/Inritsu

P25-Phase 2 Tx Test Solution

MS2830A
Signal Analyzer

P25-Phase 2 Tx Test Solution

P25 Phase 2 Technical Specifications

**Physical Layer Protocol Specification
TIA-102.BBAB (Jul 2009)**

**Transceiver Performance Recommendations
TIA-102.CCBA (Oct 2011)**

**Transceiver Measurement Methods
TIA-102.CCAA-A (May 2011)**

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

Version 3.00

Oct. 2014

Anritsu Corporation

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[Anritsu] P25-Phase 2 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)
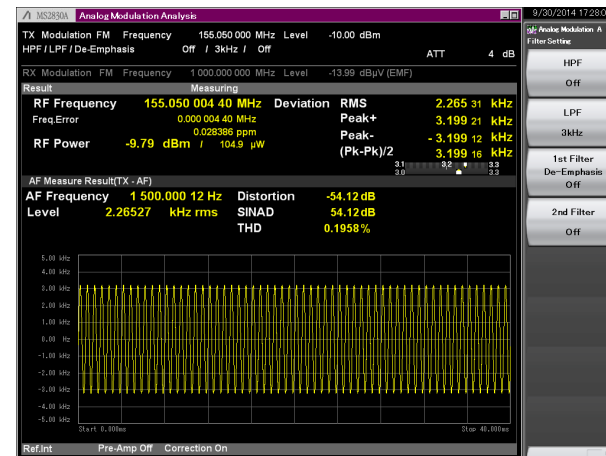- **FM Demodulator**
  (MX269018A)

MX269017A
Vector Modulation Analysis Software

MX269018A
Analog Modulation Analysis Software

[Anritsu] P25-Phase 2 Tx Test Solution

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

TIA-102 CCAB	TIA-102 CCAA	Transmitter test items	Signal Analyzer MS2830A	Other
3.2.1	2.2.1	RF Output Power	√	or Power Meter
3.2.2	2.2.2	Operating Frequency Accuracy	√ [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	---	Audio Noise Generator, Distortion Meter etc.
3.2.5	2.2.5	Modulation Emission Spectrum	√	---
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	√ or √ [1]	---
3.2.9	2.2.9	Intermodulation Attenuation (Base Station only)	√	Signal Source etc.
3.2.10	2.2.10	Average 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	Frequency Deviation for H-CPM	√ [2]	---
3.2.13	2.2.13	Modulation Fidelity	Ongoing development	---
3.2.14	2.2.14	Symbol Rate Accuracy	√ [2]	---
3.2.15	2.2.15	H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio (IB only)	√ [1]	---
3.2.16	2.2.16	H-CPM Transmitter Logical Channel Off Slot Power (IB only)	√ [1]	---
3.2.17	2.2.17	H-CPM Transmitter Logical Channel Power Envelope (IB only)	√ [3]	---
3.2.18	2.2.18	H-CPM Transmitter Logical Channel Time Alignment (IB only)	Under investigation	SG for VCH & CCH Signal Autocorrelation Processor

1. Requires MS2830A-006 Analysis Bandwidth 10 MHz for Frequency vs. Time function
2. Requires MX269018A Analog Measurement Software with A0086A USB Audio
3. Requires MX269017A Vector Modulation Analysis Software with MS2830A-006

Anritsu envision:ensure
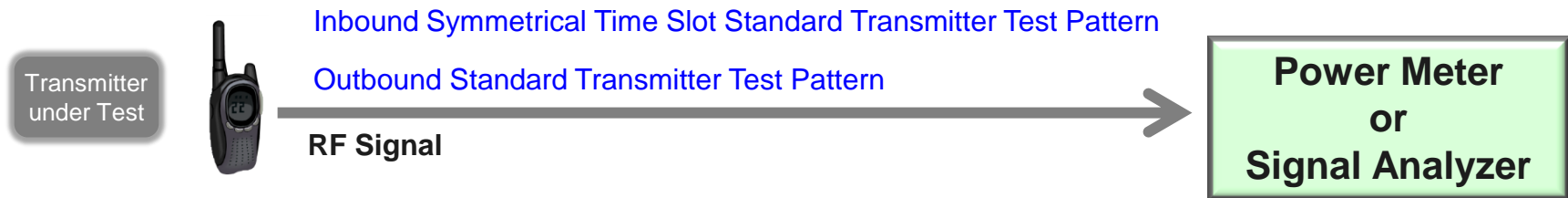
Transmitter Performance Measurement Methods

RF Output Power

Measures transmitter output power

Limits: (≤+20%: Specified by manufacturer)

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

Limits: for FCC part 27.50-b (775-776/805-806 MHz) and part 90.541 (769-775/799-805 MHz)

Station Type	Maximum output power
Mobile, and Control	30 Watts
Portable (handheld)	3 Watts

Transmitter under Test

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

Outbound Standard Transmitter Test Pattern

RF Signal

**Power Meter
or
Signal Analyzer**

✓ **Measure the transmitter output power during the defined duty cycle (see CCAA 1.5.2)**

✓ **The power is measured using a gated power measurement over a 24 ms duration centered over the center of the transmit on time slot intervals.**
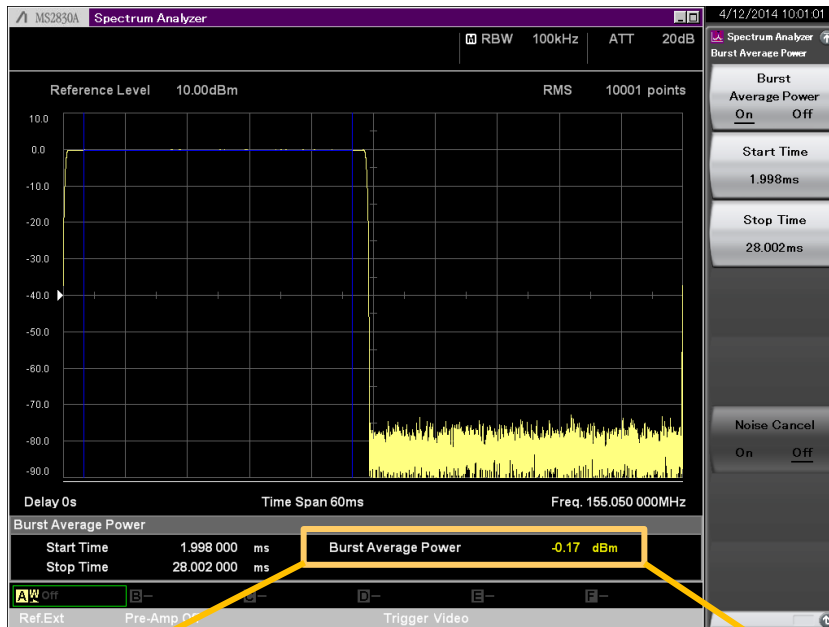
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Transmitter Performance Measurement Methods

