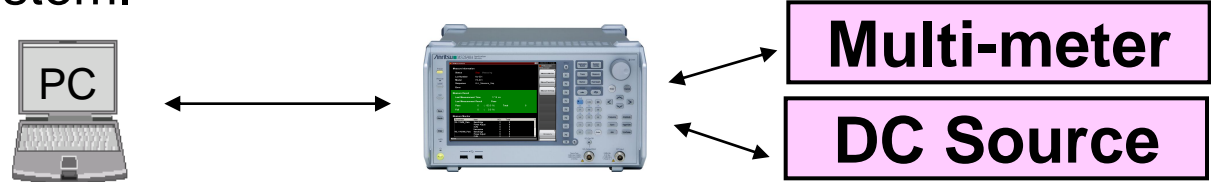
**[Conventional]**



In this new system, the **MS269xA takes control of each measuring instrument.**

The controller PC communicates with the MS269xA, simplifying the measurement system.

**[MS269xA]**





# Features

## ◆ Cost Advantage

Low cost test system that doesn't give up performance.

One-box format contains Signal Analyzer and Signal Generator.

Average price for system: \$150,000.

## ◆ Excellent Repeatability

$\sigma \leq 0.015$  dB (typ.) power adjustment repeatability using a modulated signal.

Improves design margin and product yield

## ◆ High-Speed Measurement

Modulated wave power adjustment in 30 ms (typ.)

Save time, save money!

## ◆ Simple Measurement System

The PC controller communicates with the MS269xA which controls the other equipment

The MS269xA is controlled by parameter files.

# Demo

# Using MX269074A

Initial settings are saved on the MS269xA.

Remote commands from PC launch measurements.

Measurement results are output as a CSV file.



Remote commands  
(GPIB, USB, LAN)



## Measurement Result CSV

Parameter Name	D	E	F	G	H	I				
1	Index	Error	Rank	Error	SG Out	SA In	EVM	BandEdge 1	Harmonics 2nd	Harmonics 3rd
2		-9.08	-13	-50.53	-1.06	35	-64.47	-79.42		
3	0	NORMAL		-9.11	-13	-49.72	-1.06	74	-64.49	-79.23
4	0	NORMAL		-9.11	-13	-50.17	-1.06	89	-64.5	-79.63
5	4	0	NORMAL	-9.11	-13.02	-50.62	-1.07	31	-64.49	-79.44
6	0	NORMAL		-9.09	-12.99	-50.47	-1.06	75	-64.48	-79.6
7	0	NORMAL		-9.11	-13.02	-50.38	-1.07	01	-64.47	-79.63
8	0	NORMAL		-9.1	-12.99	-50.52	-1.07	25	-64.47	-79.2
9	0	NORMAL		-9.09	-12.95	-50.22	-1.06	82	-64.44	-79.66
10	0	NORMAL		-9.12	-13.02	-50.06	-1.07	22	-64.44	-79.13
11	0	NORMAL		-9.11	-12.99	-50.14	-1.07	02	-64.49	-79.5

**Remote commands**  
LOTSTART: Specify initial setting file  
MEASEXEC?: Measure  
LOTEND: Stop measurement

Save in predefined folder

**Initial setting files**

- Measurement sequence file
- Measurement parameter file
- Waveform pattern file

# Simple Setting

Parameter files are created using an Excel macro tool.

Parameter descriptions and ranges are shown in the spreadsheet.

Placing values into the designated cells creates a parameter file.

Measurement Parameters		
Common Parameter	Description	Setting
System	Selects the communication system. WiMAX, WLAN11a, WLAN11b, WLAN11g, WLAN11n, CW	
Waveform	Specifies the path for the waveform pattern information file. Max 200 string	
Carrier Freq	Specifies the carrier frequency. Min 200MHz Max 5.9GHz In MHz, Resolution: 0.001 MHz	
Start Level	Specifies the SG output level at the start of measurement. Min -140dBm Max -5dBm In dBm, Resolution: 0.01dB	
End Level	Specifies the SG output level at the end of measurement. Min -140dBm Max -5dBm In dBm, Resolution: 0.01dB	

# MX269074A Display

Perform manual measurements and confirm measurement results, Pass/Fail evaluation and measurement times.

The screenshot displays the PA Measurement software interface. The main window is titled 'PA Measurement' and shows the following information:

- Measure Information:**
  - Status: Stop Measuring
  - Lot Number: No-001
  - Model: PA-001
  - Sequence: ALL\_Measure\_Seq
  - Error: (empty)
- Measure Result (Green background):**
  - Last Measurement Time: 1718 ms
  - Last Measurement Result: Pass
  - Pass: 6 ( 100.0 %) Total: 6
  - Fail: 0 ( 0.0 %)
- Measure Monitor Table:**

Parameter	Item	NG	Total
WL11A6M_Para	BandEdge	0	6
	Power Adjust	0	6
	EVM	0	6
	Harmonics	0	6
WL11A54M_Para	BandEdge	0	6
	Power Adjust	0	6
	EVM	0	6

On the right side, there is a vertical menu with buttons for 'Measure Monitor', 'Manual Operation', 'Measure Settings', and 'Accessory'. The top right corner shows the date and time: 2009/06/01 11:23:49.

