Product Introduction

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P25-Phase 2 Tx Test Solution

MS2830A Signal Analyzer MG3710A Vector Signal Generator Product Introduction

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 2.00 August 2014 Anritsu Corporation

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Slide 1

MS2830A-E-L-13

[Anritsu] P25-Phase 2 Tx Test Solution

Tx Evaluation

Multi-functions supported with one unit!



MX269017A Vector Modulation Analysis Software

MS2830A Vector Modulation Analysis					_	3/30/2014 13:43:02
Carrier Freq. 155 050 000 Hz Input Leve	l -10.0	00 dBm	Trigge		Video	Vector Modulation A 🕤 Trace 1 Mode
ATT		4 dB	Delay		0.000 µs	Equalizar
						Equanzer
Result						Impulse Response
Custom Numeric	Eve Dia	aram				ESK Error vs
Frequency Error 0.03 Hz						
Frequency Error 0.00016805 ppm						Symbol
Mod. Fidelity (ms) 0.08 %	-		1.1	-		
Deviation Average 3,000 kHz	-			×~	<u> </u>	Fidelity vs
litter p-p Min -22 52 %	V	100		\sim	Same	
Jitter p-p Max 22.09 %	6		20	36.33		Symbol
Frequency Error 0.00016805ppm	<	-		× .		
	V		- A - A	S-290		
-10.00 0 10.00 ppm			-			Histogram
Mod. Fidelity (rms) 0.08%						
0 10 %	0.0					Custom Numeric
Signal Monitor	Fidelity	vs Symbo	ol			
8.00	MKR	Symbol	8.0	Fidelity	0.21 %	
-10.00						
-20.00						
-30.00						
-40.00						
-50.00						
-60.00						
-70.00						
-60.00						
-9000						
0.155 057 500 GH2 0.155 052 500 GH	n. 1				167	
Ref.Ext Pre-Amp Off Correction On						3 of 3 🗈 🕄 🕄

MX269018A Analog Modulation Analysis Software



Slide 2 MS2830A-E-L-13

[Anritsu] P25-Phase 2 Tx Test Solution

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

TIA	TIA-102 Transmitter test items		Signal Analyzer	Other	
CCAB	CCAA		MS2830A	Other	
3.2.1	2.2.1	RF Output Power	\checkmark	or 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,	
3.2.4	2.2.4	Acoustic Audio Performance		Distortion Meter etc.	
3.2.5	2.2.5	Modulation Emission Spectrum	\checkmark		
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)	\checkmark	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	$\sqrt{2}$		
3.2.13	2.2.13	Modulation Fidelity	Ongoing development		
3.2.14	2.2.14	Symbol Rate Accuracy	$\sqrt{2}$		
3.2.15	2.2.15	H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio (IB only)	$\sqrt{1}$		
3.2.16	2.2.16	H-CPM Transmitter Logical Channel Off Slot Power (IB only)	$\sqrt{1}$		
3.2.17	2.2.17	H-CPM Transmitter Logical Channel Power Envelope (IB only)	$\sqrt{3}$		
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

RF Output Power

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

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



- 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.

RF Output Power

Measures transmitter output power



Burst Average Power Function [pre-installed]

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

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





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 kHz < f _d ≤ 12.5 kHz	7.27 (f _d – 2.88 kHz)
12.5 kHz < f _d	50 + 10log 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 + 10log ₁₀ (RFOP), or 70 whichever smaller

RFOP: RF Output Power in Watts

Modulation Emission Spectrum



Example: FCC 12.5 kHz

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Slide 8 MS2830A-E-L-13

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 + 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)



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 + 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.

Application Note	∕inritsu	 Reflect Applications Fixed See the spectra of the state of the state. The device and maple of the state of th
Conducted Spurious VSWR Measuremen M32830A Synd Anayser	Emission into Method	<text><text><caption><text><text><image/><text><text><text><text><text><text><text></text></text></text></text></text></text></text></text></text></caption></text></text>

Check the application note (MS2830A_EF6100.pdf)

Slide 10 MS2830A-E-L-13

Unwanted Emissions:

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

Non-Spurious Adjacent Channel Power Ratio

Measures ratio of <u>total power of transmitter in standard transmitter test pattern</u> to <u>leakage power falling</u> <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 6kHz.

