

P25-Phase 1 Tx Test Solution

MS2830A
Signal Analyzer

P25-Phase 1

Tx Test Solution

P25 Phase 1 Technical Specifications

Transceiver Performance Recommendations

TIA-102.CAAB-C (Jun 2010)

Transceiver Measurement Methods

TIA-102.CAAA-D (Apr 2013)

Note: For details, refer to the TIA-102 standard.

Version 2.00

August 2014

Anritsu Corporation

[Anritsu] P25-Phase 1 Tx Test Solution

Tx Evaluation

Multi-functions supported with one unit!

Unit, Module*



*Output in Test Mode

MS2830A
Signal Analyzer



Spectrum Analyzer

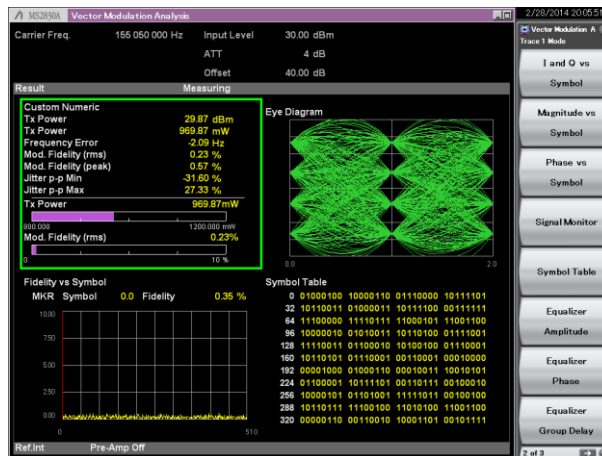
Frequency Counter

Modulation Analyzer
(MX269017A)

FM Demodulator
(MX269018A)

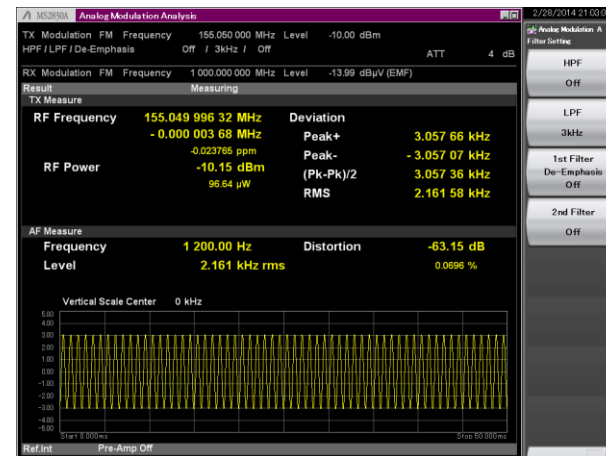
MX269017A

Vector Modulation Analysis Software



MX269018A

Analog Modulation Analysis Software



[Anritsu] P25-Phase 1 Tx Test Solution

Note: For details, refer to the TIA-102 standard.

TIA-102		Transmitter Test Items	Signal Analyzer	Other
CAAB-C	CAAA-D		MS2830A	
3.2.1	2.2.1	RF Output Power	---	Power Meter
3.2.2	2.2.2	Operating Frequency Accuracy	$\sqrt{2}$	---
3.2.3	2.2.3	Electrical Audio Performance	---	Audio Noise Generator, Distortion Meter, etc.
3.2.4	2.2.4	Acoustic Audio Performance	---	
3.2.5	2.2.5	Modulation Emission Spectrum	$\sqrt{}$	---
3.2.6	2.2.6	Unwanted Emission: Radiated Spurious	---	Radiation Test Site
3.2.7	2.2.7	Unwanted Emission: Conducted Spurious	Under investigation	Signal Generator
3.2.8	2.2.8	Unwanted Emission: Adjacent Channel Power Ratio	$\sqrt{}$	---
3.2.9	2.2.9	Intermodulation Attenuation	$\sqrt{}$	Signal Source, etc.
3.2.10	2.2.10	Radiated Power Output	---	Radiation Test Site
3.2.11	2.2.11	Conducted Spurious Emission into VSWR	---	Network Analyzer, etc.
3.2.12	2.2.12	Transmitter Power and Encoding Attack Time	---	Oscilloscope, etc.
3.2.13	2.2.13	Transmitter Power and Encoding Attack Time with Busy/Idle Operation	---	Oscilloscope, etc.
3.2.14	2.2.14	Transmitter Throughput Delay	---	Oscilloscope, etc.
3.2.15	2.2.15	Frequency Deviation for C4FM	$\sqrt{2}$	---
3.2.16	2.2.16	Modulation Fidelity (C4FM, CQPSK, Linear Simulcast Modulation)	Ongoing Development	---
		Modulation Fidelity (C4FM additional testing)	Under investigation	---
3.2.17	2.2.17	Symbol Rate Accuracy	$\sqrt{2}$	---
3.2.18	2.2.18	Transmitter Frequency Behavior	---	Power Meter, etc.
3.2.19	2.2.19	RFSS Throughput Delay	---	RF Decoder,
3.2.20	2.2.20	RFSS Idle to Busy Transition Time	---	Oscilloscope, etc.

1. Requires MS2830A-006 Analysis Bandwidth 10 MHz for Frequency vs. Time function
2. Requires MX269018A Analog Measurement Software with A0086A USB Audio

Transmitter Performance Measurement Methods

Transmitter Power

Note: For details, refer to the TIA-102 standard.

