Technical Note

Anritsu

MS8608A/MS8609A

Digital Mobile Radio Transmitter Tester

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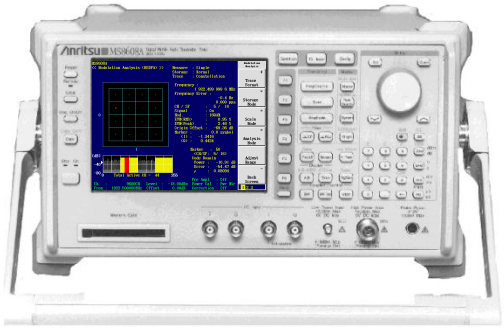

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Contents

1. Wireless communication systems
   - 1.1 Using transmitter tester
   - 1.2 Wireless communications
   - 1.3 Analog modulation
   - 1.4 Digital modulation

2. MS860xA Transmitter Tester
   - 2.1 MS860xA Product outline
   - 2.2 Features
   - 2.3 Parts
   - 2.4 Screens
   - 2.5 Installing measurement software

3. Measurement meaning and principle
   - 3.1 Base Station Tx test items
   - 3.2 Power meter measurements
   - 3.3 Spectrum analyzer measurements
   - 3.3 Modulation analysis measurements

1. Wireless communication systems

1.1 Using transmitter tester
1.2 Wireless communications
1.3 Analog modulation
1.4 Digital modulation

1.1 Using transmitter tester

Wireless communication systems include radio, TV, mobile phones, wireless LANs, etc. Radio and TV uses analog modulation, while mobile phones and wireless LANs use digital modulation.

Developing, manufacturing, inspecting, and maintaining these communications systems requires various measuring instruments, such as power meters, frequency counters, spectrum analyzers, modulation analyzers, signal generators, and signaling testers. The transmitter tester combines the functions of a spectrum analyzer, modulation analyzer, and power meter to measure the transmission characteristics of these wireless equipment.

1.2 Wireless communications

	Method name	Name of a country	Access	Modulation method
1G	AMPS	USA	FDMA	
	TACS	UK, Japan		Analog FM modulation
	NTT method	Japan		
	NMT	Northern Europe		
2G	GSM	Europe, China	TDMA	GMSK
	PDC	Japan		pi/4 DQPSK
	IS-136	USA		pi/4 DQPSK
	IS-95	USA, Japan, etc.	CDMA	QPSK
3G	EDGE(GSM)	Europe	TDMA	GMSK/8PSK
	W-CDMA	Japan, Europe, etc.	CDMA	QPSK
	CDMA 2000 1x	USA, Korea, Japan		QPSK
	TD-SCDMA	China		QPSK
3.5G	CDMA2k 1xEVDO	USA, Korea, Japan	TDMA	QPSK/8PSK/16QAM
	HSDPA	Japan, Europe, etc.	CDMA	QPSK/16QAM
	W-LAN (IEEE802.a,b,g)	Each country	CSMA	DS, OFDM BPSK/QPSK/16QAM/64QAM
	WiMAX (IEEE802.16)	Each country		OFDM BPSK/QPSK/16QAM/64QAM

1.3 Analog modulation

- **What is a carrier?**

  The signal carrier is a high-frequency sine wave for carrying the the baseband signal.

- **What are the three elements of the sine wave?**

  $A_0 \cos (\omega_0 t + \theta)$ A_0: Amplitude, $\omega_0 = 2\pi f$: Frequency, θ: Phase

- **The modulation of the signal carrier changes the baseband signal.**

  Amplitude Modulation: The amplitude is changed by the signal.

  $A_0 (1 + K \cos pt) \cos \omega_0 t$ K: Modulation ratio

  Frequency Modulation: The frequency is changed by the signal.

  $A_0 \cos (\omega_0 t + m_f \sin pt)$ m_f: Frequency deviation

  Phase Modulation: The phase is changed by the signal.

  $A_0 \cos (\omega_0 t + m_p \sin pt)$ m_p: Phase deviation

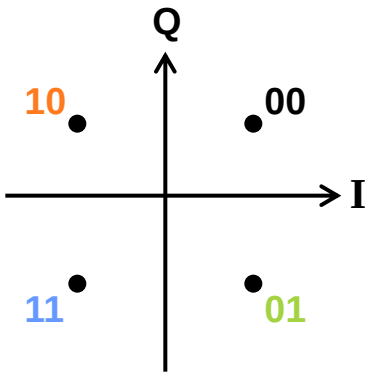
1.4 Digital modulation (QPSK)

QPSK (Quadrature Phase Shift Keying)

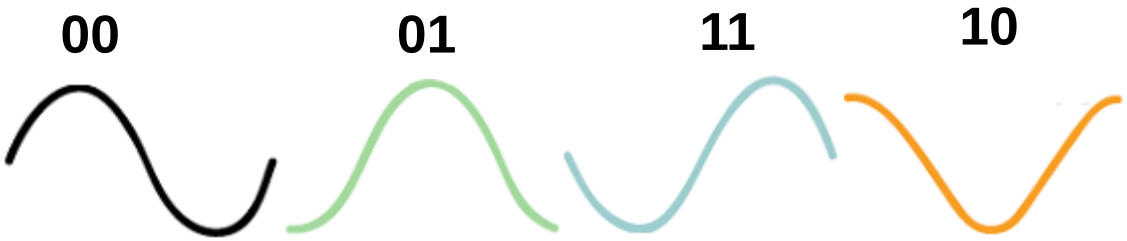
Send data
00011110

Divide by every two bits

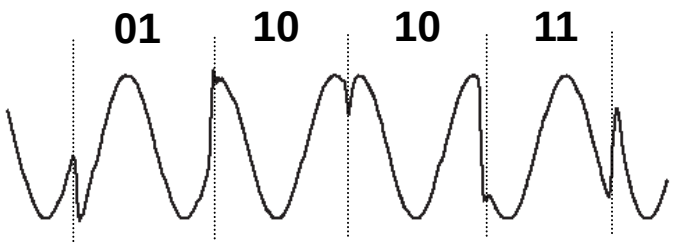
00 01 11 10



Data is sent by using 4 wave shapes that change phase.



Two bits of information are carried in one wave.



1.4 Digital modulation (16QAM)

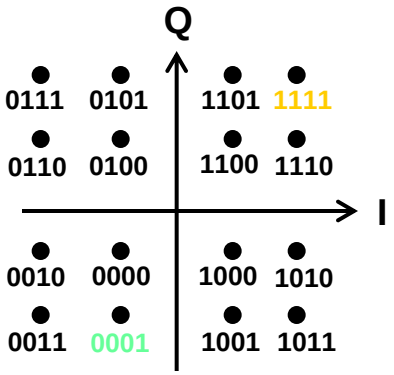
16QAM (16-position Quadrature Amplitude Modulation)

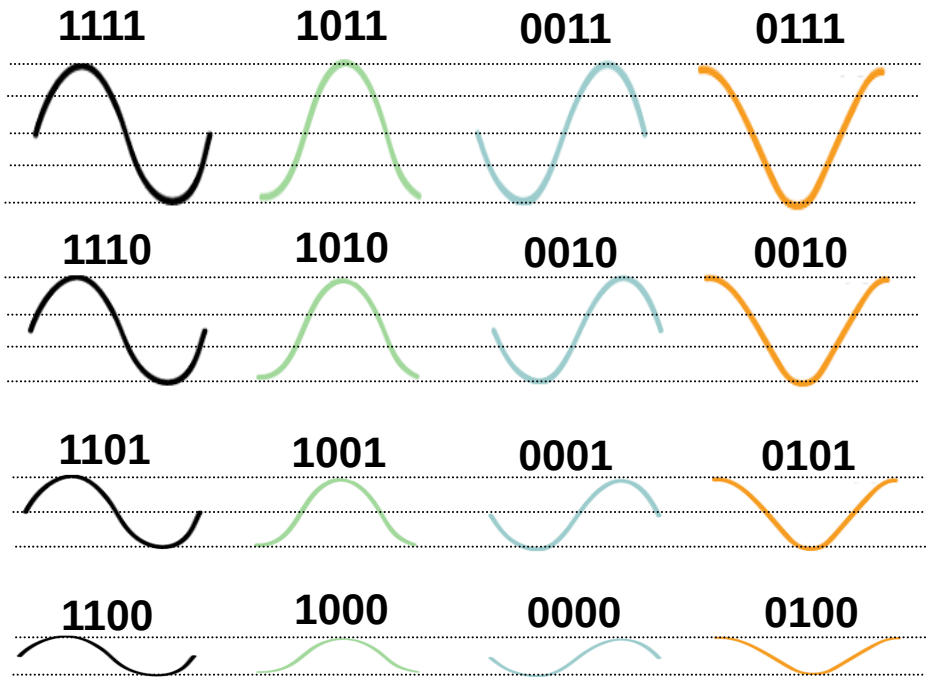
Data is sent by using 16 wave shapes with 4 phases and 4 amplitudes.

Send data
00011111

Divide by every four bits

0001 1111





Four bits of information are carried in one wave.

2. MS860xA Transmitter Tester

2.1 MS860xA Product outline
2.2 Features
2.3 Parts
2.4 Screens
2.5 Installing measurement software

2.1 MS860xA Product outline

The MS8608A/MS8609A Digital Mobile Radio Transmitter Tester is a measuring instrument with functions for testing various equipment used in digital mobile communications.

It efficiently evaluates the performance of digital mobile communication equipment supporting various digital modulation methods.

