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Easy EVM Measurement of 5G Base Station Tx Signal

Signal Analyzer MS2850A/MS269xA

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1 Introduction

The 5G base station Tx test performs evaluation using the Test Model signal defined by 3GPP TS38.141-1 and TS38.141-2. The Signal Analyzer MS2850A/MS2690A/MS2691A/MS2692A models (hereafter

MS2850A/MS269xA) have functions for analyzing the 5G NR downlink Test Model signal in four easy steps.

- 1. Set RF frequency
- 2. Select Test Model
- 3. Execute Auto Range
- 4. Execute measurement

This simple guide is intended for test engineers with little experience in 5G base station Tx testing and for operators requiring efficient measurement; it explains an easy procedure using the MS2850A/MS269xA to measure the EVM of 5G NR downlink Test Model signals.

2 Preparation

2.1 Required Software

First, confirm that the following measurement software is installed in the MS2850A/MS269xA according to the 5G base station to be measured.

Model Measurement Software					
	MX285051A 5G Measurement Software (Basic License)				
MCODEDA	MX285051A-011 NR TDD Sub-6 GHz Downlink				
M32850A	MX285051A-021 NR TDD mmWave Downlink				
	MX285051A-031 NR FDD Sub-6 GHz Downlink				
	MX269051A 5G Measurement Software (Basic License)				
MS269xA	MX269051A-011 NR TDD Sub-6 GHz Downlink				
	MX269051A-031 NR FDD Sub-6 GHz Downlink				

2.2 Selecting 5G Measurement Software

Load and select the 5G NR Measurement Software. The following procedure is explained using the MS2850A, but the procedure is the same using the MS269xA.

[Setting Procedure]

- 1. Load the 5G Measurement Software.
- 2. Press [System Config] to display the Configuration screen and press [F4] Application Switch Settings.

 MIS2850A Configuration



- 3. (1) Press [F1] Load Application Select at the Application Switch Registration screen.
 - ② Select MX285051A 5G Measurement in Unloaded Applications.
 - ③ Press [F7] Set and wait until 5G Measurement is displayed in Loaded Applications.

Application Sw	- itch Registration		×	2020/04/13 19:11:15	
Applicati	on Switch Registration			Gonfiguration Setting	
Loaded Applica	ations			Load	
Type MX269000A	Name Spectrum Analyzer	Version 19.00.00	Position P1 – F1	Application Select	
MX269000A -	Signal Analyzer -	19.00.00	P1 - F2 P1 - F3	UnLoad	
-	-	-	P1 - F4 P1 - F5 P1 - F6	Application Select	
-	-		P1 - F7 P2 - F1	8	
	-		P2 - F2 P2 - F3	Position Change	
-	-		P2 - F4 P2 - F5		
-	-	_	P2 - F6 P2 - F7		
Unloaded Appli	ications				
Туре	Name	Version			
MX269000A MX269000A MX269017A	Phase Noise Power Meter Vector Modulation Analysis	19.00.00 19.00.00 19.00.00	2 2		
MX285051A	5G Measurement	19.00.00			_ (3)
				Set	
				Close	
			Close		

4. Press [Application Switch] and press the button displaying 5G Measurement ([F3] in the screen below).



5. Press [F3] Standard at the Top menu of the 5G NR Measurement Software and select the measurement function matching the base station type from the displayed menu.

Measurement Function	Base Station To Measure
[F3] NR TDD Sub-6 GHz Downlink	Sub-6 GHz TDD Base Station
[F7] NR FDD Sub-6 GHz Downlink	Sub-6 GHz FDD Base Station
[F4] NR mmWave Sub-6 GHz Downlink	mmWave TDD Base Station



Remote Command	Remarks
INST CONFIG	Switch to System Configuration function
*OPC?	Wait for switch to "System Configuration"
SYST:APPL:LOAD BASE5G	Load 5G NR Measurement Software
*OPC?	Wait for load 5G NR measurement software
INST BASE5G	Select 5G NR Measurement Software
*OPC?	Wait to select 5G NR measurement software
RAD:STAN NR_TDD_SUB6GHZ_DL	Select NR TDD Sub-6 GHz Downlink
	Specify following parameters for other than above measurement functions
	NR FDD Sub-6 GHz Downlink: NR_FDD_SUB6GHZ_DL
	NR mmWave Sub-6 GHz Downlink: NR_TDD_MMWAVE_DL

3 5G Base Station Tx Signal Measurement Procedure

3.1 Setting RF Frequency

Set the RF frequency output by the 5G base station to be measured.