RF Output Power

Measures transmitter output power

Burst Average Power Function [pre-installed]

Power vs. Time [Opt-006]
Burst Average Power Function

Burst Average Power -0.17 dBm
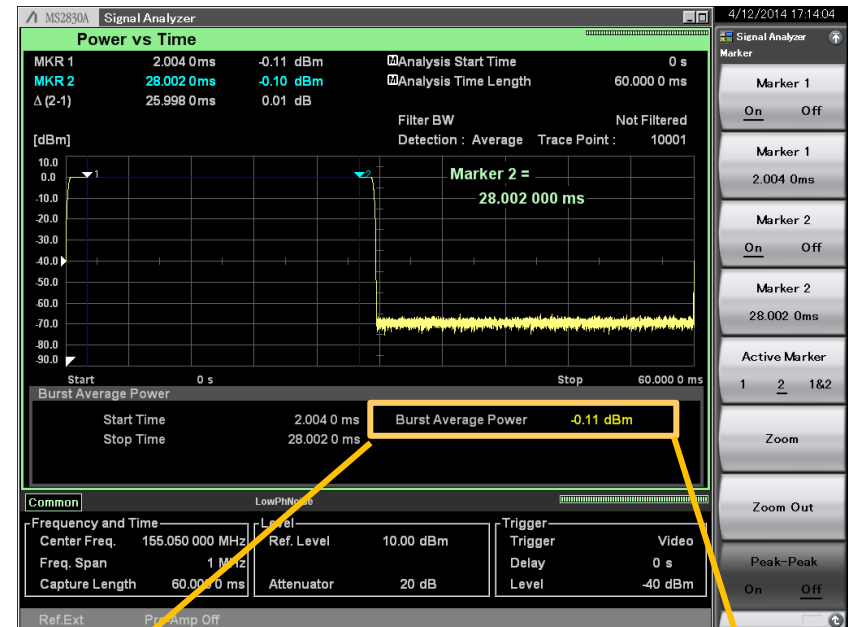
Burst Average Power -0.11 dBm
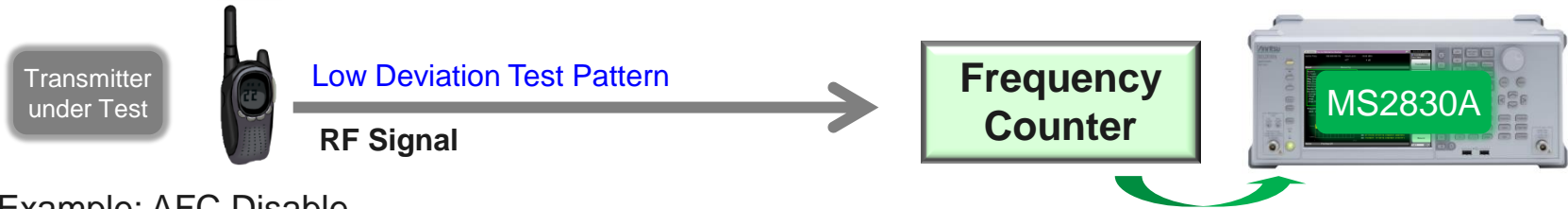
Transmitter Performance Measurement Methods

Operating Frequency Accuracy

Measures frequency of transmitter
Calculate the ppm frequency error.

Transmitter under Test

Low Deviation Test Pattern

RF Signal

Frequency Counter

MS2830A

Example: AFC Disable

MX269018A
Analog Modulation Analysis Software

RF Frequency   155.050 004 41 MHz
Freq.Error   0.000 004 41 MHz
                    0.028426 ppm
RF Power   -9.79 dBm / 104.9 µW
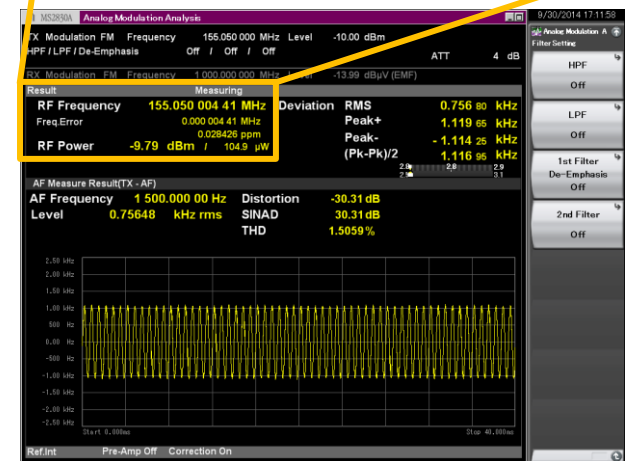
Limits:

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)"

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Transmitter Performance Measurement Methods

Modulation Emission Spectrum

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 kHz < f_d ≤ 12.5 kHz	7.27 (f_d − 2.88 kHz)
12.5 kHz < f_d	50 + 10$\log_{10}$(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 kHz < f_d ≤ 12.5 kHz	7 (f_d − 2.5 kHz)
12.5 kHz < f_d	50 + 10$\log_{10}$(RFOP), or 70 whichever smaller

RFOP: RF Output Power in Watts

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Transmitter Performance Measurement Methods