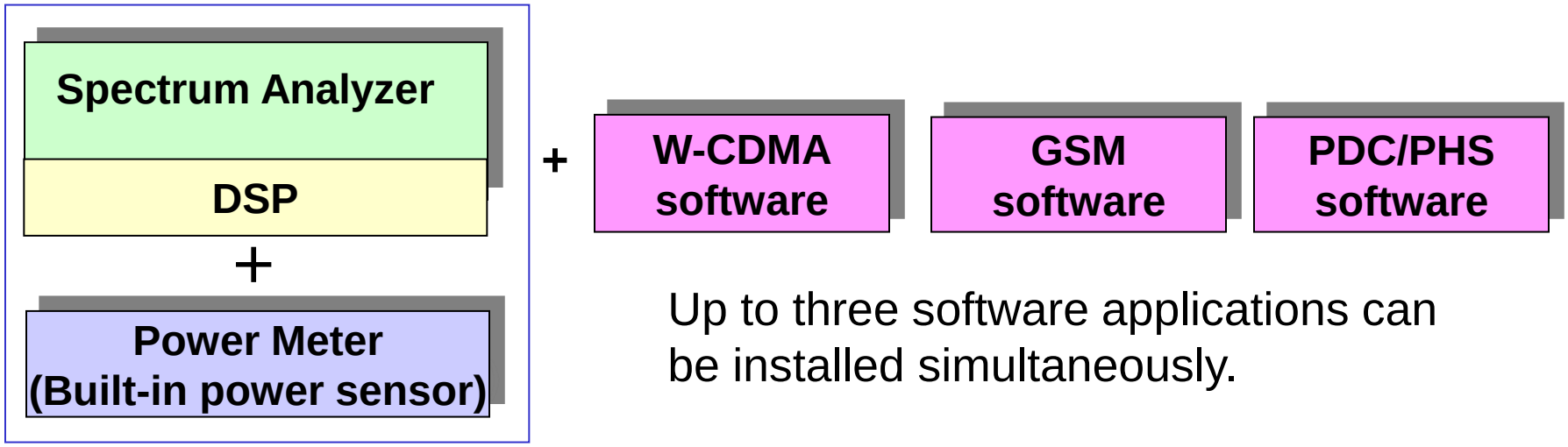
It can also be used as a spectrum analyzer without any measuring software.

2.2 Features

- Single instrument for evaluating all transmission test items of wireless communication systems

Measurement software:

W-CDMA, HSDPA, W-CDMA Release 5 uplink, PDC, PHS, IS-95, cdma2000 1x, 1xEV-DO, GSM, EDGE, TD-SCDMA, ARIB STD-39, T61, T79, W-LAN, etc.



Up to three software applications can be installed simultaneously.

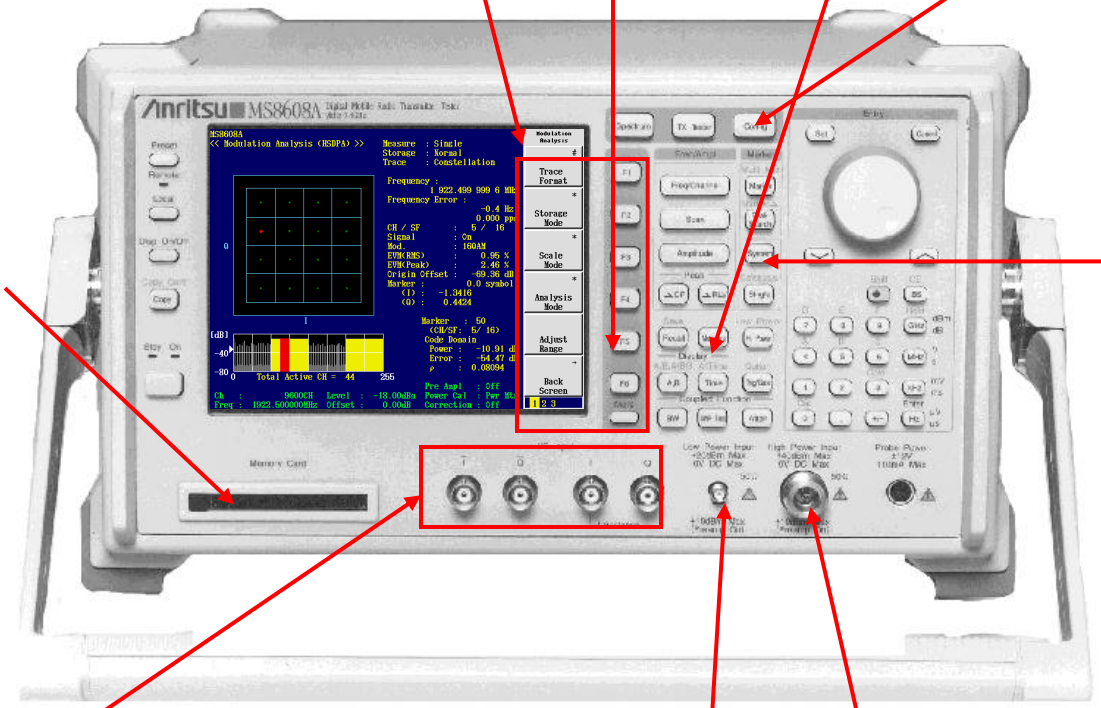
2.2 Features

- Built-in power sensor

  High-level accuracy from 8° to 50°
- Dedicated measurement software for each wireless communications method

  Easy and fast measurement
- Broad analytical bandwidth (up to 20 MHz)

2.3 Parts



Function keys

Spectrum key

Tx Tester key

Config key

System key

Memory card

I/Q Input

Low Power Input +20 dBm Max.

High Power Input +40 dBm Max.

2.3 Parts

RF Input: MS8608A Frequency: 9 kHz to 7.8 GHz
Max. input level: High (+40 dBm), Low (+20 dBm)

MS8609A Frequency: 9 kHz to 13.2 GHz,
Max. input level: +20 dBm

I/Q Input: Balance and unbalance inputs

Spectrum key: Switches to spectrum analyzer mode

Tx Tester key: Switches to transmitter tester mode

Config key: Switches to configuration mode

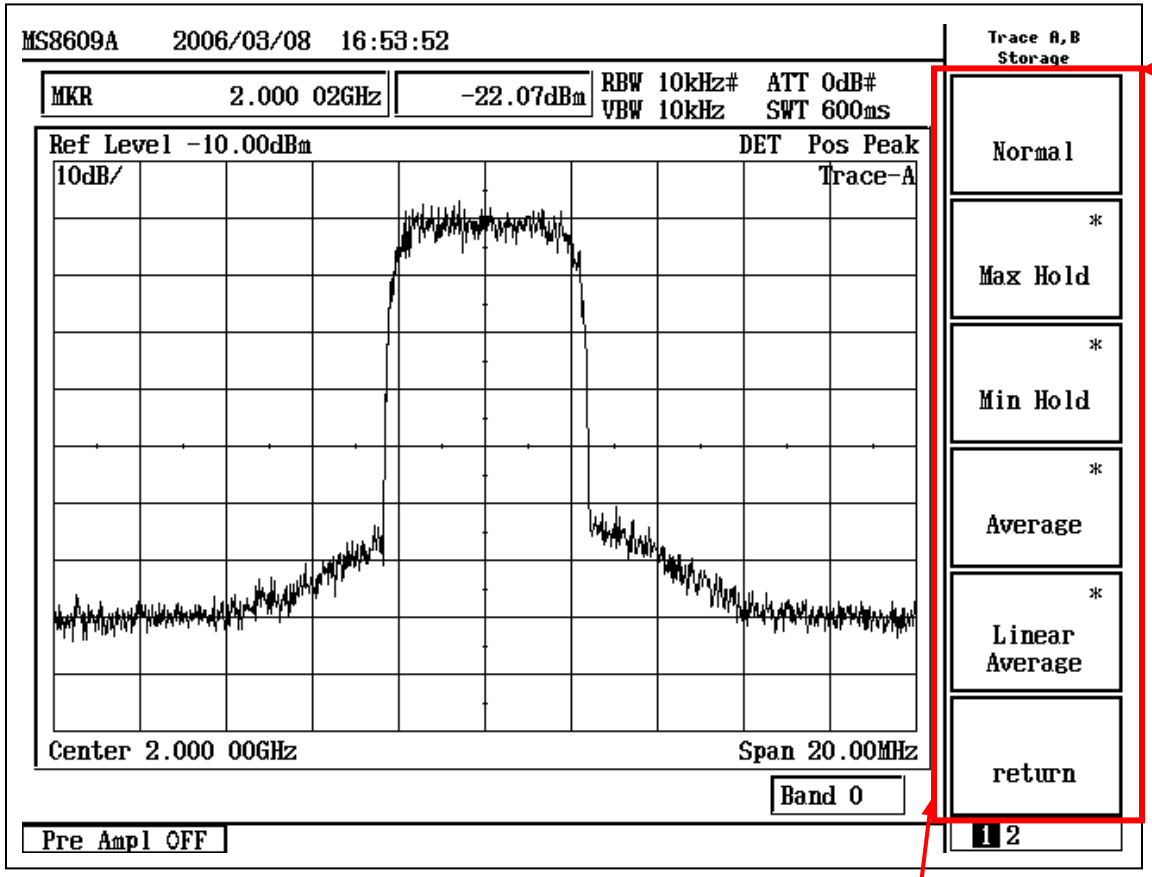
System key: Changes measurement software on Tx tester

Function keys: Panel keys linked to screen soft keys

Memory card: For saving waveform data
(ATA flash card or compact flash card)

2.4 Screens (spectrum analyzer)

Press the [Spectrum] key to display the spectrum analyzer screen.