[Setting Procedure]

- 1. Press either [F1] at the Top menu or [Frequency] at the front panel.
- 2. Press [F1] Center Frequency at the Frequency menu and input the measured RF frequency.



Remote Command	Remarks
FREQ:CENT 3750MHZ	Set frequency to 3750 MHz

3.2 Setting Test Model

Set the subcarrier spacing, bandwidth, and Test Model type for the measured signal.

[Setting Procedure]

1. Press [F4] Measure at the Top menu → [F1] Modulation Analysis → [F2] Basic Settings to display the Basic Settings dialog.



- Set the parameters at the Basic Settings dialog as follows: Set Test Model, Subcarrier Spacing, and Number of RBs to match the measurement-target base station.
 - Test Model NR-FR1-TM3.1a
 - Test Model Version Auto
 - Subcarrier Spacing 30 kHz
 - Number of RBs 273 (100-MHz Channel Bandwidth)
 - Cell ID 1
 - Phase Compensation Checked

Masic Settings					
Number of Carriers :	1	Ð	Frequency Offse	et [Hz]:	0 ÷
Reference Carrier :	0	÷	Carrier State :	V	
Frame Parameter SlotP	arameter				
Test Model : Test Model Version:	NR-FR1-TM Auto	/3.1a <u>-</u>	•		
Subcarrier Spacing:	30kHz	•	·		
Number of RBs :	273	-	·		
Channel Bandwidth :	100MHz				
Cell ID :		1	-		
Synchronization Mode :	DM-RS for F	PDSCH	1 💌		
Phase Compensation :	$\overline{\mathbf{v}}$				
Copy To All CC				Set	Cancel

Remote Command	Remarks
RAD:TMOD FR1_TM3_1A	Set Test Model to NR-FR1-TM3.1a
RAD:TMOD:VERS AUTO	Set Test Model Version to Auto
RAD:SUBC:SPAC 30	Set Subcarrier Spacing to 30 kHz
RAD:RBL:NUMB 273	Set Number of RBs to 273
CALC:EVM:CELL 1	Set Cell ID to 1
RAD:PCOM ON	Set Phase Compensation to checked

3.3 Executing Auto Range

Execute Auto Range to set the optimum Input Level and attenuator setting matching the input signal.

[Setting Procedure]

- 1. Press [F2] Amplitude at the Top menu or [Amplitude] at the front panel.
- 2. Press [F5] Auto Range.



Remote Command	Remarks
POW:RANG:AUTO ONCE	Execute Auto Range
*OPC?	Wait until execution of Auto Range completed

3.4 Executing Measurement

Measure the 5G base station Tx signal.

[Setting Procedure]

1. Press [Single] at the front panel.

[Remote Command Example]

Remote Command	Remarks
INIT:CONT OFF	Set single sweep
INIT	Execute measurement
*OPC?	Wait until measurement completed

4 Viewing Measurement Results

[See measurement result at Screen]

Display the Summary trace screen using the following procedure. Press [F4] Measure at the Top menu \rightarrow [F1] Modulation Analysis \rightarrow (Page 2 menu) \rightarrow [F1] Trace \rightarrow [F1] Trace Mode \rightarrow [F8] Summary.



Details of measurement results are displayed as follows on the Summary trace screen.

For the 3GPP TS38.141-1 and 3GPP TS38.141-2 Modulation quality, refer to the PDSCH EVM (rms) measurement result displayed in the red frame in the following diagram.

Total EVM (rms) displayed in the blue frame in the following diagram is the EVM measurement result including PDCCH, DM-RS (PDCCH), DM-RS (PDSCH) excluding PDSCH. The EVM of the entire Tx signal including channels/signals other than PDSCH is displayed here.