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

Unwanted Emissions: Note: Fo 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	Measurement	ACPR
Frequency [kHz]	Bandwidth [kHz]	[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

 (s) indicates that a swept measurement may be used. RBW <2% x Measurement

 2) 12.5 kHz Mobile and Portable transmitter ACPR limits
 3) 12.5 kHz Base transmitter

4) Requires "Band pass filter for

Bandwidth

ACPR limits

Rx-band"



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

Unwanted Emissions: Note: For details, refer to the TIA-102 standard. Non-Spurious Adjacent Channel Power Ratio



Slide 14

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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)



Slide 15 MS2830A-E-L-13

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

Frequency Deviation for H-CPM (IB)

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 \leq 15 Hz and the low-pass corner frequency is \geq 3 kHz. Turn the De-emphasis function off.

Limits: High deviation = 2995 Hz to 3310 Hz Low deviation = 998 Hz to 1104 Hz



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%

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

Note: This feature is under development.



Slide 17 MS2830A-E-L-13

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]

Vector modulation in	/ MS2691A Vect	or Modulation	ranatysis					10/E I/E01E 00.103
ce	Carrier Freq.	1 000 000	000 Hz Input Level	-10.00 dE	Зm			Common Setting
ResultSelect			ATT	4 dE	3			
FSK Fidelity								
8 	Result	Custom Numeri	c Setting					×
Satting	Numeric Tx Power	Result1	Tx Power dBm	-		-		
Setting	Frequency En	Result2	Frequency Error Hz			-		
Specific Word	Deviation Ave	Desuite				_		
Setting	BER	Resulta	Mod. Fidelity (rms)	<u> </u>				
prp ^l *	Symbol Rate E	Result4	Deviation Average	•				
BER	L .	Result5	SpecificWord	•				
Setting	-50 Mod. Fidelity (Result6	BER	•		-		
	, .	Result7	Symbol Rate Error	·		-		
	FSK Error vs	Bar Granh	1-,			Min	Max	
	MKR Symb	Result1	Ty Dower dBm					dBm
	5.00	Pocult?					10	- «.
	3.75	Nesuitz	IMIOD. FIDELITY (rms)	<u> </u>		μ	10	~
	250	OK	Cancel					
		1						
	1.25	and had done	Alleria and Antone a					
	0.00 10 10 1 0					N	200	Close
	0						2.0	

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.

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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



H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio (

 $P_{TX} - P_{IOW}$: 35 dB or greater

Note: For details, refer to the TIA-102 standard. (IB only)





Spectrum analyzer setting

Center Frequency	: DUT ±12.5 kHz
Span	: Zero Hz
RBW	: 5 kHz (±5%)
Filter Type	: Gaussian
Detection	: Peak
Sweep Time	: 360 ms
Trigger	: Internal Magnitude
	-

 $\mathsf{P}_{\mathsf{HI}}, \mathsf{P}_{\mathsf{LOW}}$

: Maximum power level

H-CPM Transmitter Logical Channel Peak Adjacent Channel Power Ratio (II

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

(IB only)



Power vs. Time [Opt-006]

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

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



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



(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

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

P_{ON-REL} MKR 1 28.669 0ms -0.17 dBm ▲ MS2830A Signal Analyze Power vs Time 📮 Signal Analyz Lin Average 10/ MKR 1 28.669 0 ms MAnalysis Start Time 1.000 0 ms -0.17 dBr MAnalysis Time Length 27.999 0 ms Peak Search Filter BW 100 kHz [dBm] Detection : Average Trace Point : 9334 10.0 Next Peak Marker 1 = 0.0 -10.0 28.669 000 ms -20.0 -30.0 -40.0 -50.0 -60.0 .70.0 -80.0 Resolution .90.0 Start 1.000 0 ms Stop 28.999 0 m 1.00dB ower vs Time 10.0 Threshold 40.0 .90.0 🔽 0 s Start 60.000 0 m LowPhNoise Common Frequency and Time-Leve rigger Center Freq. 155.050 000 MHz Ref. Level 10.00 dBm Trigger Video 1 MH: Delav Freg. Span 0 s 60.000 0 ms 20 dB -40 dBm Capture Length Attenuator Level

 $\mathsf{P}_{\mathsf{ON}\,\mathsf{REL}}$ is the maximum level observed during the interval from 1 ms to 29 ms.