Soft keys for setting items

F1 key

F2 key

F3 key

F4 key

F5 key

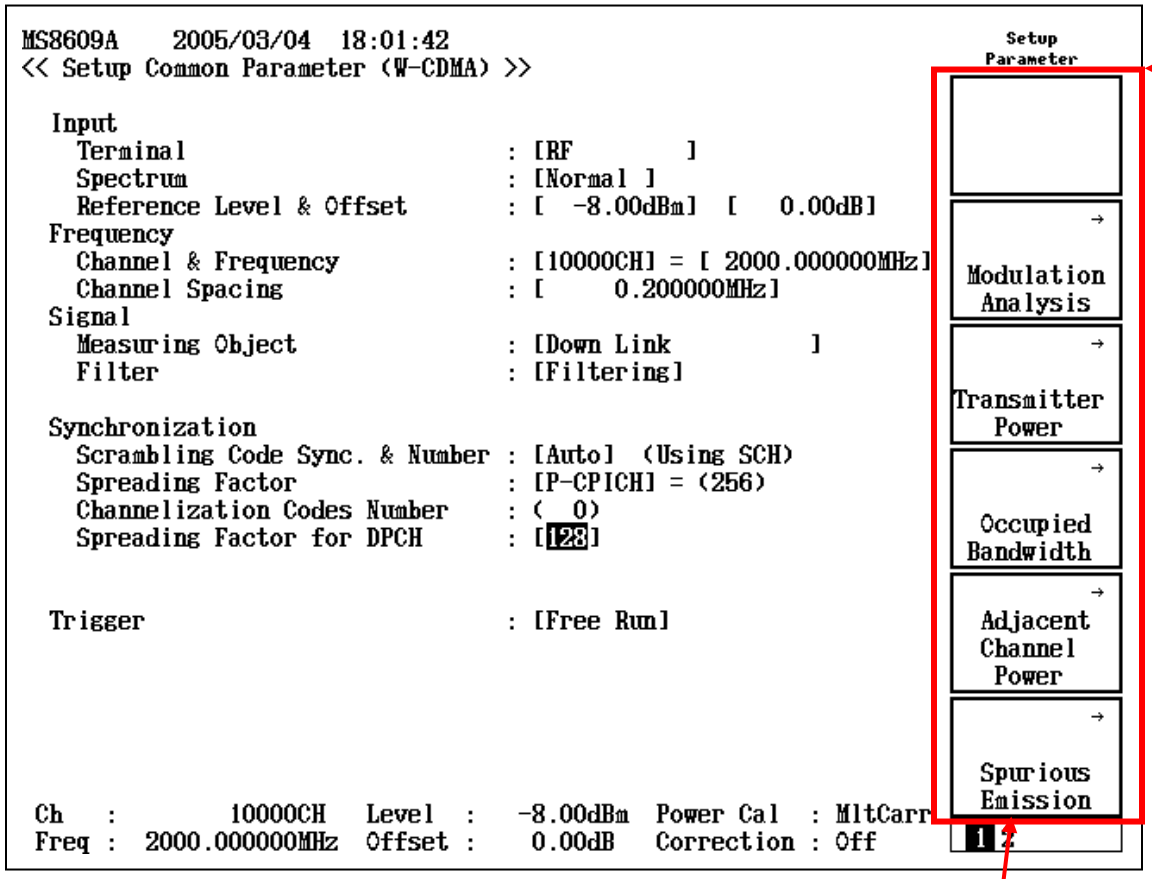
F6 key

More key

Press the [More] key to display more soft keys.

2.4 Screens (transmitter tester)

Press the [Tx Tester] key to display the transmitter tester screen.
Only the Setup Common Parameter screen is used for setting.



Soft keys for setting items

F1 key

F2 key

F3 key

F4 key

F5 key

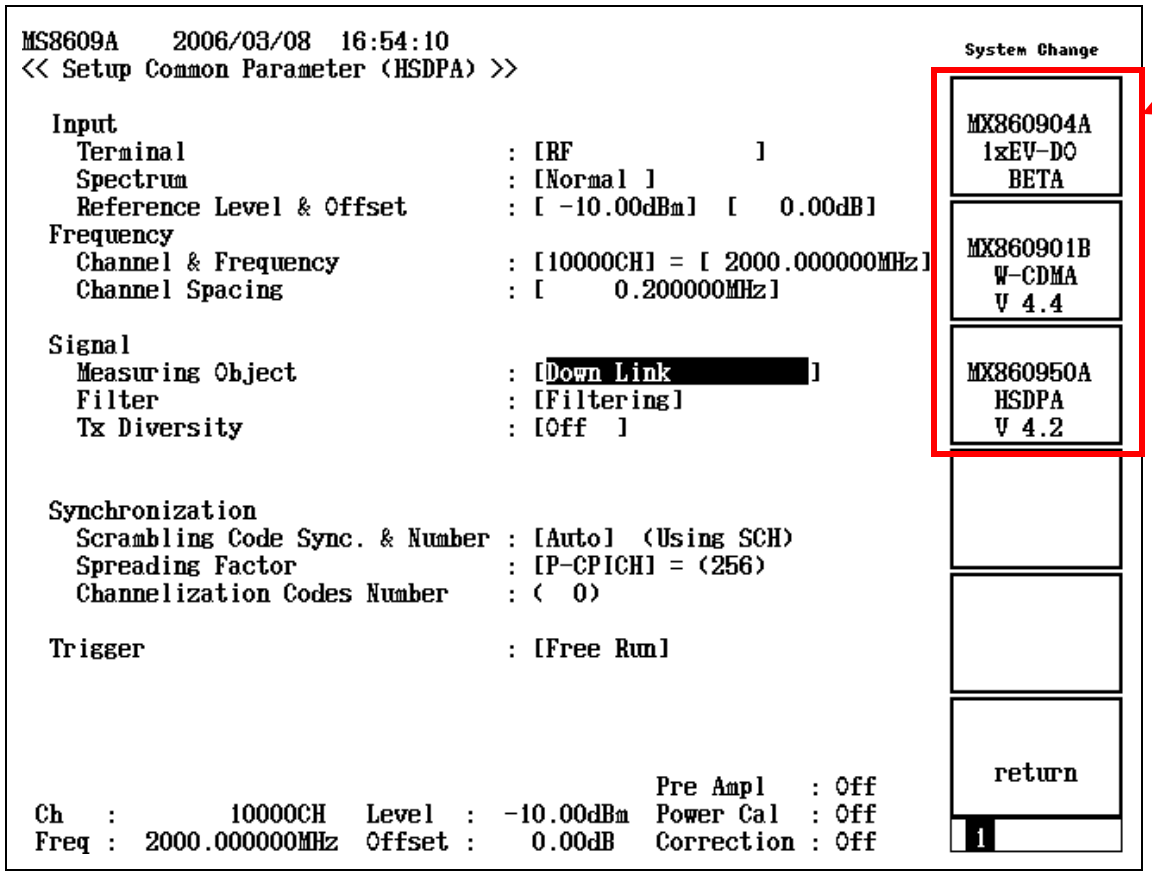
F6 key

More key

Press the [More] key to display more soft keys.

2.4 Screens (change system)

Press the [System] key to display the soft key menu.