Measures transmitter **output power**

Limits: ($\leq +20\%$: Specified by manufacturer)

Limits: (≤ 10 W for mobile or portable radios intended for public safety airborne application)



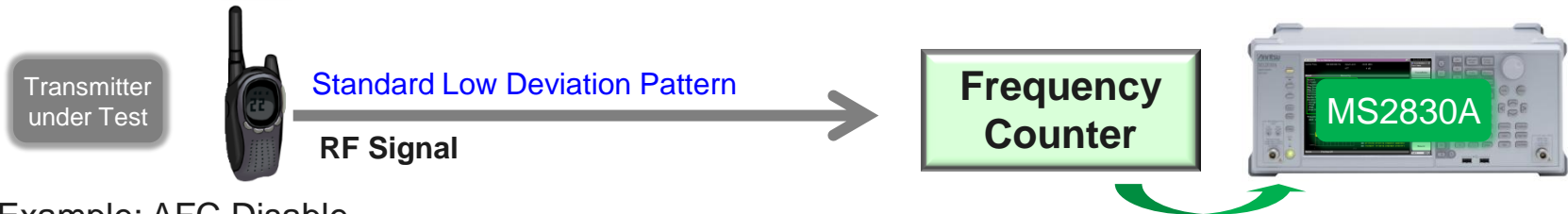
Transmitter Performance Measurement Methods

Operating Frequency Accuracy

Note: For details, refer to the TIA-102 standard.

Measures **frequency of transmitter**

Calculate the ppm frequency error.



Example: AFC Disable

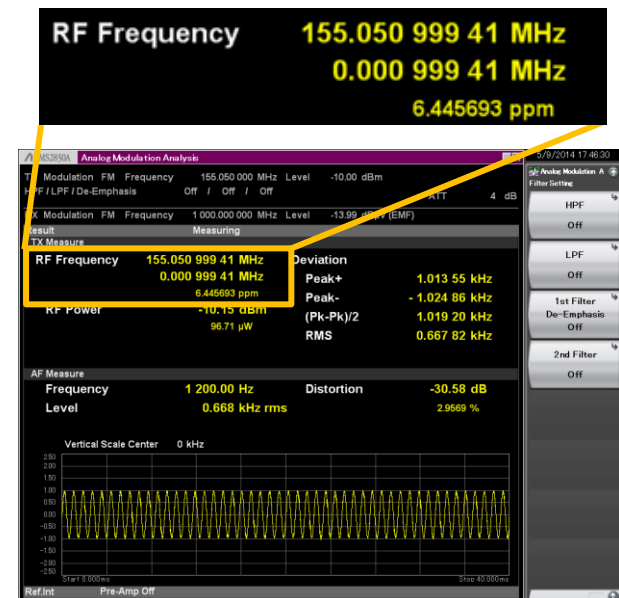
Limits:

Assigned Frequency [MHz]	Frequency Departure [ppm]	
	Mobile and Portable	Base Station
Below 100	5.0	2.5
From 138 to 174	2.5	1.5
From 406 to 512	2.0	0.5 ³
From 769 to 806	0.4 ^{1,3} /1.5 ²	0.1 ³
From 806 to 869	1.5	0.15 ³
From 896 to 941	1.5	0.1 ³

1. When AFC locked to base station
2. When AFC not locked to base station
3. Requires "External Reference Clock" or "High Stability Reference Oscillator (Opt.002)"

MX269018A

Analog Modulation Analysis Software



Transmitter Performance Measurement Methods

Modulation Emission Spectrum

Note: For details, refer to the TIA-102 standard.

Measures spectrum of emitted modulation signal

Limits: FCC standard mandatory and NTIA standard recommended

FCC Standard (47 CFR 90.210-d)

Displacement Frequency (f_d)	Attenuation [dB]
0 kHz to 5.625 kHz	0.0
$5.625 \text{ kHz} < f_d \leq 12.5 \text{ kHz}$	$7.27 (f_d - 2.88 \text{ kHz})$
$12.5 \text{ kHz} < f_d$	$50 + 10\log_{10}(\text{RFOP})$, or 70 whichever smaller

RFOP: RF Output Power in Watts

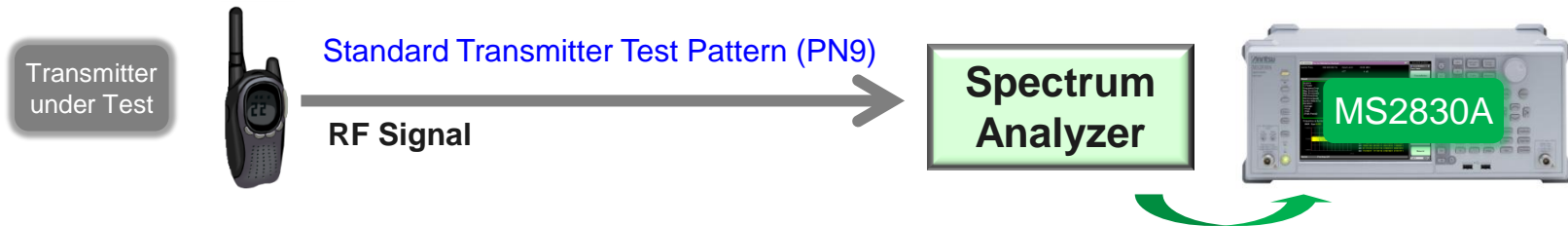
NTIA Standard (NTIA manual part 5.3.5.2)

Displacement Frequency (f_d)	Attenuation [dB]
0 kHz to 2.5 kHz	0.0
$2.5 \text{ kHz} < f_d \leq 12.5 \text{ kHz}$	$7 (f_d - 2.5 \text{ kHz})$
$12.5 \text{ kHz} < f_d$	$50 + 10\log_{10}(\text{RFOP})$, or 70 whichever smaller