Modulation Emission Spectrum

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

Outbound Standard Transmitter Test Pattern

Transmitter under Test

RF Signal

Spectrum Analyzer

MS2830A
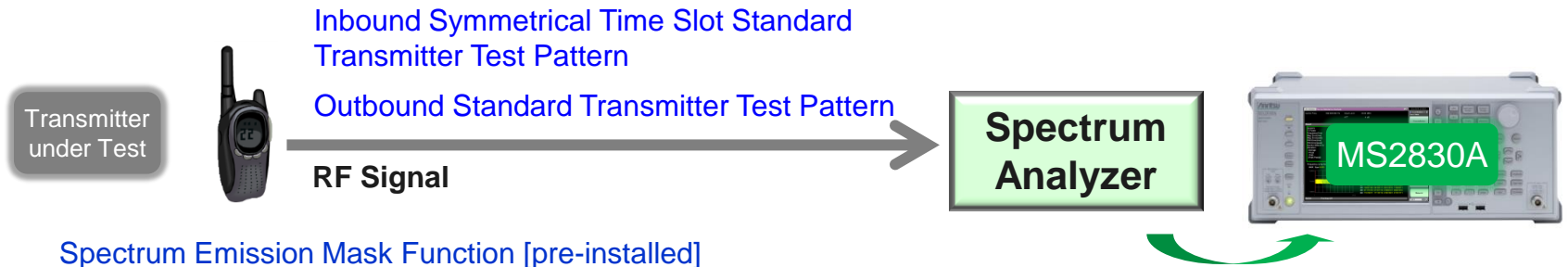
Spectrum Emission Mask Function [pre-installed]
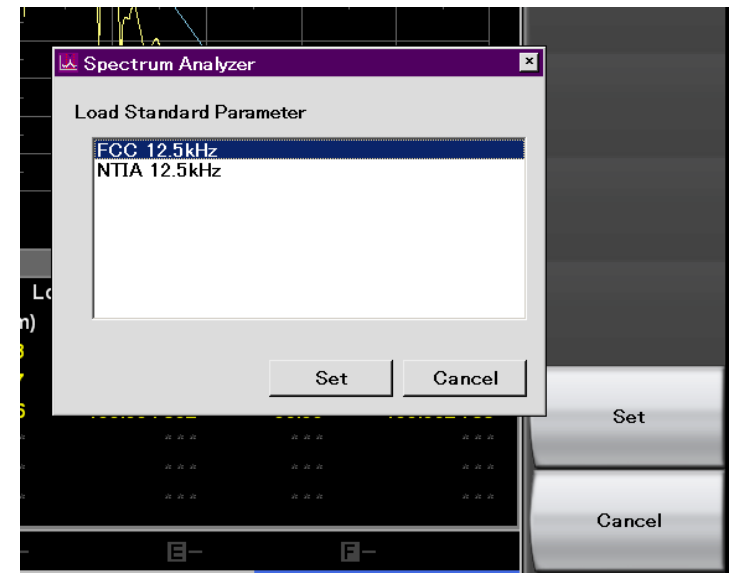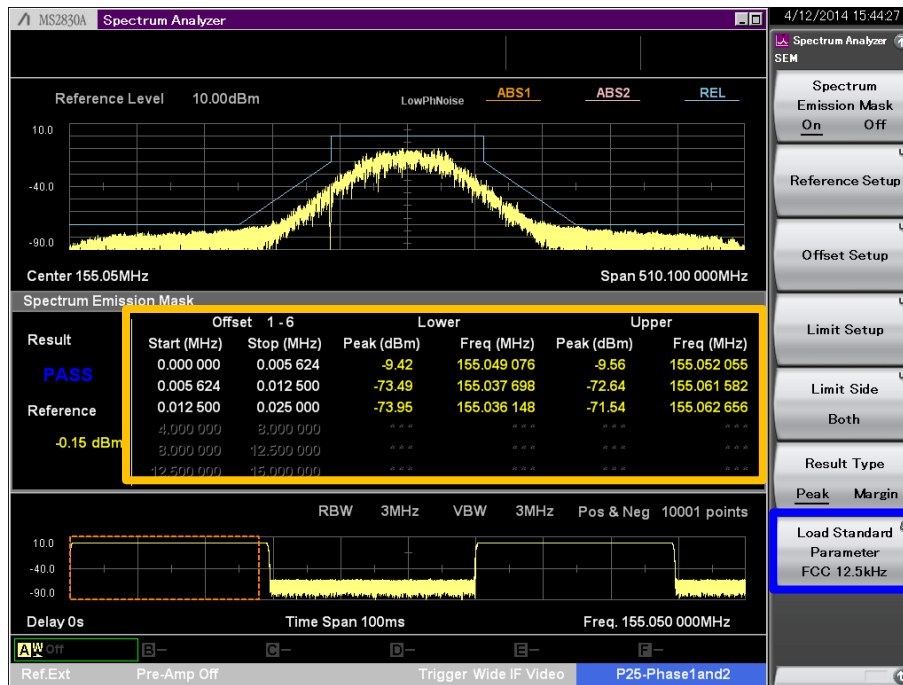
Example: FCC 12.5 kHz

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Transmitter Performance Measurement Methods

Unwanted Emission: Radiated Spurious

Measures power of spurious signals

Limits: Non-radiating load (47 CFR 2.1053 and 47 CFR 90.210-d)
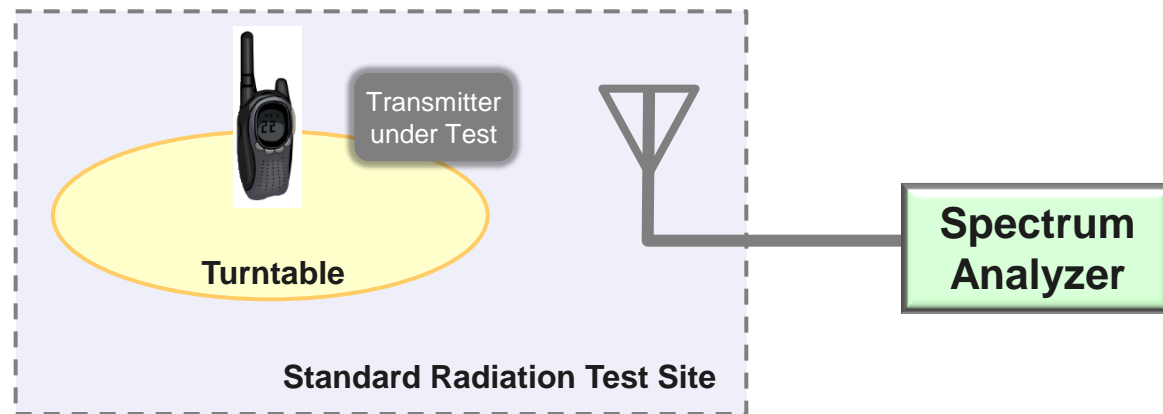Shall be attenuated by at least 50 + 10log(P) dB, or 70 dB, whichever is smaller

Limits: 700 MHz Band (47 CFR 27.53-e-8 and 47 CFR 90.543-c)
Shall be attenuated by at least 43 + 10log(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 under Test

Spectrum Analyzer

Turntable

Standard Radiation Test Site

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Transmitter Performance Measurement Methods
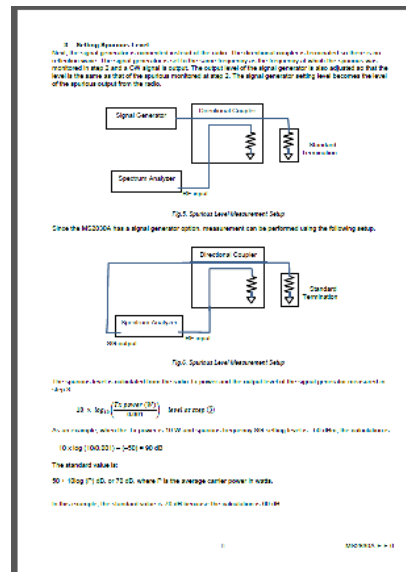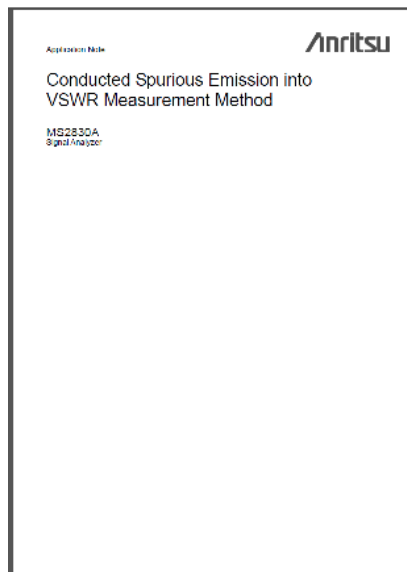
Unwanted Emission: Conducted Spurious

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 + 10log(P) dB, or 70 dB, whichever is lesser attenuation below the reference. P is the average carrier power in watts.