F1 key

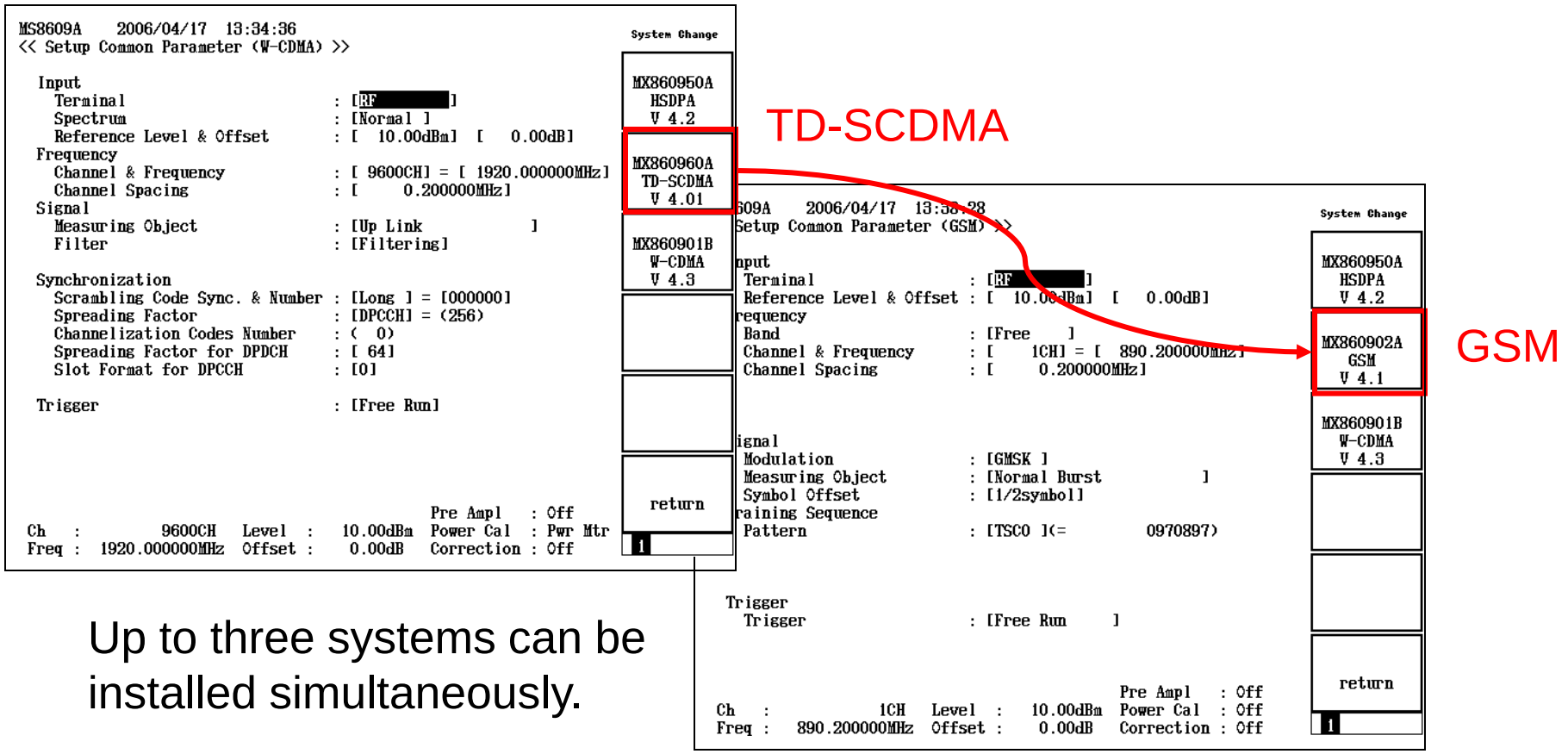
F2 key

F3 key

When a function key is pressed, the system is switched in a few seconds.

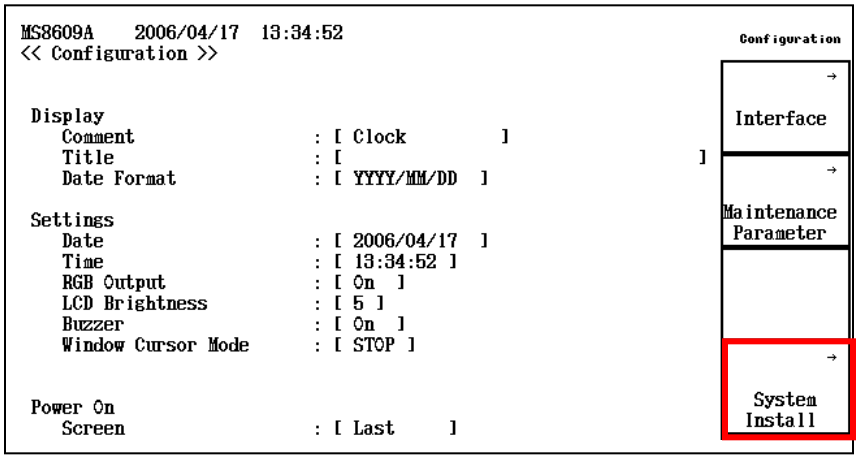
2.5 Installing measurement software

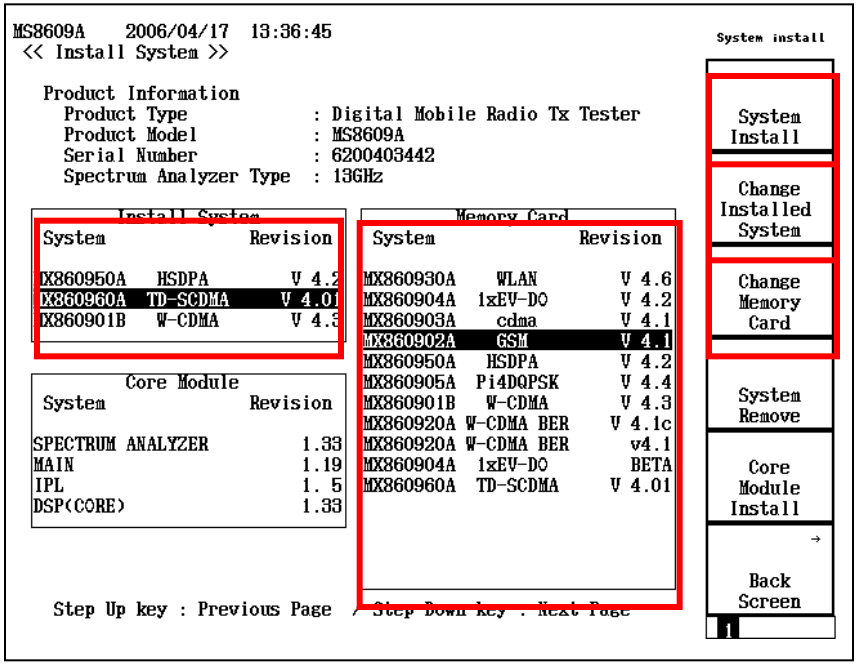
To install other measurement software
(TD-SCDMA → GSM)



Up to three systems can be installed simultaneously.

2.5 Installing measurement software





F1

F2

F3

F4

F5

F6

1. Insert a PC card with the measurement software into the memory card slot.
2. Press the [Config] key.
3. Press the [F4] System Install key.
4. Scroll to Install System using the rotary knob.
5. Move the the cursor with the [F3] Choose Memory Card key. When control of the cursor is returned, press the [F2] Change Installed System key.
6. Use the rotary knob to move the cursor to the memory card.
7. Press the [F1] System Install key. The system is installed in about 30 s.

3. Measurement meanings and principles

3.1 Base station transmitter tests
3.2 Power meter measurements
3.3 Spectrum analyzer measurements
3.3 Modulation analysis measurements

3.1 Base station transmitter test items

GSM Tests
Output power
Output RF spectrum (modulation)
Output RF spectrum (switching transient)
Spurious emissions
Radio frequency tolerance
Output level dynamic operation
Modulation accuracy
Intermodulation attenuation

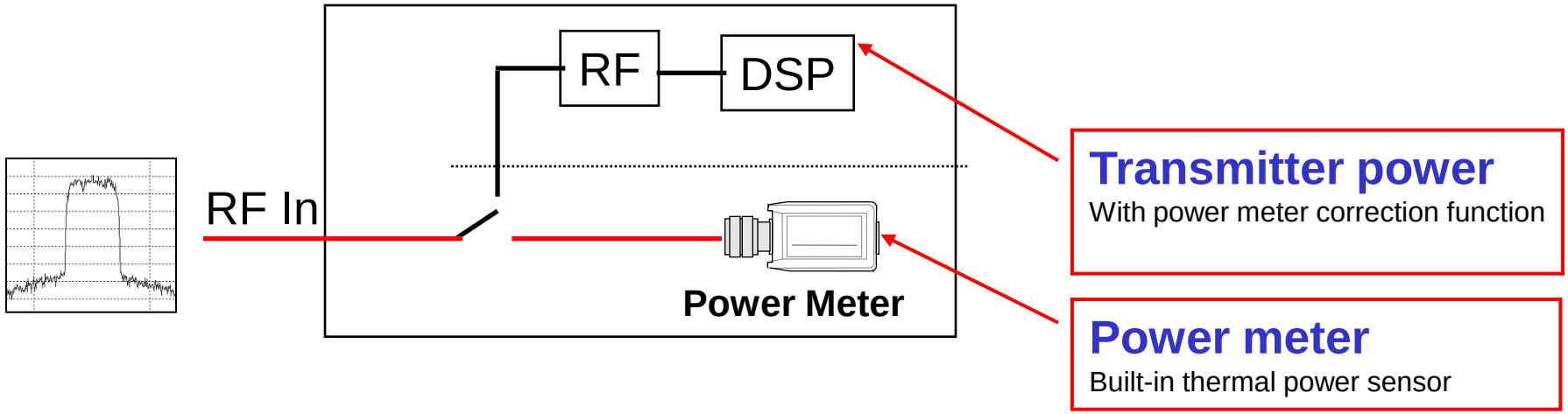
W-CDMA Tests
Maximum output power
CPICH Power accuracy
Frequency error
Power control steps
Power control dynamic range
Total power dynamic range
Occupied bandwidth
Spurious emission mask
Adjacent channel leakage power ratio
Spurious emissions
Transmit intermodulation
EVM
Peak code domain error

3.2 Power meter measurements

(1) Maximum output power

(1) Maximum output power

The maximum power of the radio wave (total power) is measured to check that the value satisfies the standard.