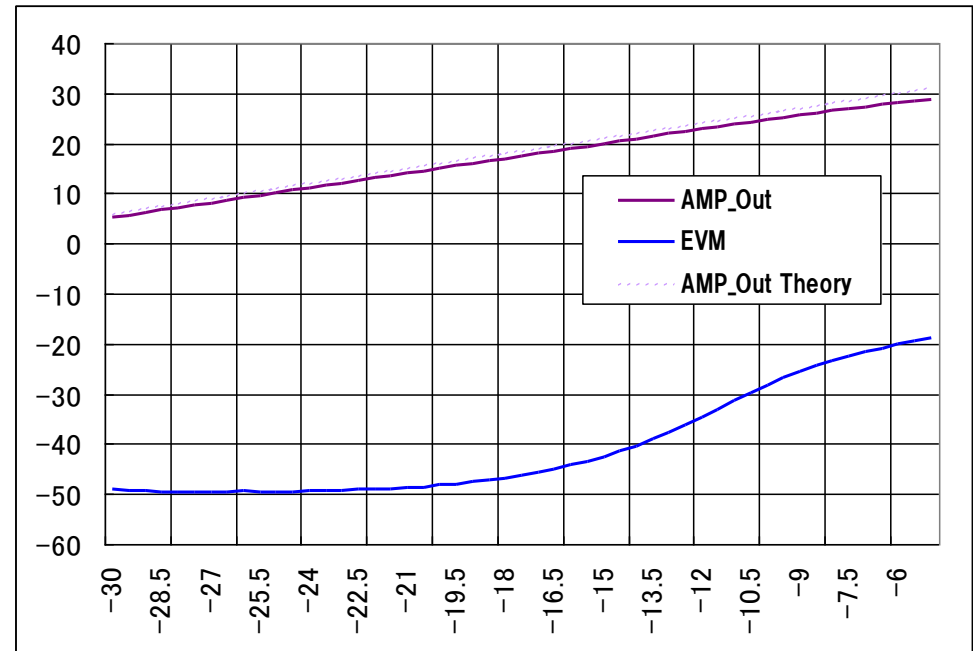
# AM/EVM Curve Data Creation

In addition to high-speed measurement on manufacturing lines, the M269xA is a powerful tool for collecting design data such as curve data.

At creation of curve data for AM/AM curves for normal modulation and AM/EVM curves, work is needed to measure the EVM before and after checking the non-linear generation points at AM/AM. The SA and SG must be separately controlled, which is difficult and time consuming.

**The MS269074A sequence control makes this work quick and easy.**

The data in the figure on the right was captured by the MX269074A in about 2 seconds.



# Measurement Items

## Measurements for Communication Systems

	Power Adjust	EVM	SEM	ACP	Band Edge	Harmonics <sup>*1</sup>	Power Measurement	Spurious
Mobile WiMAX	V	V	V	V		V	V	
WLAN(11a)	V	V			V	V	V	V
WLAN(11g ERP-OFDM)	V	V			V	V	V	V
WLAN(11n)	V	V			V	V	V	V
WLAN(11b)	V				V	V	V	V
WLAN(11ac) <sup>*2</sup>	V	V			V	V	V	V
CW	V					V	V	

\*1: Harmonics measurement is not supported by the MS2690A.

Harmonics measurement is only supported by the MS2691A and MS2692A with Option-003 “Extension of Preselector Lower Limit to 3 GHz” installed. In addition, harmonics measurement not supported under the following conditions:

- By MS2691A when Carrier Freq x Harmonics Order > 13.5 GHz
- By MS2692A when Carrier Freq x Harmonics Order > 26.5 GHz

\*2: The MX269074A-011 software option must be installed to perform WLAN 802.11ac measurements (20/40 MHz channel bandwidth) using the MX269074A.

The MX269074A-011/012 software and MS269xA-077/078 hardware options must be installed to perform WLAN 802.11ac measurements (20/40/80 MHz channel bandwidth) using the MX269074A.

# Ordering Information

	Model	Product Name
Main Frame	MS2690A	Signal Analyzer (50 Hz to 6 GHz)
	MS2691A	Signal Analyzer (50 Hz to 13.5 GHz)
	MS2692A	Signal Analyzer (50 Hz to 26.5 GHz)
Option	MS2691A/92A-003	Extension of Pre-selector Lower Limit to 3 GHz
	MS2690A/91A/92A-020	Vector Signal Generator (125 MHz to 6 GHz)
	MS2690A/91A/92A-077	Analysis Bandwidth Extension to 62.5MHz
	MS2690A/91A/92A-078	Analysis Bandwidth Extension to 125MHz
	MX269074A <sup>Note</sup>	Power Amplifier measurement software
	MX269074A-011	802.11ac (40MHz) measurement software
	MX269074A-012	802.11ac (80MHz) measurement software

**Note:**

The MX269074A-011 software option must be installed to perform WLAN 802.11ac measurements (20/40 MHz channel bandwidth).

The MS269xA-x77/x78 and MX269074A-011/012 hardware and software options must be installed to perform WLAN 802.11ac measurements (20/40/80 MHz channel bandwidth).

The MX269074A-012 and MS2692A-067 “Microwave Preselector Bypass” options cannot be installed simultaneously.



# Note

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