Limits: 700 MHz Band (47 CFR 27.53-e-8 and 47 CFR 90.543-c)
Shall be attenuated by at least 43 + 10log(P) dB below the reference. P is the average carrier power in watts.

Check the application note
(MS2830A_EF6100.pdf)

Transmitter Performance Measurement Methods

Unwanted Emissions:
Non-Spurious Adjacent Channel Power Ratio

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

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

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 the applicable limit in following table when measured using a measurement (integration) bandwidth of 6 kHz.

Modulation	Mobile
H-CPM	65 dB
H-DQPSK	67 dB

Slide 11

MS2830A-E-L-13

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Transmitter Performance Measurement Methods

Unwanted Emissions:
Non-Spurious Adjacent Channel Power Ratio

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"

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Transmitter Performance Measurement Methods

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

Unwanted Emissions: Non-Spurious Adjacent Channel Power Ratio

Inbound Symmetrical Time Slot Standard
Transmitter Test Pattern

Outbound Standard Transmitter Test Pattern

Transmitter under Test
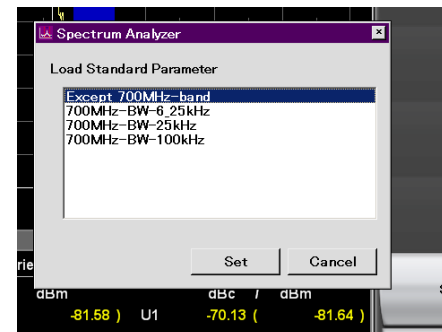
RF Signal

ACP Analyzer

MS2830A

Adjacent Channel Power Function [pre-installed]

Example: Except 700 MHz band

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

Burst signal (IB) is measured by a gate sweep function. However, it will take 30 seconds per once.

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Transmitter Performance Measurement Methods

Unwanted Emissions:
Non-Spurious Adjacent Channel Power Ratio

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

ACP function [Opt-006]
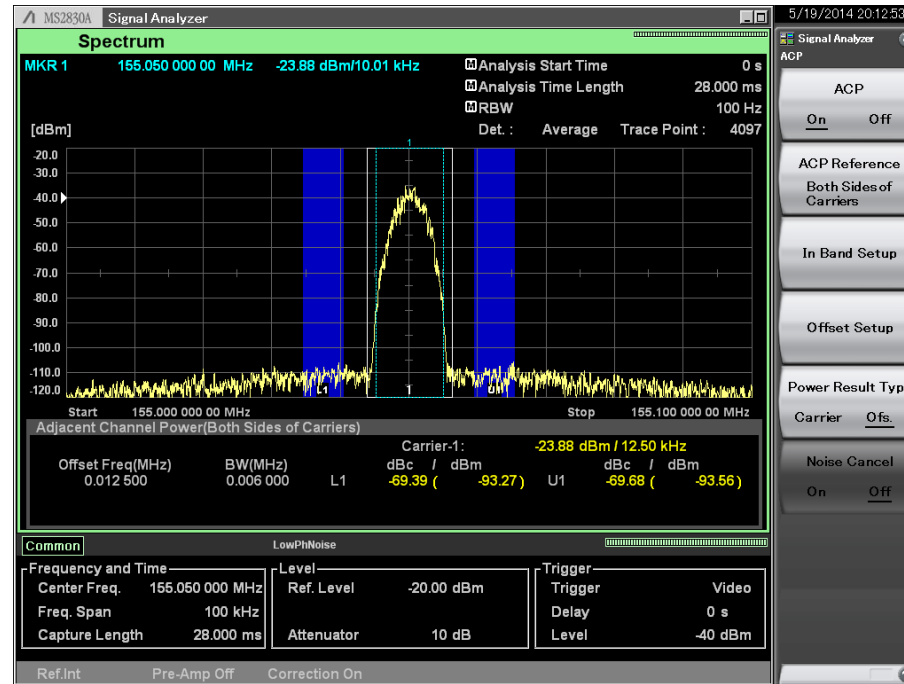
With the signal analyzer mode (Opt-006), FFT processing is supported.
Therefore one measurement will be completed in 150 ms.

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Transmitter Performance Measurement Methods

Intermodulation Attenuation

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)
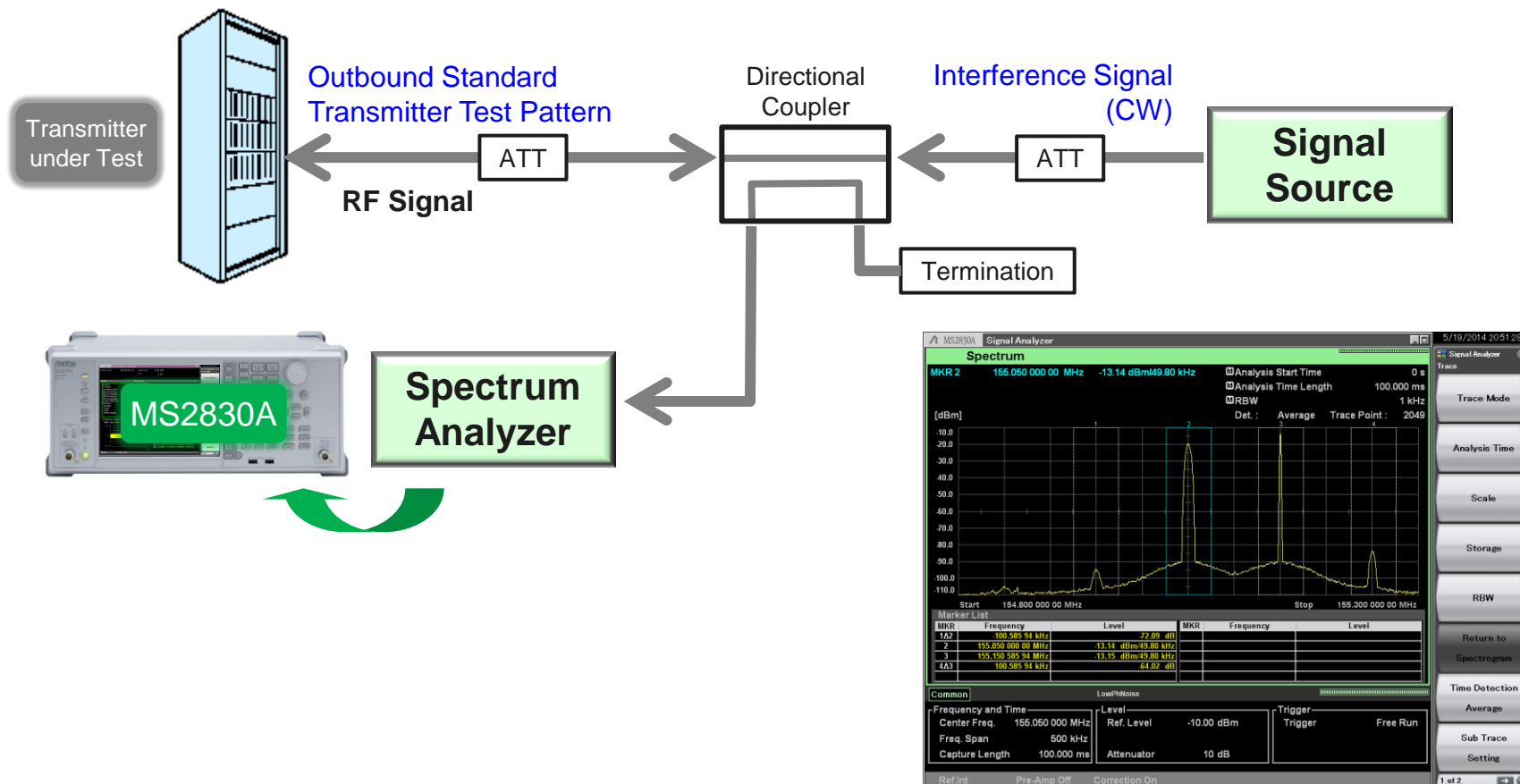
Multi-Marker Function [pre-installed]