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

∕I MS2830A Signa	l Analyzer							4/12/2014 14:06:53
Power	vs Time					Lin Average	e 10/ 10	🚼 Signal Analyzer 🛛 👘
MKR 1	MKR 1 53.927 0ms -78.32 dBm			MAnalysis Start Time 30			.200 0 ms	SignalSearch
			Analysis Time Length 29			.598 0 ms	Peak Search	
			Filter B	N			100 kHz	
[dBm]			Detectio	on:Avera	age Trac	e Point :	9867	
10.0				Marker	1 =			Next Peak
-10.0					927 000 i			
-20.0								
-30.0								
-40.0								
-50.0								
-60.0								
.70.0								
-80.0 -90.0	and the state of state of state of state	a a star a s			participation (lana aktor an	. Name at Main a bala t	Resolution
Start	30.200 0 ms				S	top	59.798 0 ms	1.00dB
Power vs	Time							
10.0								
-40.0								Inreshold
Start	0 €				6	top	60 000 0 ms	
Common		LowPhNoise						
-Frequency and T	ime	-Level-			Trigger —			
Center Freq.	155.050 000 MHz	Ref. Level	10.00 dBm	,	Trigger		Video	
Freq. Span	1 MHz				Delay		0 s	
Capture Length	60.000 0 ms	Attenuator	20 dB		Level		-40 dBm	
Ref.Ext	Pre-Amp Off							0

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

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

MS2830A-E-L-13

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

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

Inbound Symmetrical Time Slot Standard **Transmitter Test Pattern** Transmitter Spectrum under Test MS2830A Analyzer RF Signal, P_{TY} Limits: Time1 [ms] Power [dBc] Spectrum analyzer setting - 0.2 to 1.0 P max-on 4 Span : Zero Hz P max-ss 1.0 to 29.0 1 RBW : 100 kHz P min-ss 1.0 to 29.0 -3 VBW : 100 kHz P max-off 29.0 to 30.2 4 Sweep Speed(Time) : 60 ms Trigger : Video, Rising Edge Detector : Peak Pmax-on $Pmax-on = P_{REF} - Pmax(t1)$ Pmax-ss $[Pmax(t1) - P_{REE}]$? $Pmax-ss = P_{RFF} - Pmax(t2)$ Pmin-ss $[Pmax(t2) - P_{REE}]$? P_{RFF}: 0dBc reference point $Pmin-ss = P_{REF} - Pmin(t2)$ $[Pmin(t2) - P_{RFF}]$? 14 ms 14 ms $Pmax-off = P_{RFF} - Pmax(t3)$ 0.2 ms 0.2 ms 28 ms 1 ms [^] 1 ms $[Pmax(t3) - P_{REE}]$? (t1) (t2) (t3)

Slide 24 MS2830A-E-L-13

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



Slide 25

MS2830A-E-L-13

[Appendix] P25 Phase 2 PHY Specifications 1/2

Two-Slot TDMA Modulation

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

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

[Appendix] P25 Phase 2 PHY Specification 2/2

Two-Slot TDMA Transmission Format

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



Ordering Information

Recommended Configuration

Medal	Broduct Name	Recommended Set			
woder	Product Name	Base	Base 2	Extension	
MS2830A	Signal Analyzer	\checkmark	\checkmark	\checkmark	
MS2830A-040	3.6 GHz Signal Analyzer	\checkmark	V	\checkmark	
MS2830A-002	High Stability Reference Oscillator	\checkmark	\checkmark	V	
MS2830A-006	Analysis Bandwidth 10 MHz		\checkmark	\checkmark	
MS2830A-066	Low Phase Noise Performance	\checkmark	\checkmark	\checkmark	
MX269017A	Vector Modulation Analysis Software			\checkmark	
MX269018A	Analog Measurement Software			V	
A0086A	USB Audio	S. K. Son	States.	V	

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

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

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Specifications are subject to change without notice.

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