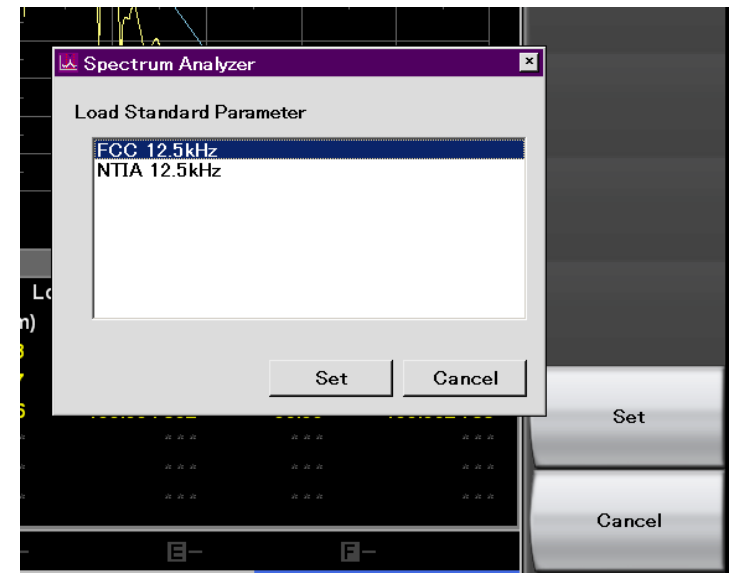
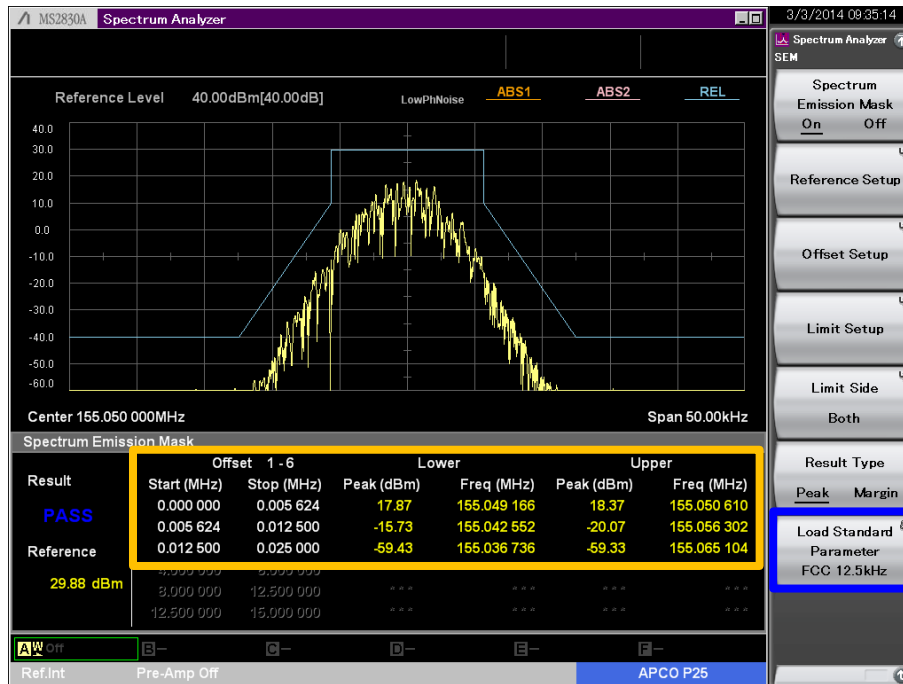
RFOP: RF Output Power in Watts

Transmitter Performance Measurement Methods

Modulation Emission Spectrum



Spectrum Emission Mask Function [pre-installed]



Example: FCC 12.5 kHz

Transmitter Performance Measurement Methods

Unwanted Emission: Radiated Spurious

Note: For details, refer to the TIA-102 standard.

Note: For details, refer to the 47 CFR.

Measures **power of spurious signals**

Limits: Non-radiating load (47 CFR 2.1053 and 47 CFR 90.210-d)

Shall be attenuated by at least $50 + 10\log(P)$ dB, or 70 dB, whichever is smaller

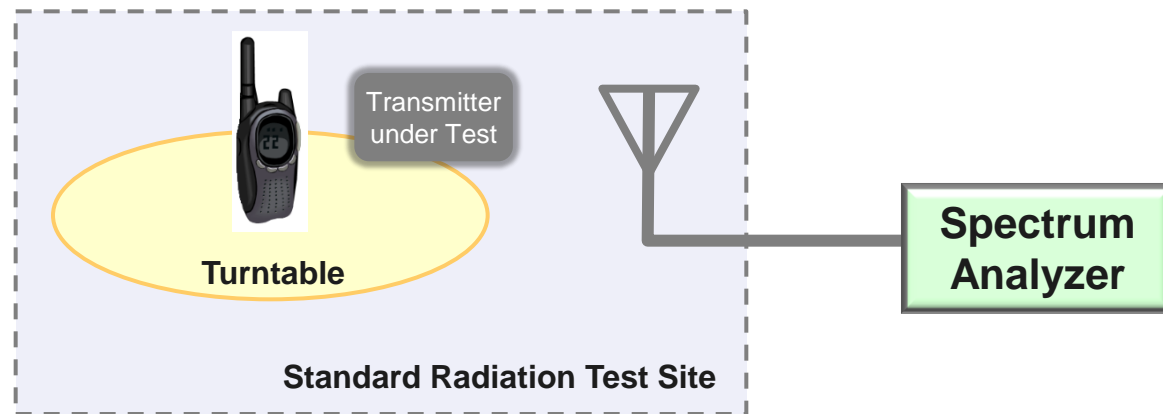
Limits: 700 MHz Band (47 CFR 27.53-e-8 and 47 CFR 90.543-c)

Shall be attenuated by at least $43 + 10\log(P)$ dB below average carrier power

Limits: EIRP Emission in GNSS Band (47 CFR 27.53-f and 47 CFR 90.543-f)

Shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIPR) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth

Limits: Calculated EIRP Emission in GNSS Band (47 CFR 27.53-f and 47 CFR 90.543-f)
(Same as above)



Transmitter Performance Measurement Methods

Unwanted Emission: Conducted Spurious

Note: For details, refer to the TIA-102 standard.

Note: For details, refer to the 47 CFR.