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Transmitter Performance Measurement Methods

Frequency Deviation for H-CPM (IB)

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 = 2995 Hz to 3310 Hz
             Low deviation = 998 Hz to 1104 Hz

Transmitter under Test

Inbound High Deviation Test Pattern
Inbound Low Deviation Test Pattern

RF Signal

FM Demodulator

MS2830A

MX269018A

Analog Modulation Analysis Software

Example: High Deviation

Transmitter Performance Measurement Methods

Modulation Fidelity:
H-CPM, H-DQPSK

Measures modulation fidelity rms.

Limits: Modulation Fidelity limits

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

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

Outbound Standard Transmitter Test Pattern

Transmitter under Test

RF Signal

Modulation Fidelity

MS2830A
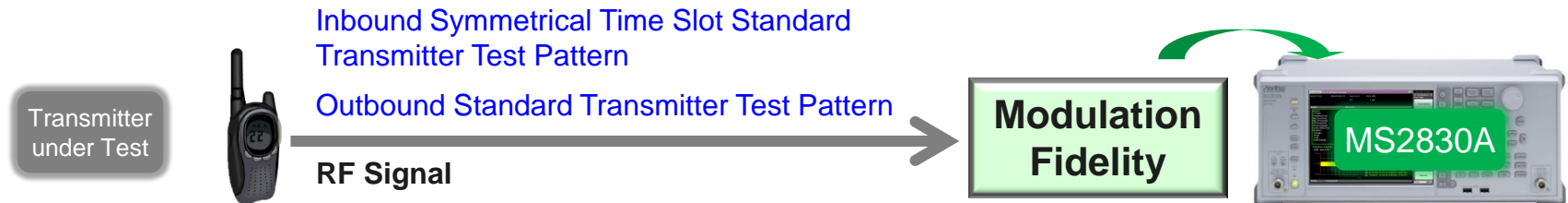
MX269017A

Vector Modulation Analysis Software

Frequency Error	0.02 Hz
	0.000105 ppm
Mag. Error(rms)	0.07 %
Mag. Error(peak)	-0.13 % at symbol 192
FSK Error(rms)	0.11 %
FSK Error(peak)	0.28 % at symbol 203
BER	100.00 %
Mod.Fidelity(rms)	0.06 %
Mod.Fidelity(peak)	0.17 % at symbol 186

Example: Frequency Error = 1 kHz

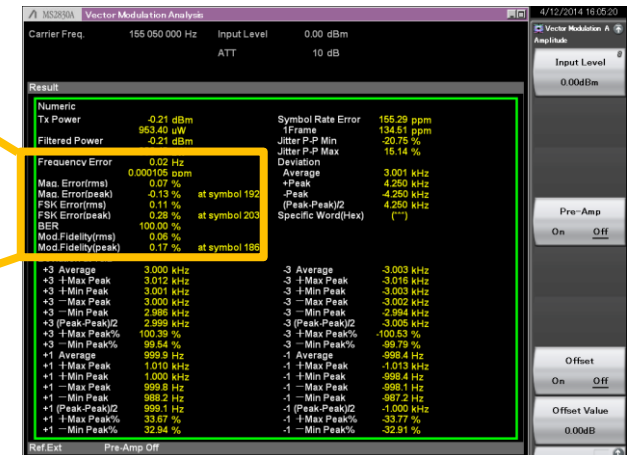# Transmitter Performance Measurement Methods

## Modulation Fidelity: H-CPM, H-DQPSK

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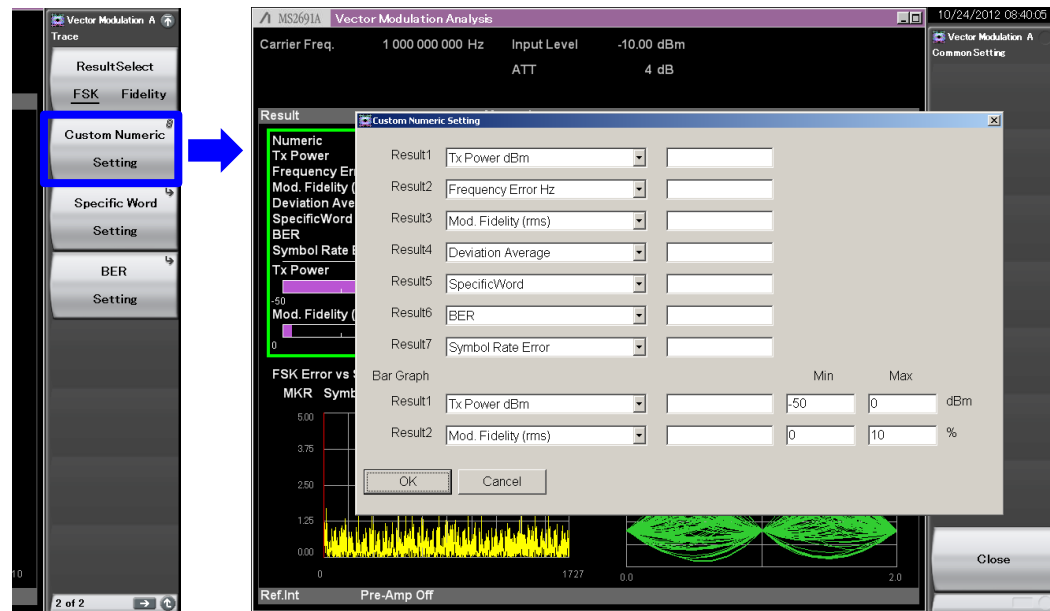
Numeric and graphical results can be checked simultaneously on four sub-screens by displaying any item from the many numeric results on the Numeric screen. Moreover, difficult-to-evaluate numeric values can be evaluated intuitively from bar graphs.
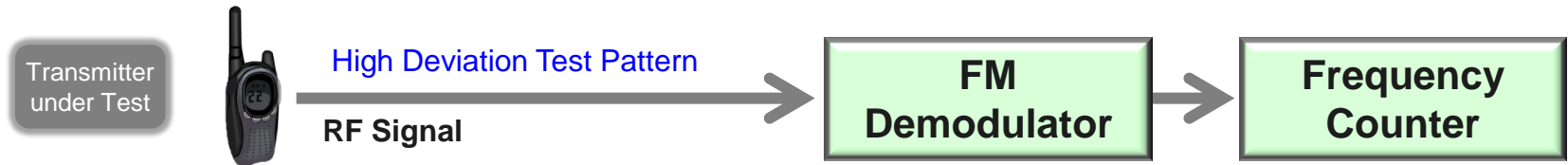
Transmitter Performance Measurement Methods