e.g. W-CDMA Standard

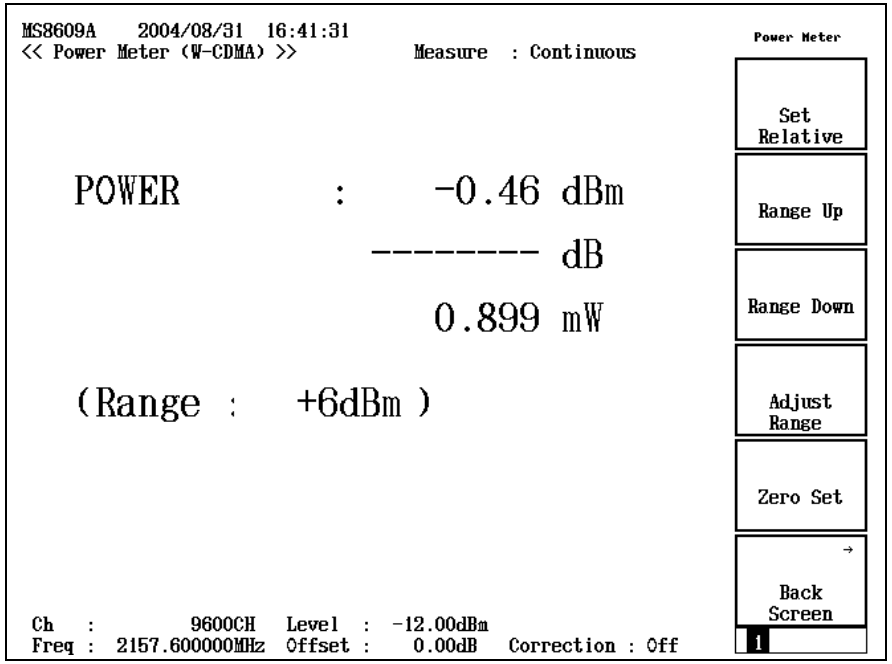
Max. power: +43 dBm ±2 dB

MS8608A/09A Level accuracy: ±0.4 dB

(1) Maximum output power

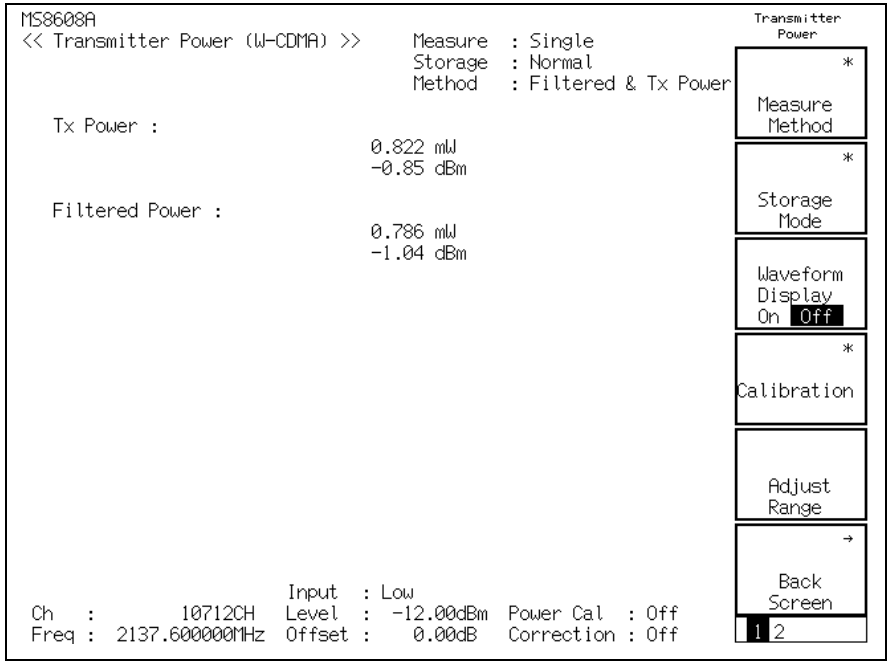
Power meter

(Single carrier)



Transmitter power

(Multi-carrier and Burst wave)



Transmitter power

Calibration: Corrects difference between result of power meter and result of DSP

Adjust range: Optimizes level in measuring instrument

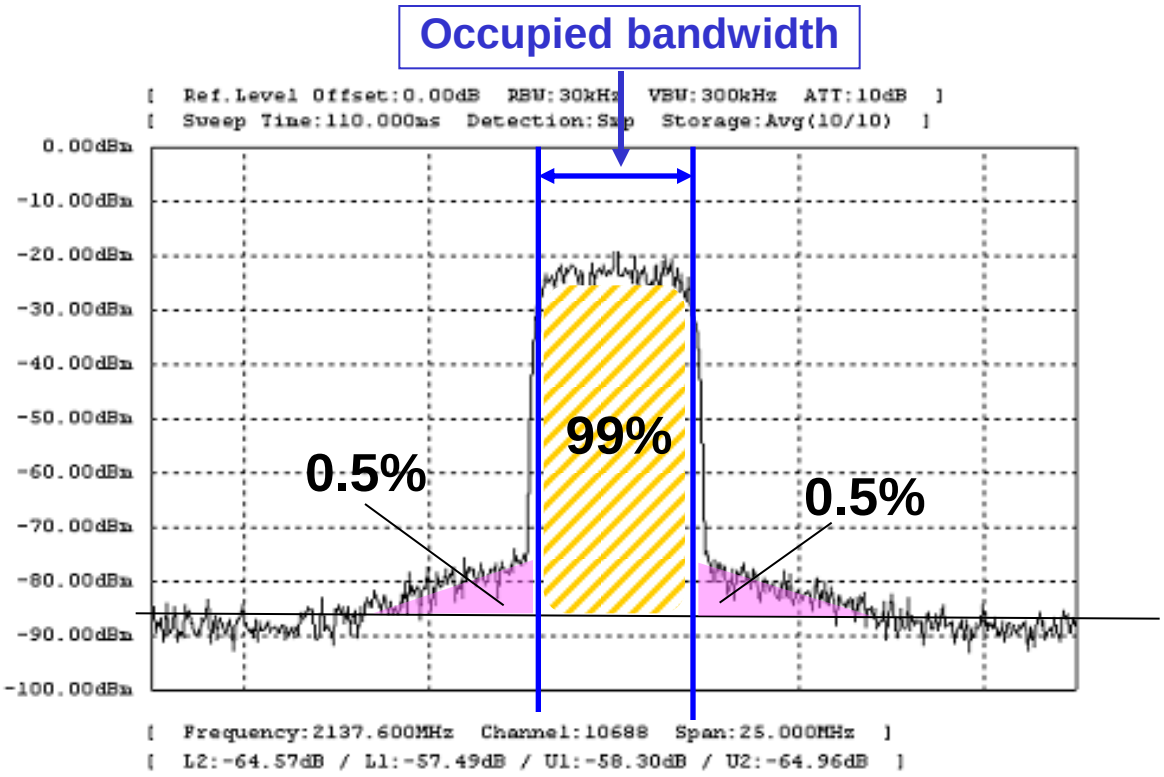
3.3 Spectrum analyzer measurement items

(1) Occupied bandwidth
(2) Adjacent channel leakage power ratio
(3) Spurious

(1) Occupied bandwidth

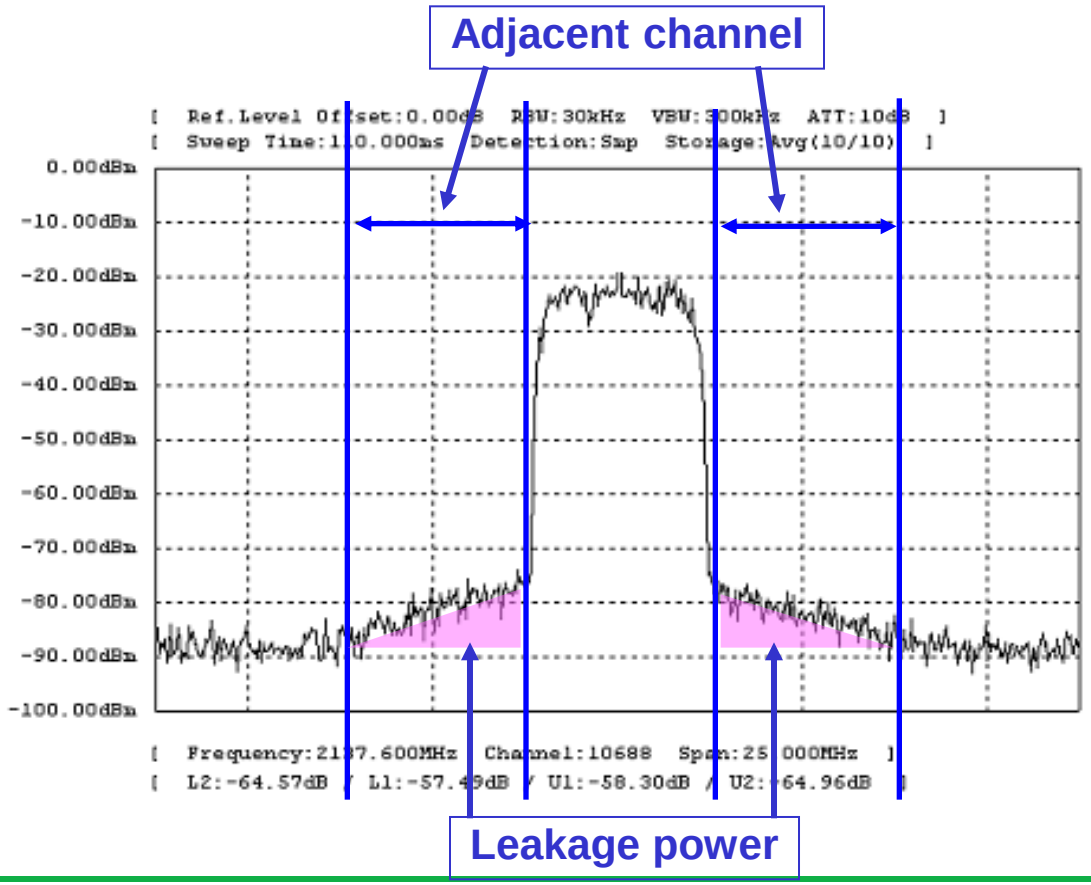
When the occupied bandwidth is wide, communication quality is stable but when it is narrow, quality becomes unstable.

The transmission signal is measured and the bandwidth containing 99% of the power is calculated to check that the value satisfies the standard.