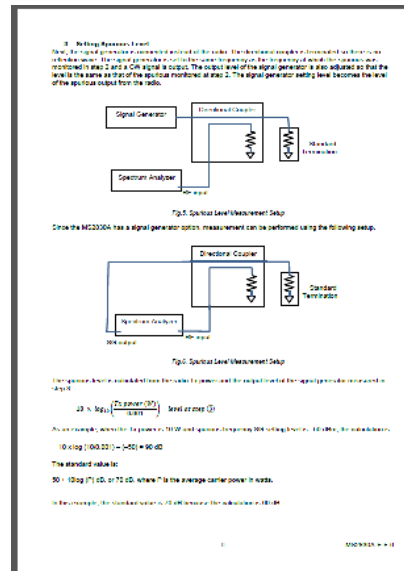
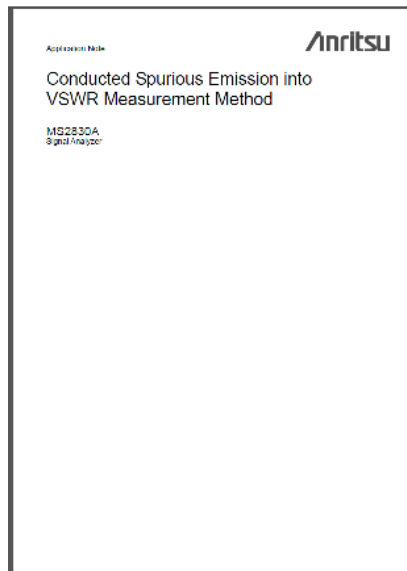
Measures **power of spurious signals**

Limits: Applicable to all frequency bands below 1 GHz, excluding frequencies in 700 MHz band as specified in 47 CFR 27.53-e-8 and 47 CFR 90.543-e

Shall be attenuated by at least $50 + 10\log(P)$ dB, or 70 dB, whichever is smaller

Limits: 700 MHz Band (47 CFR 27.53-e-8 and 47 CFR 90.543-c)

Shall be attenuated by at least $43 + 10\log(P)$ dB below average carrier power



*Check the application note
([MS2830A_EF6100.pdf](#))*

Transmitter Performance Measurement Methods

Unwanted Emissions:

Note: For details, refer to the TIA-102 standard.

Non-Spurious Adjacent Channel Power Ratio

Measures ratio of total power of transmitter in standard transmitter test pattern to leakage power falling within bandwidth of adjacent channels

Limits: Applicable to all frequency bands below 1 GHz excluding frequencies in 700 MHz band as specified in 47 CFR 27.53-e-6 and 47 CFR 90.543-a

Shall meet or exceed 67 dB for 6 kHz BW and 100 Hz RBW

Limits: 700 MHz Band (47 CFR 27.53-e-6 and 47 CFR 90.543-a)

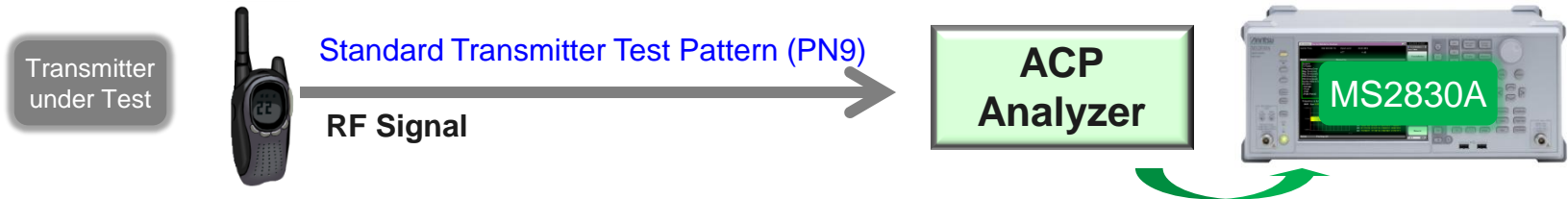
Offset from Center Frequency [kHz]	Measurement Bandwidth [kHz]	ACPR [dB]
9.375	6.25	40
15.625	6.25	60
21.875	6.25	60
37.5	25	60
62.5	25	65
87.5	25	65
150	100	65
250	100	65
350	100	65
>400 kHz to 12 MHz	30 (s) ¹	$75^2/80^3$
12 MHz to Paired Receiver Band	30 (s) ¹	$75^2/80^3$
In Paired Rx Band	30 (s) ¹	100^4

- 1) (s) indicates that a swept measurement may be used. RBW <2% x Measurement Bandwidth
- 2) 12.5 kHz Mobile and Portable transmitter ACPR limits
- 3) 12.5 kHz Base transmitter ACPR limits
- 4) Requires "Band pass filter for Rx-band"

Transmitter Performance Measurement Methods

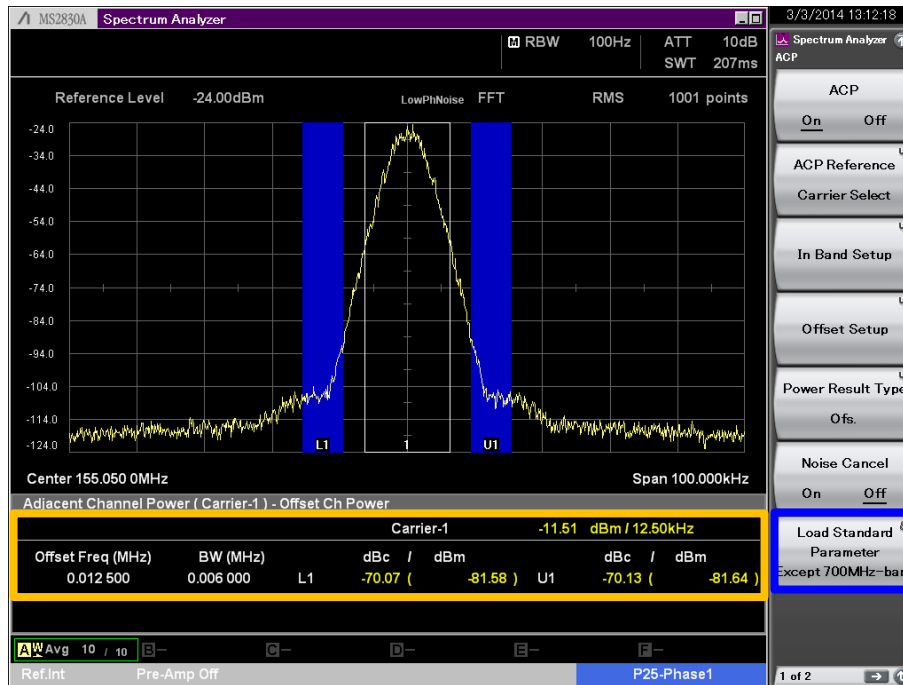
Note: For details, refer to the TIA-102 standard.