Symbol Rate Accuracy

Measures accuracy of modulation speed of transmitter

Limits: Shall not exceed 10 ppm

Transmitter under Test

High Deviation Test Pattern

RF Signal

FM Demodulator

Frequency Counter

MX269018A

Analog Modulation Analysis Software

AF Measure Result(TX - AF)

AF Frequency   1 500.000 12 Hz

Level   2.26527   kHz rms
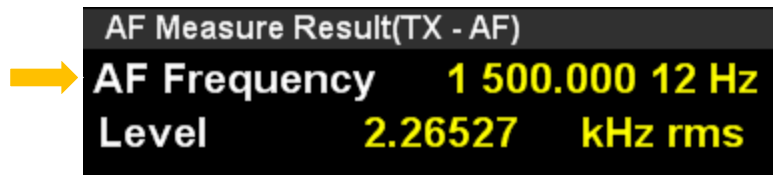
$$ppm\ error = \left[\frac{Frequency_{Hz}}{1500} - 1 \right] \times 10^6$$

Note) 1500 Hz x 10 ppm = 0.015 Hz

Enable when "Time Range" set to " ≥ 21 ms".
[Trace] > [F2: Time Domain Setting] > [F4: Time Range]
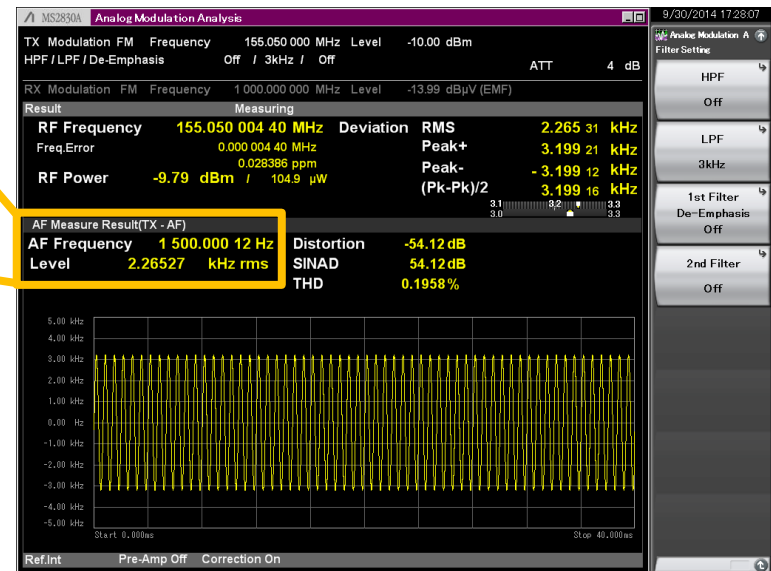
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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio (IB only)

Transmitter under Test

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

RF Signal

Spectrum Analyzer

MS2830A
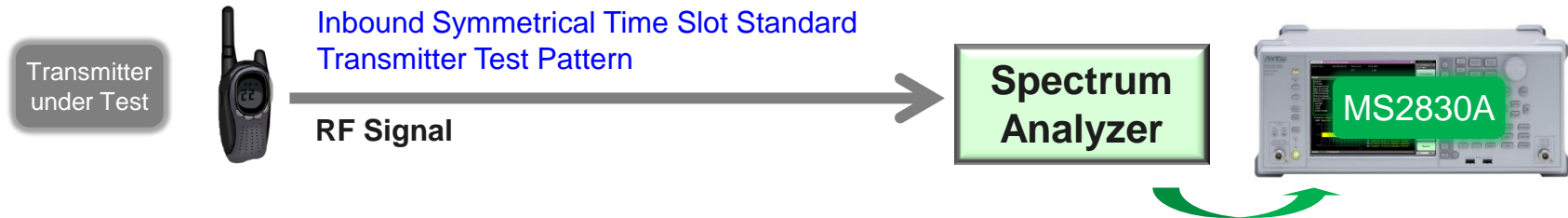
Limits: $P_{TX} - P_{HI}$: 35 dB or greater
$P_{TX} - P_{LOW}$: 35 dB or greater

12.5 kHz   12.5 kHz

Span: 0
RBW: 5 kHz

Zero Span
RBW: 5 kHz

P_{LOW}

P_{HI}

Transmitter
Frequency

P_{TX}

(P_{TX} = RF Output Power)

Spectrum analyzer setting

Center Frequency : DUT $\pm$12.5 kHz
Span : Zero Hz
RBW : 5 kHz ($\pm$ 5%)
Filter Type : Gaussian
Detection : Peak
Sweep Time : 360 ms
Trigger : Internal Magnitude
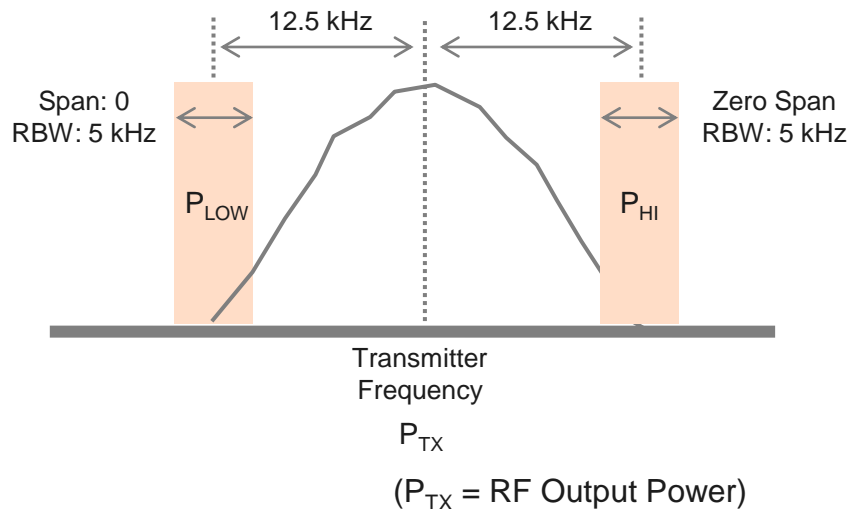
P_{HI}, P_{LOW} : Maximum power level

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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio   (IB only)

P_{HI} and P_{LOW} are the maximum power level.