(2) Adjacent channel leakage power ratio

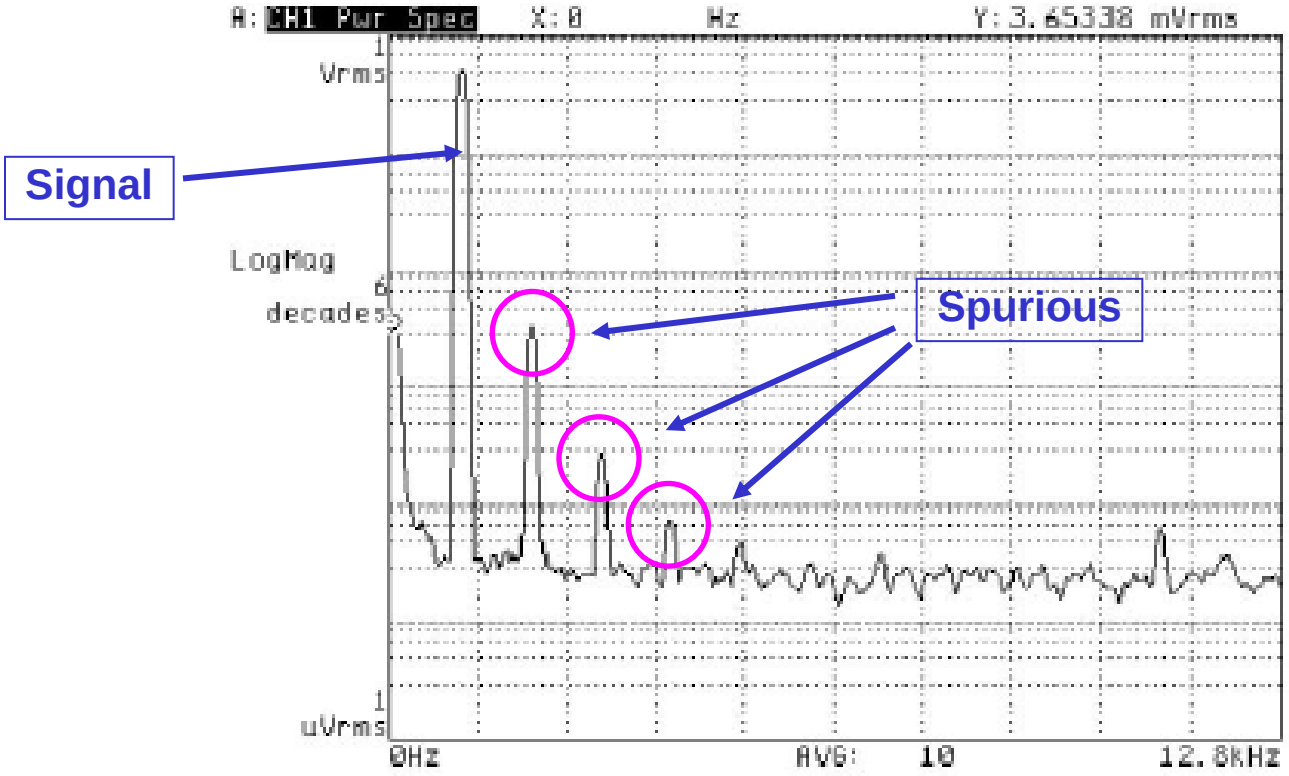
Leakage power interferes with the adjacent channel.
Therefore, leakage power into the next channel is measured to check that the value satisfies the standard.



(3) Spurious

A lot of wireless communications equipment uses oscillators.

The standard limits power (called spurious) outside the intended radio wave.



3.3 Modulation analysis measurements

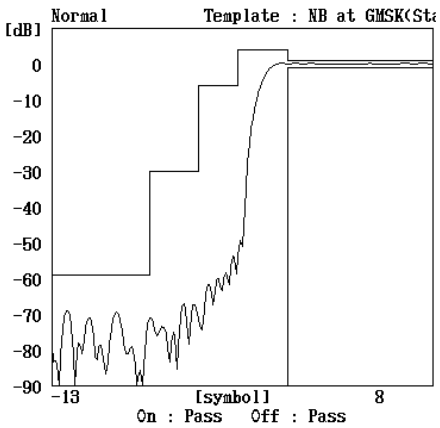
(1) RF Power
(2) Modulation analysis
(3) Frequency tolerance
(4) EVM and phase error
(5) Constellation
(6) Code domain

(1) RF Power

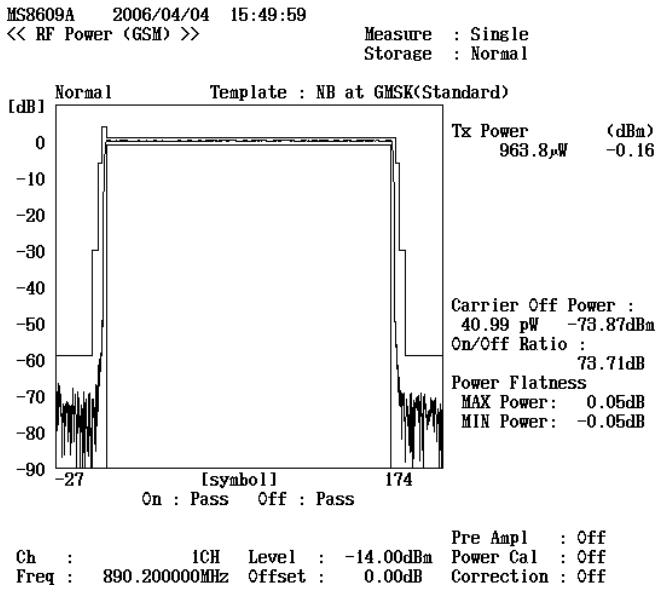
In a burst wave like GSM and PHS, the rise time, fall time, slot term, flatness, etc., are measured to confirm that the value satisfies the standard.

e.g GSM Signal

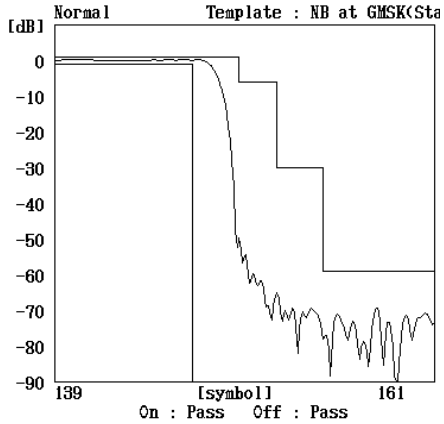
Rise time



Slot term, Flatness



Fall time

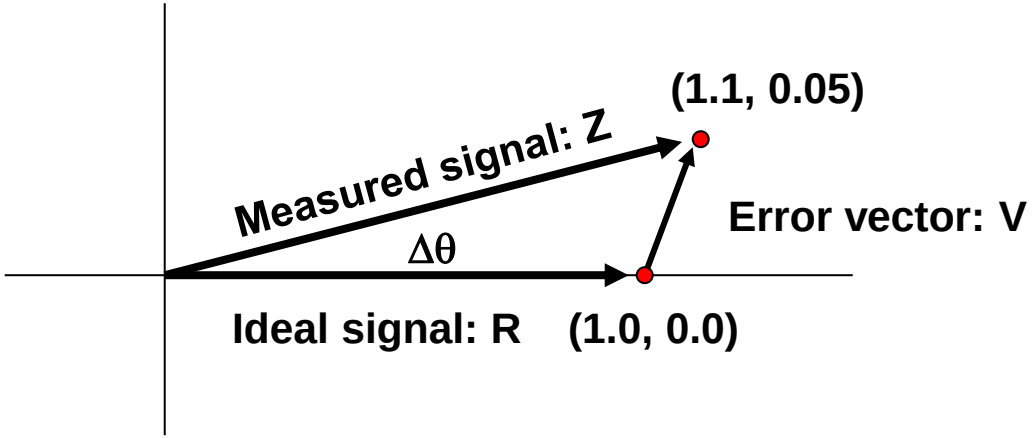


(2) Modulation analysis

The received signal that is digital modulation measures the error margin for the ideal signal. The measurement items are EVM, magnitude error, phase error, origin offset, etc.

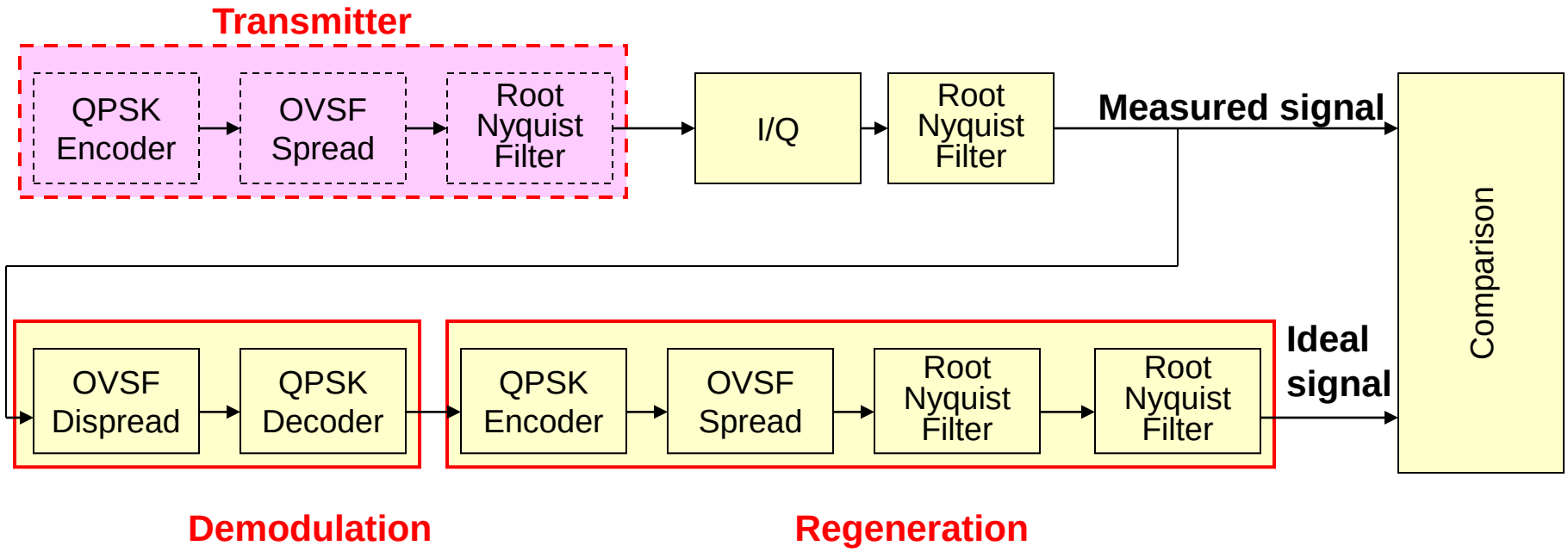
<Modulation>

- The signal quality can be evaluated immediately.
- Measurement is fast.