Unwanted Emissions: Non-Spurious Adjacent Channel Power Ratio

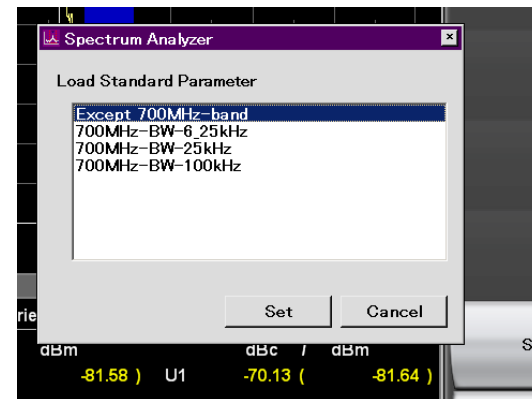


Adjacent Channel Power Function [pre-installed]

Ex: Applicable to all frequency bands below 1 GHz



Span : 100 kHz
Measurement BW : 6 kHz
Detection : Sample or RMS
RBW : 100 Hz
VBW : RBW x10



Example: Except 700 MHz band

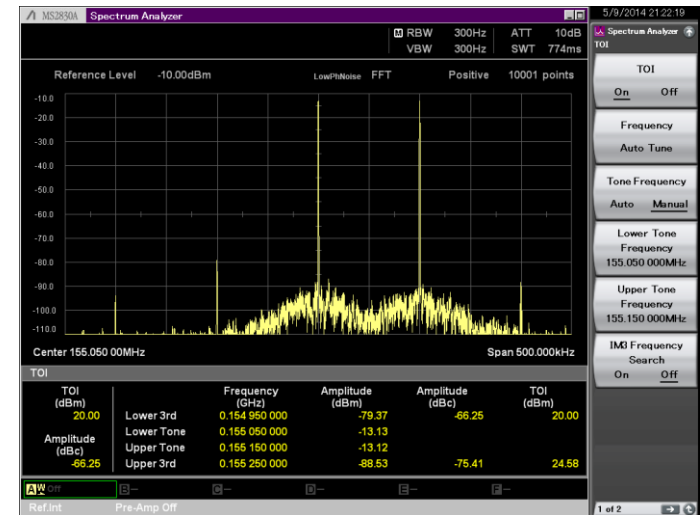
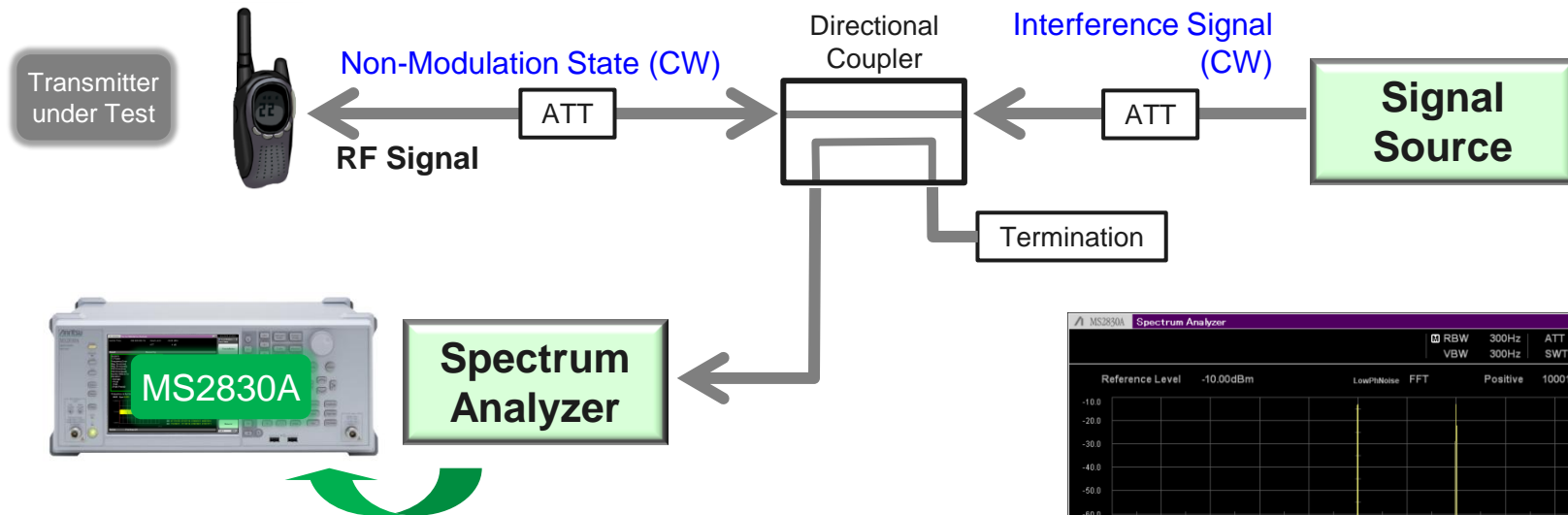
Transmitter Performance Measurement Methods

Intermodulation Attenuation

Note: For details, refer to the TIA-102 standard.