Power vs. Time [Opt-006]

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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Off Slot Power   (IB only)

Transmitter under Test

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

RF Signal, P_{TX}

Spectrum Analyzer

MS2830A

Limits: $P_{TX} - (P_{ON\text{-}REL} - P_{OFF\text{-}REL})$: Shall not exceed -57 dBm

Timeslot 1

30 ms

$P_{ON\text{-}REL}$

Timeslot 2

30 ms

$P_{OFF\text{-}REL}$
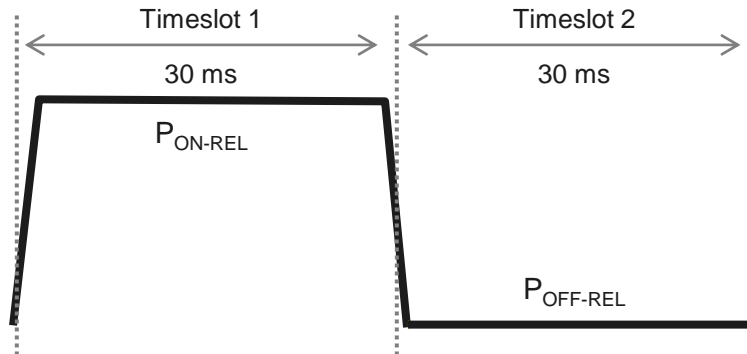
(P_{TX} = RF Output Power,
  ex: 30Wmax for Mobile)

Spectrum analyzer setting

Span   : Zero Hz
RBW   : 100 kHz
VBW   : 100 kHz
Sweep Speed(Time) : 60 ms
Trigger   : Video, Rising Edge
Detector   : Average (sample)
Average   : Power, 10 sweeps

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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Off Slot Power   (IB only)

$P_{ON REL}$ is the maximum level observed during the interval from 1 ms to 29 ms.
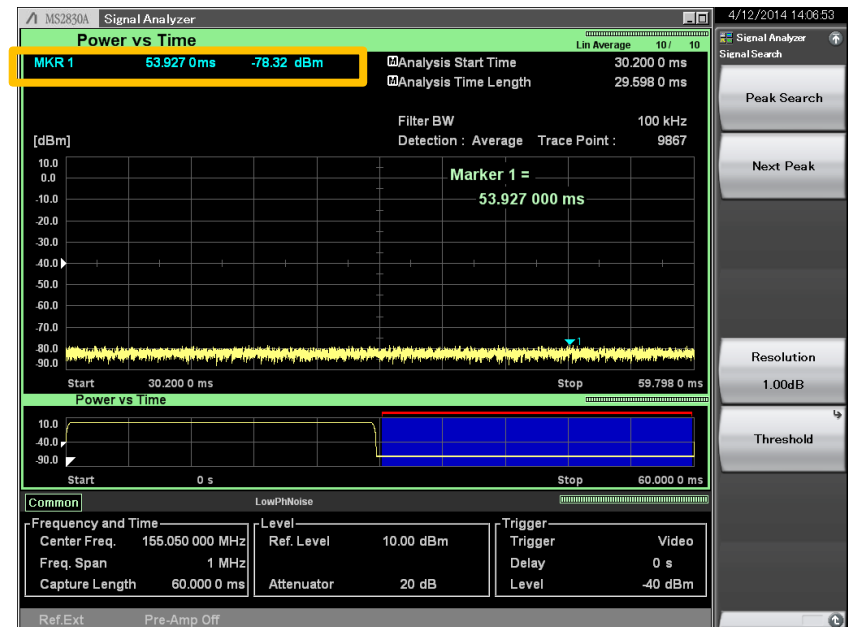
$P_{OFF REL}$ is the maximum level observed during the interval from 30.2 ms to 59.8 ms.

$$(P_{ON-REL} - P_{OFF-REL}) = -0.17 - (-78.32) = 78.15 \text{ dB}$$

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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Power Envelope (IB only)

Transmitter under Test

Inbound Symmetrical Time Slot Standard Transmitter Test Pattern

RF Signal, P_{TX}

Spectrum Analyzer

MS2830A

Limits:

	Time1 [ms]	Power [dBc]
P max-on	- 0.2 to 1.0	4
P max-ss	1.0 to 29.0	1
P min-ss	1.0 to 29.0	-3
P max-off	29.0 to 30.2	4

Spectrum analyzer setting

Span	: Zero Hz
RBW	: 100 kHz
VBW	: 100 kHz
Sweep Speed(Time)	: 60 ms
Trigger	: Video, Rising Edge
Detector	: Peak

Pmax-on

Pmax-ss

Pmin-ss

P_{REF}: 0dBc reference point

14 ms

14 ms

0.2 ms

1 ms (t1)

28 ms (t2)

1 ms (t3)

0.2 ms

$Pmax\text{-}on = P_{REF} - Pmax(t1)$

$Pmax\text{-}ss = P_{REF} - Pmax(t2)$

$Pmin\text{-}ss = P_{REF} - Pmin(t2)$

$Pmax\text{-}off = P_{REF} - Pmax(t3)$

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Transmitter Performance Measurement Methods

H-CPM Transmitter Logical Channel Power Envelope   (IB only)
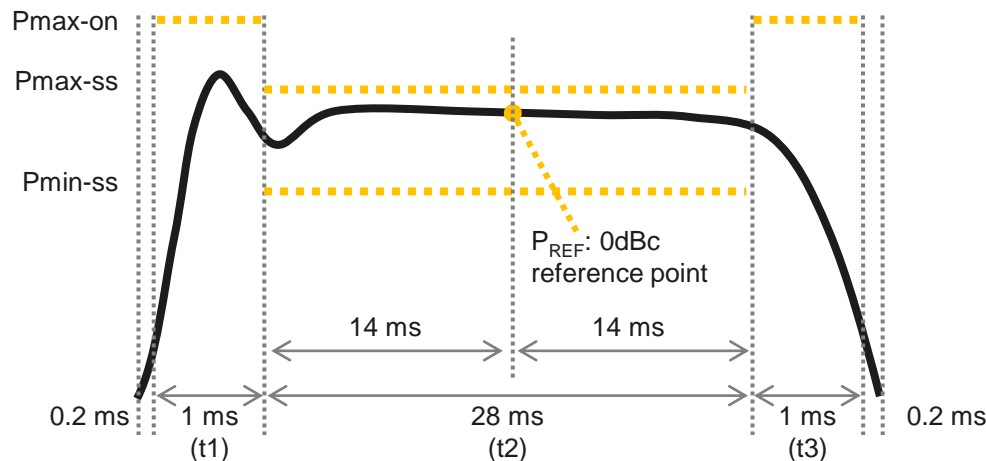
Note: For details, refer to the TIA-102 standard.