(2) Modulation analysis

Block diagram

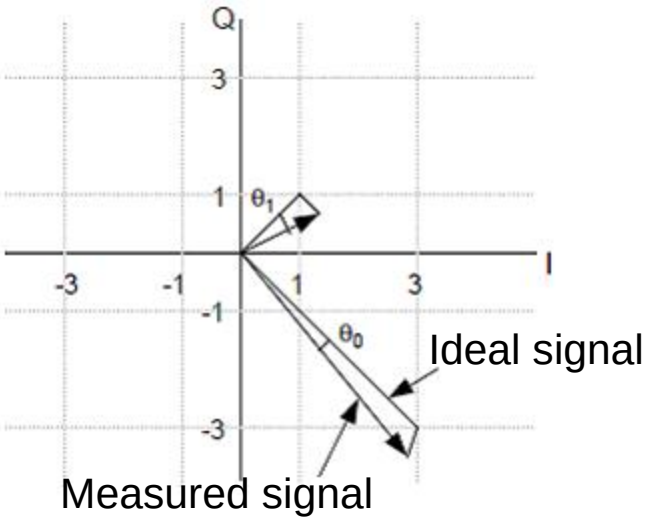


The received signal is demodulated, creating the data bits of the received signal. The data bits are modulated again by the same modulation method to generate the ideal signal.

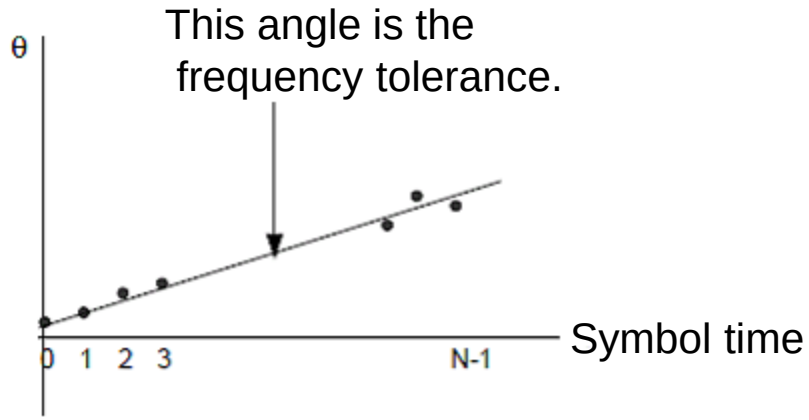
(2) Modulation analysis

The phase-locus method is used to calculate the frequency tolerance of the modulation signal. This method plots the phase difference between the ideal signal vector and the measured signal vector as data on a time axis and the time change of the phase difference (angle) is measured.

- When there is frequency tolerance, the line has some angle.
- When there is no frequency tolerance, the line is straight.



Phase difference data

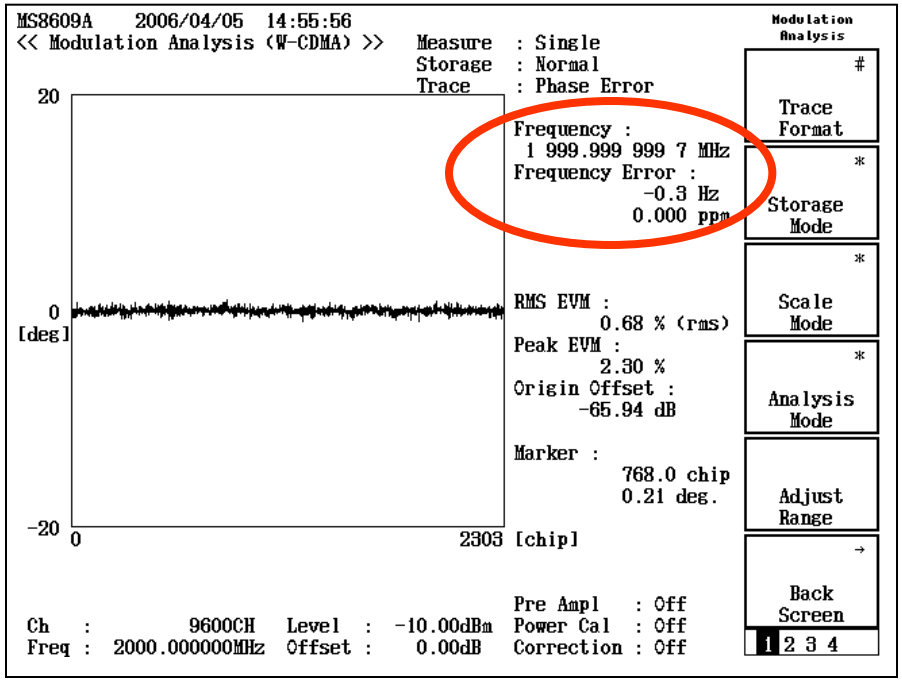


Frequency tolerance

(3) Frequency tolerance

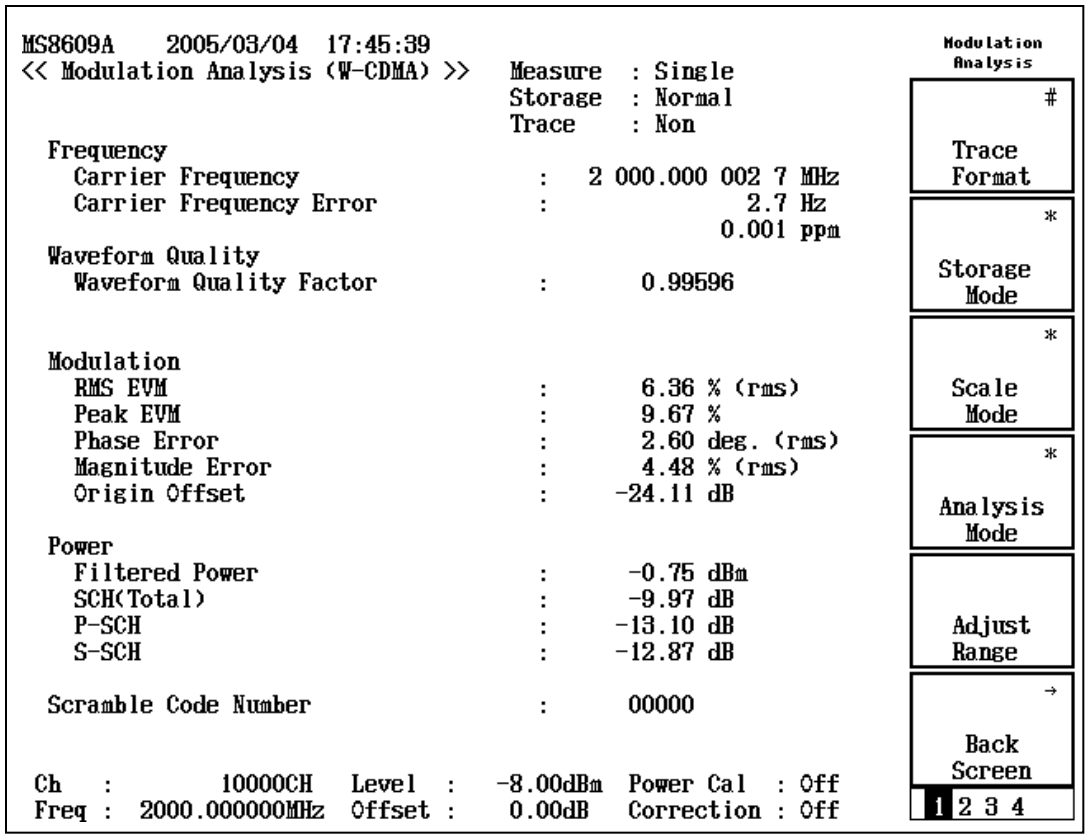
- The frequency tolerance of each slot is obtained by using the phase-locus method. Even if the frequency changes momentarily, the operating base station can be measured accurately.
- To average the change at the moment continuously, a steady frequency tolerance is obtained.

e.g. W-CDMA Signal



(4) EVM and phase error

The EVM, phase error and power of each slot can be measured.



e.g W-CDMA (Base station)