Measures ability of transmitter to withstand generation of intermodulation components caused by carrier signal and interference signal input to transmitter antenna

Limits: **Shall meet or exceed 40 dB** (Base Station only)



TOI Function [pre-installed]

Transmitter Performance Measurement Methods

Frequency Deviation for C4FM

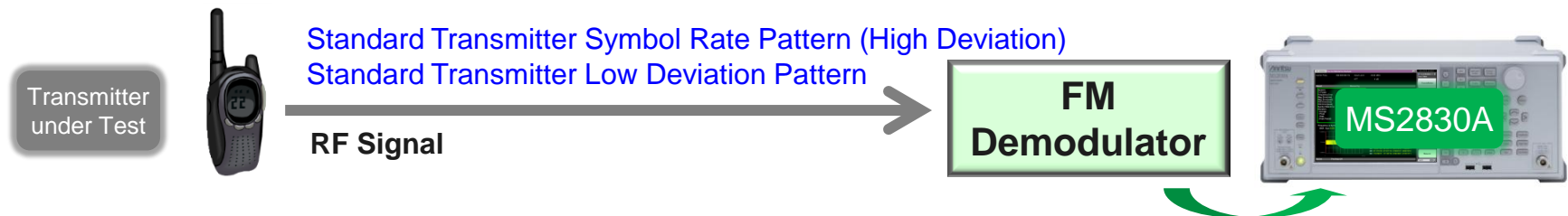
Note: For details, refer to the TIA-102 standard.

Measures frequency deviation when modulating with High and Low deviation symbols

Set the audio bandwidth of the FM demodulator so that the high-pass corner frequency is ≤ 15 Hz and the low-pass corner frequency is ≥ 3 kHz. Turn the De-emphasis function off.

Limits: High deviation = 2544 Hz to 3111 Hz ($2827.5 \text{ Hz} \pm 10\%$)

Low deviation = 848 Hz to 1037 Hz ($942.5 \text{ Hz} \pm 10\%$)

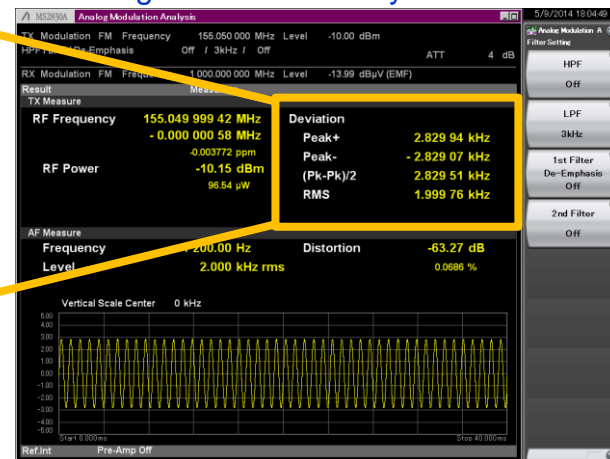


MX269018A

Analog Modulation Analysis Software

Deviation	
Peak+	2.829 94 kHz
Peak-	-2.829 07 kHz
(Pk-Pk)/2	2.829 51 kHz
RMS	1.999 76 kHz

Example: High Deviation



Transmitter Performance Measurement Methods

Modulation Fidelity: C4FM, CQPSK, LSM, WCQPSK

Note: For details, refer to the TIA-102 standard.

Note: This feature is under development.

Measures deviation, carrier frequency offset, rms deviation error (modulation fidelity rms)

Limits: Carrier frequency offset

Assigned Frequency [MHz]	Frequency Departure [ppm]	
	Mobile and Portable	Base Station
Below 100	5.0	2.5
From 138 to 174	2.5	1.5
From 406 to 512	2.0	0.5 ³
From 769 to 806	0.4 ^{1,3} /1.5 ²	0.1 ³
From 806 to 869	1.5	0.15 ³
From 896 to 941	1.5	0.1 ³

1. When AFC locked to base station
2. When AFC not locked to base station
3. Requires "External Reference Clock" or "High Stability Reference Oscillator (Opt.002)"

Limits: Modulation Fidelity limits

Radio Application	Mobile	Portable	Base Station
Class A	5%	5%	5%
Class B	10%	10%	10%

Limits: Deviation = 1620 Hz to 1980 Hz (1800 Hz \pm 10%)

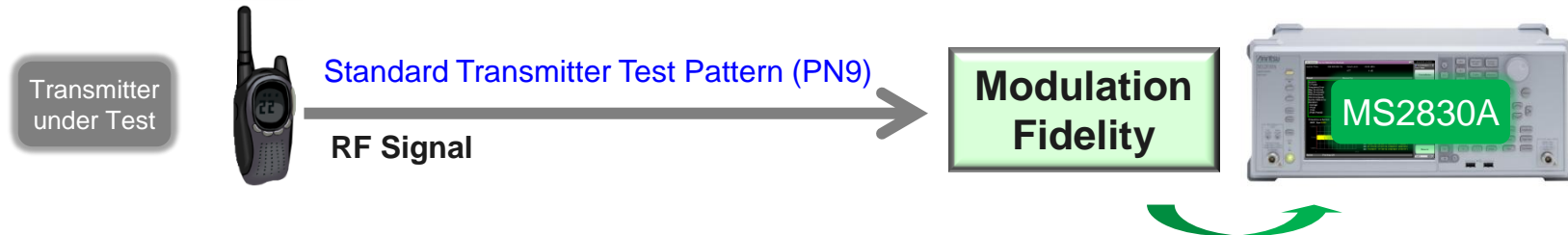
Transmitter Performance Measurement Methods

Modulation Fidelity: C4FM, CQPSK, LSM, WCQPSK

Note: For details, refer to the TIA-102 standard.