BW : 100.0kHz / Gaussian

Slot	State	Avg [dBm]	Judge	Slot	State	Avg [dBm]	Judge
0	Off	-85.39	****	7	On	-0.33	Pass
1	On	-0.33	Pass	8	Off	-85.37	****
2	Off	-85.49	****	9	On	-0.33	Pass
3	On	-0.33	Pass	10	Off	-85.37	****
4	Off	-85.38	****	11	On	-0.33	Pass
5	On	-0.33	Pass	12	****	**.** **	****
6	Off	-85.34	****	13	****	**.** **	****

MX269017A

Vector Modulation Analysis Software

envision : ensure

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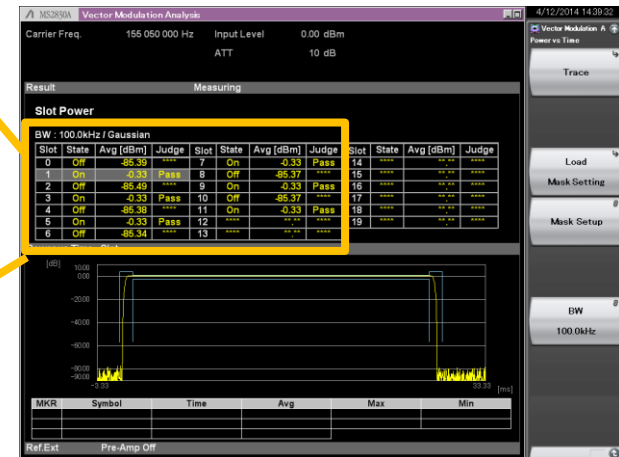
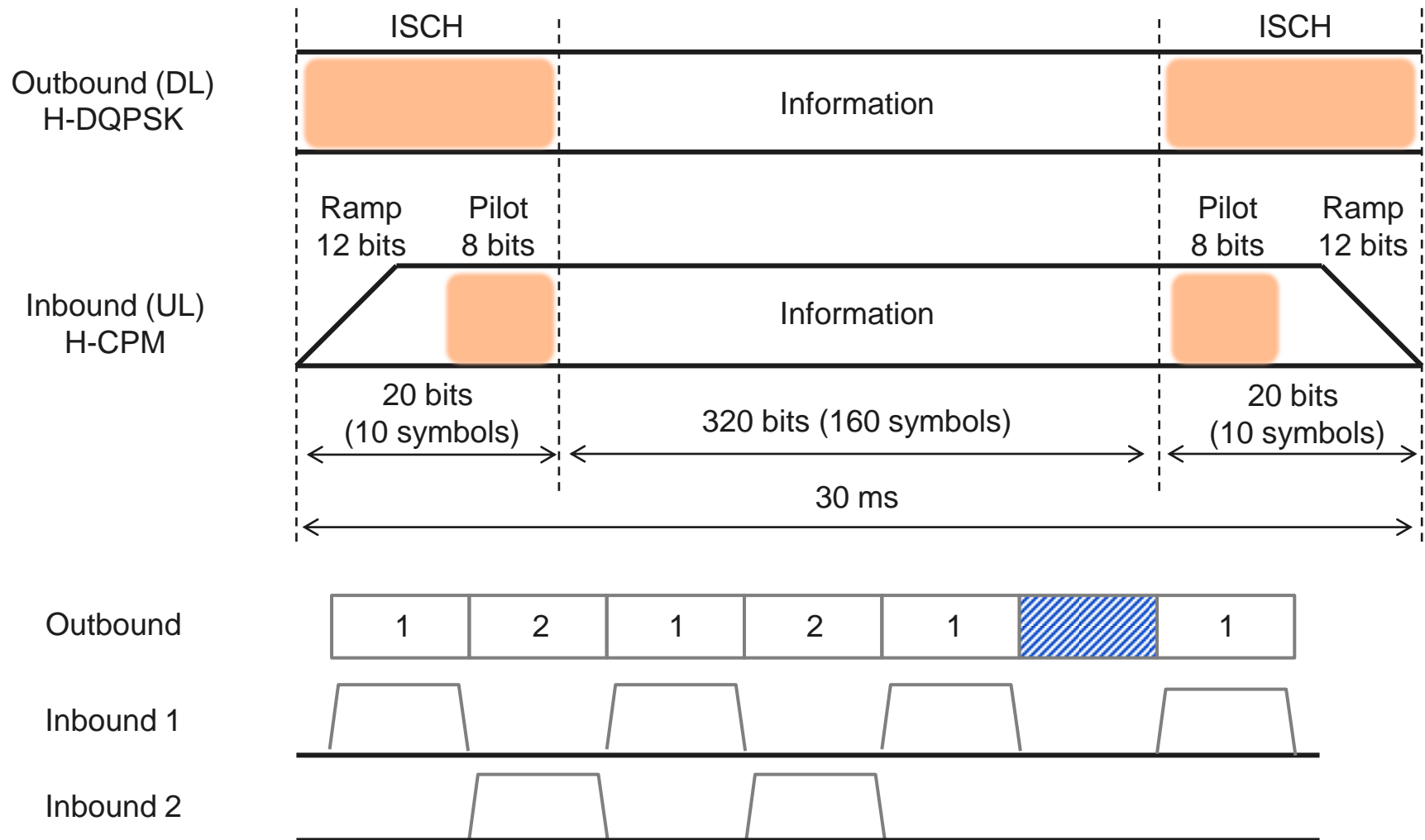**Note: For details, refer to the TIA-102 standard.**

▶Two-Slot TDMA Modulation

- ✓ Uplink Modulation: H-CPM (Harmonized Continuous Phase Modulation)
- ✓ Downlink Modulation: Pi/4-DQPSK
- ✓ Data Rate: 12 kbps
- ✓ Symbol Rate: 6000 sps

► **Two-Slot TDMA Transmission Format**

Anritsu envision : ensure

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Ordering Information

► Recommended Configuration

Model	Product Name	Recommended Set		
		Base	Base 2	Extension
MS2830A	Signal Analyzer	√	√	√
MS2830A-040	3.6GHz 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 only)	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

Anritsu envision:ensure

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