✓ MS2850A 5G Measurement									
Center Freq. 3 750 000 000 Hz Input Level -9.06 dBm									
Test Mode	Test Mode								
Channel B	Channel B Modulation quality measurement ressult								
Result									
PDSCH EVM (rms)			Freq.	Error		0.10 Hz		
QPSK	*** *	* %				0	.000 ppm		
16QAM 640AM	*** *	* %		Trans	mit Power	-1	2.19 dBm		
256QAM	0.3	5 %		Total	EVM (rms)		0.35 %		
PDSCH EVM (pea	k) / Subcarrie	r / Symbol		Total	EVM (peak)		2.07 %		
QPSK	****	* % ****	****	Sy	mbol Number		149		
16QAM	*** *	* % ****	****	_					
64QAM	*** *	* % ****	/ ****	Тс	otal EVM m	easuremen	t result		
256QAM	2.0	7 % 3275	/ 149						
Summon									
Summary									
Channel Summary									
	Ava EVM	Max EV	M (peal	k)					
Channel	(rms) EVM/Subcarrier/S		rier/Sy	mbol	ibol Avg Power	Symbol Clock Error			
P-SS	*** %	***.** %	****	****	***.*** dBm	IQ Skew	0.002		
S-SS	***.** %	***.** %	****	****	***.*** dBm	IQ Imbalance	-0.003 ns		
PBCH	***.** %	****.** %	****	****	***.*** dBm		-0.001 dB		
DM-RS(PBCH)	***.** %	***.** %	****	****	***.*** dBm	IQ Quad Error	-0.023 dea.		
PDSCH	0.35 %	2.07 %	3275	149	-11.397 dBm				
DM-RS(PDSCH)	0.34 %	1.48 %	1638	221	-11.378 dBm	Cell ID		1	
PDCCH	0.40 %	1.29 %	6	183	-12.179 dBm				
DM-RS(PDCCH)	0.35 %	0.89 %	5	1	-12.195 dBm				
Dofint Dro	Amp Off								
Renint Pre	-Amp On								

[Get measurement results using remore command]

To get measurement results remotely after measurement, the following query command can be used to obtain the measurement results.

FETC:EVM?

Comma-separated measurement results are returned in response to this query command. The correspondence between the order of the measurement results in the response and the measurement results displayed in the Summary trace screen is as follows.

Summary Trace Screen Display	Response Order
PDSCH EVM (rms) QPSK	16th (PDSCH QPSK EVM rms (Average))
PDSCH EVM (rms) 16QAM	23rd (PDSCH 16QAM EVM rms (Average))
PDSCH EVM (rms) 64QAM	30th (PDSCH 64QAM EVM rms (Average))
PDSCH EVM (rms) 256QAM	37th (PDSCH 256QAM EVM rms (Average))
Total EVM (rms)	2nd (Total EVM rms (Average))

5 Troubleshooting

When EVM measurement result is worse than expected

If the measured EVM result is worse than expected, consider that the level of the signal input to the MS2850A/MS269xA is too low. In this case, setting the preamplifier to On may improve the EVM result. The procedure for setting the preamplifier to On is described below.

The Auto Range function does not set the preamplifier On/Off automatically because there is a risk of damaging the MS2850A/MS269xA due to over-input if the preamplifier is set to On at the wrong time.

[Setting Procedure]

Press [F2] Amplitude at the Top menu or press [Amplitude] at the front panel and press [Pre-Amp] to set On. After setting the preamplifier to On, execute Auto Range.



Remote Command	Remarks
POW:GAIN ON	Set preamplifier to On

When Band-Center Subcarrier EVM measurement result is bad

Unlike LTE, 5G NR uses the subcarrier at the center of the band. Consequently, the EVM of the subcarrier at the center of the band can be degraded by carrier leakage from 5G base stations. The impact of carrier leak can be canceled using the following settings.

[Setting Procedure]

Press [F4] Measure at the Top menu or [Measure] at the front panel \rightarrow [F1] Modulation Analysis.



Remote Command	Remarks
CALC:EVM:DC:CANC ON	Set DC Cancellation to On

6 Summary

This simple guide explains how to measure the EVM of NR downlink Test Model signals easily using the MS2850A/MS269xA. MS2850A/MS269xA supports test engineers to evaluate 5G base station without rework and operation mistakes. Therefore, test engineers can evaluate 5G base station smoothly with simple and efficient measurement procedure.

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