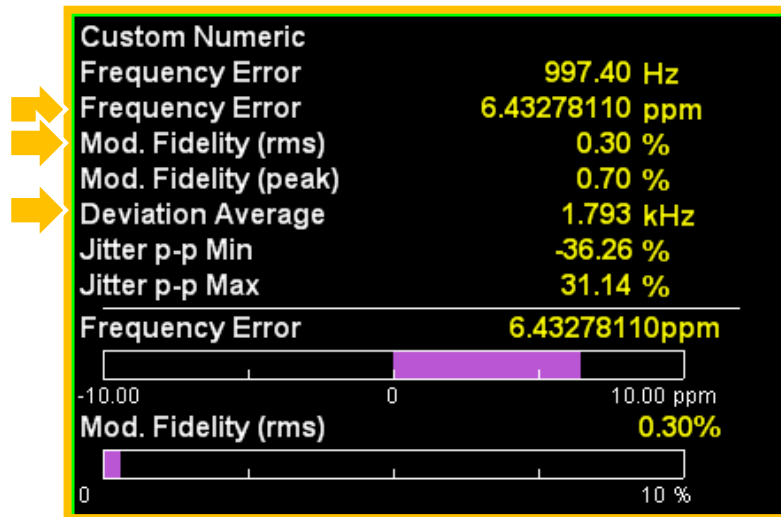
Note: This feature is under development.

Measures deviation, carrier frequency offset, rms deviation error (modulation fidelity rms)

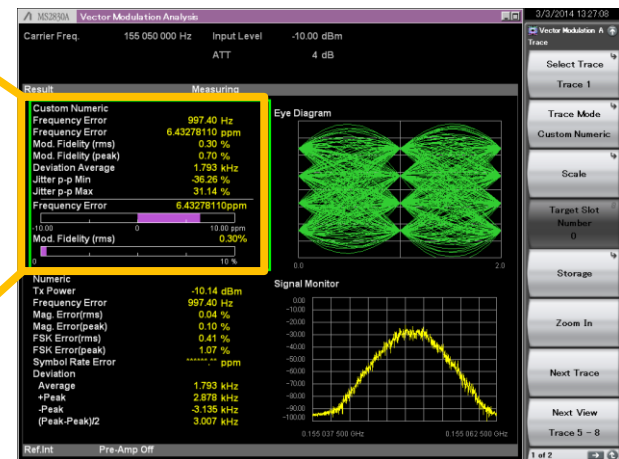


MX269017A

Vector Modulation Analysis Software



Example: Frequency Error = 1 kHz



Transmitter Performance Measurement Methods

Modulation Fidelity: C4FM, CQPSK, LSM, WCQPSK

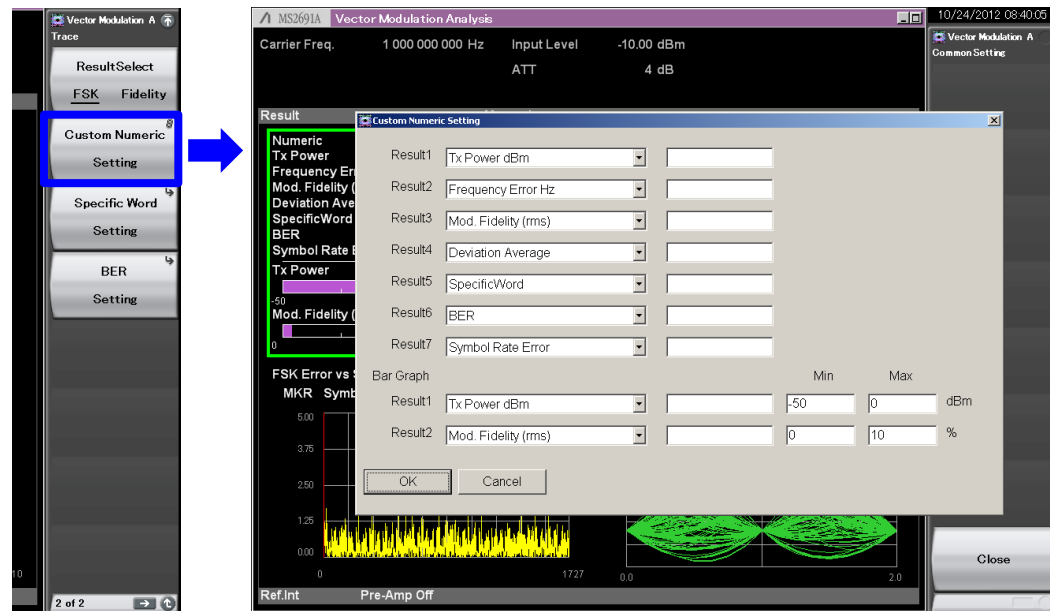
Note: For details, refer to the TIA-102 standard.

Note: This feature is under development.

Trace: Custom Numeric

Any of seven types of numeric measurement result or two types of graphical result can be selected for display at the Custom Numeric screen. (Note: The Custom Numeric screen does not support Zoom.)

[Trace] > (page 2) [F2: Custom Numeric Setting]



Numeric and graphical results can be checked simultaneously on four sub-screens by displaying any item from the many numeric results on the Numeric screen. Moreover, difficult-to-evaluate numeric values can be evaluated intuitively from bar graphs.

Transmitter Performance Measurement Methods

Modulation Fidelity: C4FM additional testing

Note: For details, refer to the TIA-102 standard.

Note: This feature is under investigation.

Measures rms error magnitude, deviation, peak spurious

Limits: C4FM rms error magnitude limits

Radio Application	Mobile	Portable	Base Station
Class A	5%	5%	5%
Class B	10%	10%	10%

Limits: Deviation = 1620 Hz to 1980 Hz

Limits: C4FM peak spurious frequency limits

Radio Application	Mobile	Portable	Base Station
Class A	100 Hz	100 Hz	50 Hz
Class B	150 Hz	150 Hz	100 Hz