Frequency error: ±0.05 ppm

EVM: <17.5%

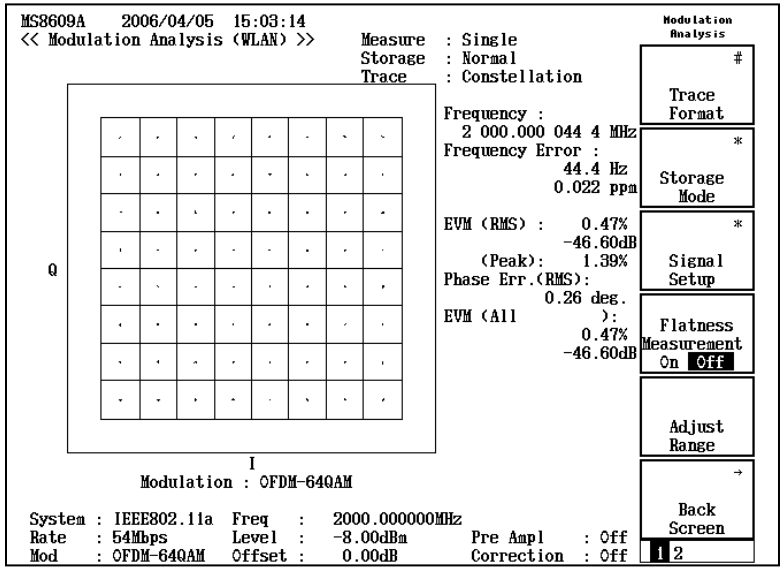
For Base Station

Standard 2×10^{-8}/day

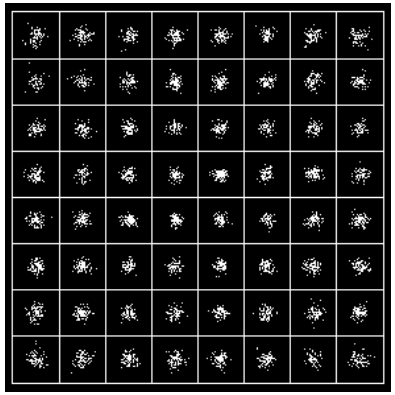
Opt-01 5×10^{-10}/day

(5) Constellation

Constellation display is useful for troubleshooting.

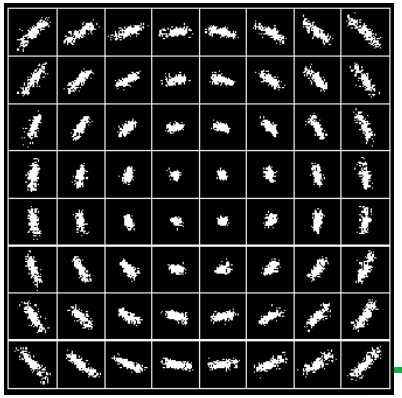


e.g. W-LAN Signal



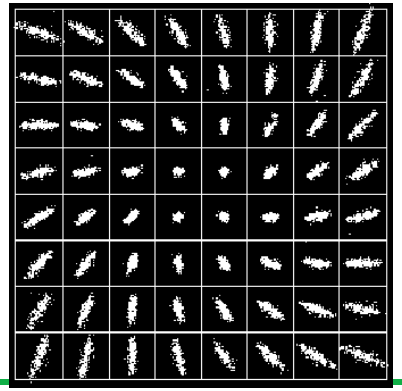
Point extension

- S/N Deterioration



Phase rotation

- Difference in carrier frequency
- Difference in symbol clock



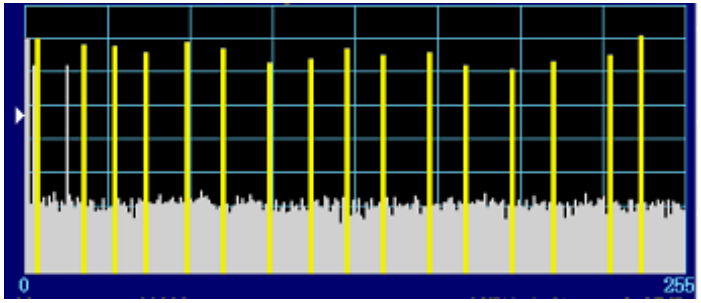
Amplitude change

- AGC Oscillation

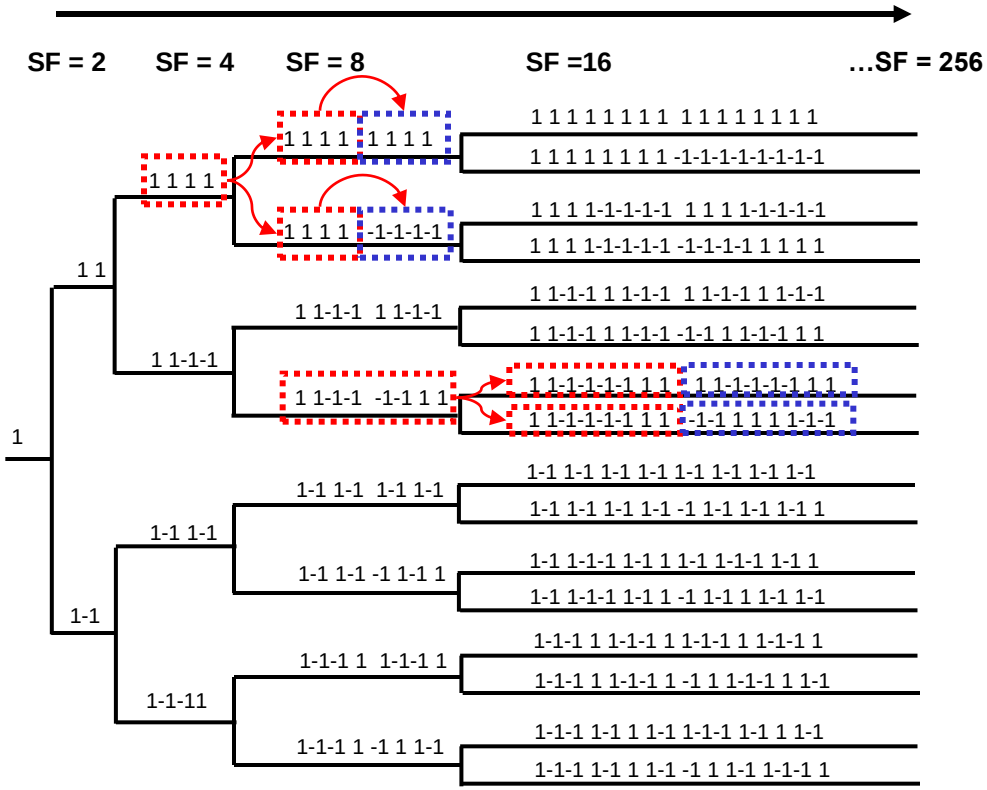
(6) Code domain

W-CDMA and CDMA2000 use an orthogonal code called spreading code. One of the spreading codes becomes one channel and a lot of codes are multiple. When a large amount of information is sent in the spreading factor (SF), the SF is small. When a small amount of information is sent, the SF is large.

The spread code diverges and created from left to right as shown in the figure.



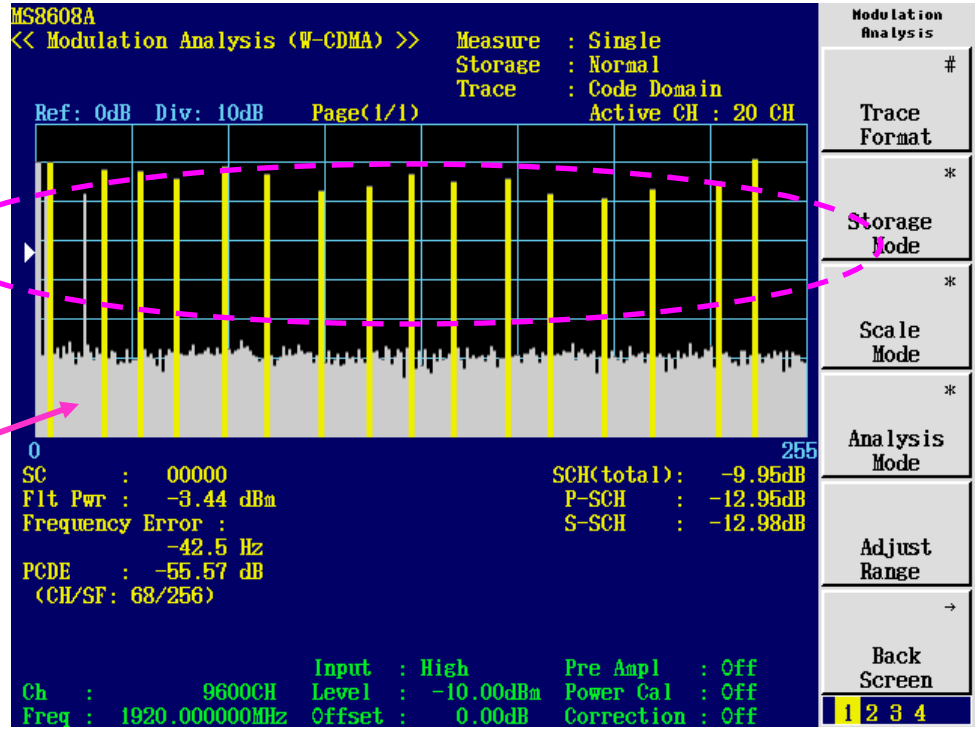
W-CDMA Code domain



(6) Code domain

- The spreading code, spreading factor, and power level of a multiple signal are measured.
- The received signal de-spreads by each spreading code and the channel power of each spreading code is calculated.

e.g. Code domain screen of W-CDMA



Each channel power

Inactive channels

Anritsu

Specifications are subject to change without notice.

• **United States**
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