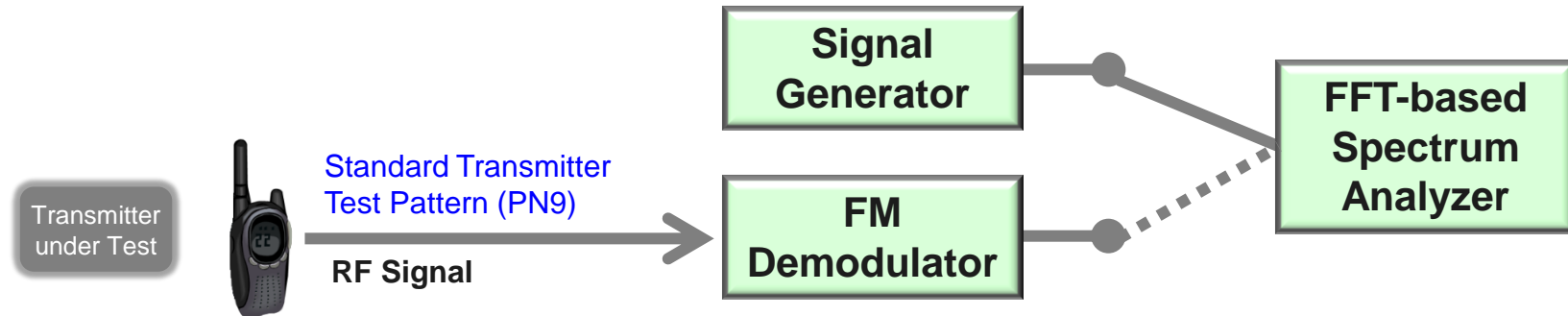
Transmitter Performance Measurement Methods

Modulation Fidelity: C4FM additional testing

Note: For details, refer to the TIA-102 standard.

Note: This feature is under investigation.

Measures rms error magnitude, deviation, peak spurious



The detailed measurement procedure will be checked.

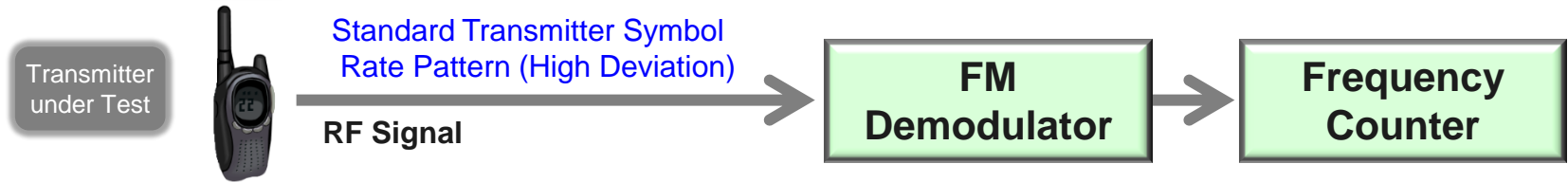
Transmitter Performance Measurement Methods

Symbol Rate Accuracy

Note: For details, refer to the TIA-102 standard.

Measures accuracy of modulation speed of transmitter

Limits: Shall not exceed 10 ppm



MX269018A

Analog Modulation Analysis Software

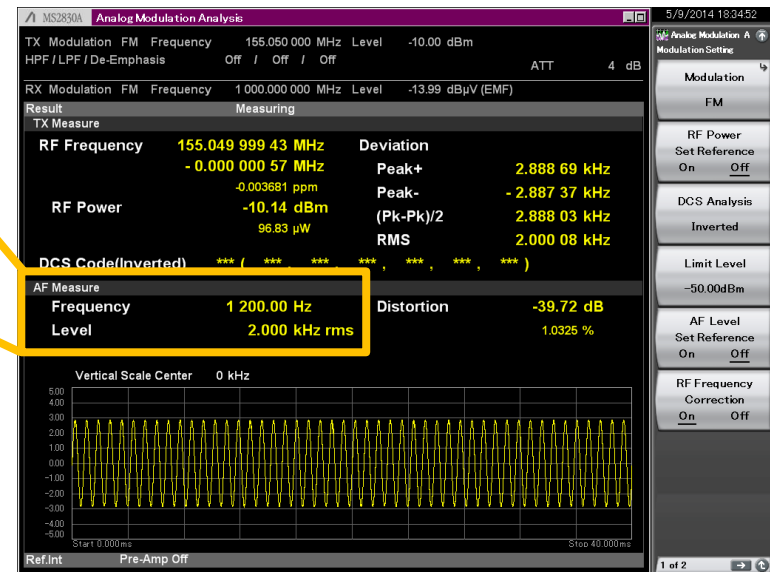


$$\text{ppm error} = \left[\frac{\text{Frequency}_{\text{Hz}}}{1200} - 1 \right] \times 10^6$$

Note) 1200 Hz x 10 ppm = 0.012 Hz

Resolution performance is insufficient

=> Under development: The number of digits will be increased.



Ordering Information

► Recommended Configuration

Model	Product Name	Recommended Set		
		Base	Base 2	Extension
MS2830A	Signal Analyzer	√	√	√
MS2830A-040	3.6 GHz Signal Analyzer	√	√	√
MS2830A-002	High Stability Reference Oscillator	√	√	√
MS2830A-006	Analysis Bandwidth 10 MHz		√	√
MS2830A-066	Low Phase Noise Performance	√	√	√
MX269017A	Vector Modulation Analysis Software			√
MX269018A	Analog Measurement Software			√
A0086A	USB Audio			√

TIA-102		Receiver test items	MS2830A		
CAAB-C	CAAA-D		Basic	Basic2	Extension
3.2.2	2.2.2	Operating Frequency Accuracy	N/A	√ ²	√ ²
3.2.5	2.2.5	Modulation Emission Spectrum	√	√	√
3.2.7	2.2.7	Unwanted Emission: Conducted Spurious	Under investigation		
3.2.8	2.2.8	Unwanted Emission: Adjacent Channel Power Ratio	√	√	√
3.2.9	2.2.9	Intermodulation Attenuation	√	√	√
3.2.15	2.2.15	Frequency Deviation for C4FM	N/A	N/A	√ ²
3.2.16	2.2.16	Modulation Fidelity (C4FM, CQPSK, linear simulcast modulation)	Ongoing development		
		Modulation Fidelity (C4FM additional testing)	Under investigation		
3.2.17	2.2.17	Symbol Rate Accuracy	N/A	N/A	√ ²

1. Requires MS2830A-006 Analysis Bandwidth 10 MHz for Frequency vs. Time function
2. Requires MX269018A Analog Measurement Software

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