Anritsu envision : ensure

5G NR Sub-6 GHz Measurement Methods

Signal Analyzer MS2850A
Vector Signal Generator MG3710A/MG3710E

Contents

1 Introduction

Fifth generation (5G) mobile communications systems use multiple connections to meet the need for increases in mobile data traffic volumes as well as new functions such as ultra-low-latency. In comparison to 4G, they aim to achieve 100 times higher data capacity as well as 90% lower latency and are expected to play a key role in other fields. such as automobile applications, in addition to mobile phone communications. 5G offers end-to-end high-quality communications meeting the needs of every usage scenario. Such networks do not require adjustments meeting every usage and provide optimum functions and quality for each use case and scenario. Implementing 5G requires use of new radio technology (NR) and higher frequency bands, such as mmWave, in addition to existing frequency bands.

The Third Generation Partnership Project (3GPP) determining the standards released the 5G NR non-standalone (NSA) specifications for making connections via multiple radio technologies, such as LTE, in Release 15 in June 2018.
Release 15 presumes the use of frequency bands up to 52.6 GHz and specifies the band from 450 MHz to 6 GHz as FR1 (Frequency Range 1), and from 24.25 GHz to 52.6 GHz as FR2 (Frequency Range 2). FR1 assumes use of the same wired tests as conventional wireless technologies whereas FR2 assumes OTA (Over the Air) testing.

This application note references the 3GPP TS38.104 and TS38.141 Conformance Test specifications, and introduces TRx test measurement examples for wired connections with sub-6 GHz base stations covering FR1 using the Signal Analyzer MS2850A and Vector Signal Generator MG3710A/MG3710E.

2 Standards

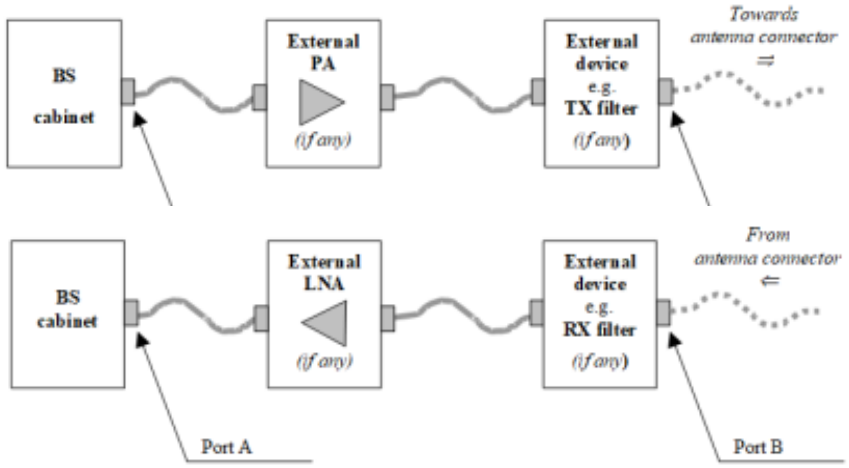
2.1 3GPP

The 3GPP standardization body for wireless systems has defined the following standards for tests of 5G base station wireless characteristics.

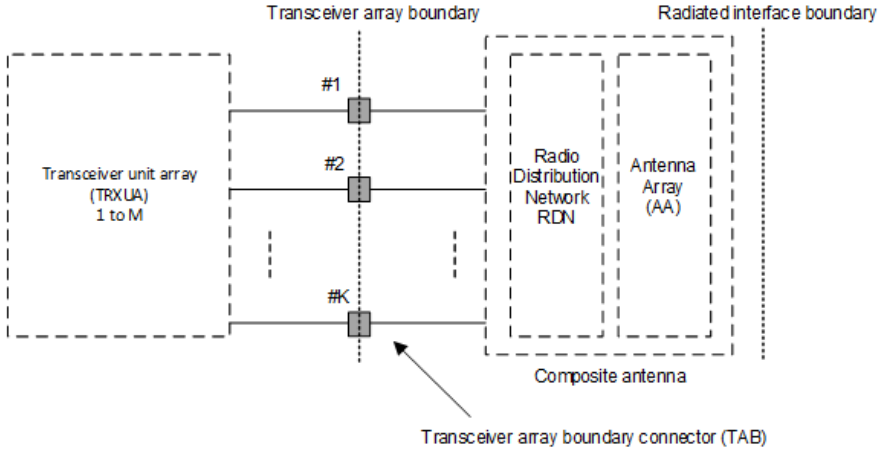
Standard	Contents
TS 38.211 V15.3.0 (2018-09)	PHY Layer Specifications
TS 38.104 V15.4.0 (2019-01)	Base Station (BS) Measurement Conditions
TS 38.141-1 V2.0.0 (2019-01)	Base Station (BS) Conducted Measurement Method
TS 38.141-2 V2.0.0 (2019-01)	Base Station (BS) Radiated Measurement Method

5G base stations are divided into three categories as follows:
- Type1-C: Type with Type with antenna connector (port A) for single transmitter or receiver
- Type1-H: Type with multiple antenna ports for connecting antennas
- Type1-O: Type with integrated antenna

Type1-C
This base station design has an antenna connector (port A) for a single transmitter or receiver, and only supports Conducted tests. In concrete terms, measurement is performed at Port A but attaching an external power amplifier and filter, etc., to the transmitter and receiver also supports measurement at Port B.

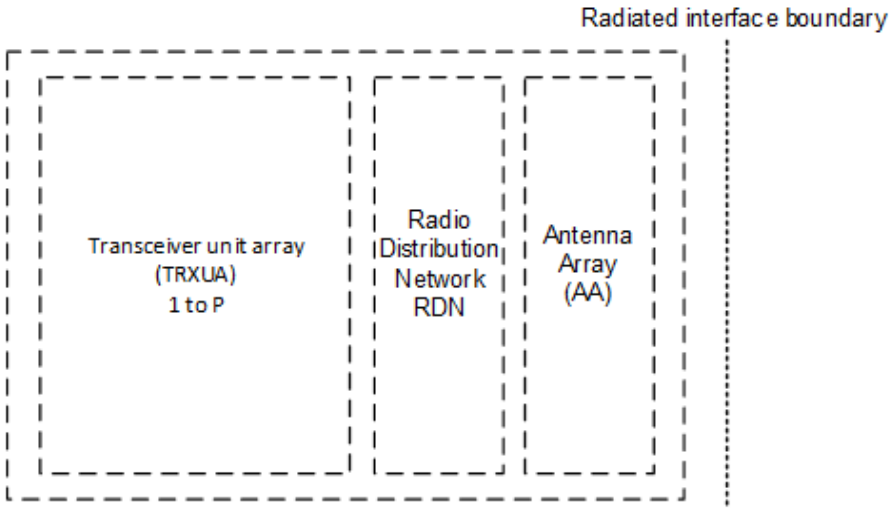


Type1-H
This base station design has multiple separate integrated antennas with multiple antenna ports. Ports other than the measurement port are terminated at the Conducted test. In addition to supporting the Conducted test, it also supports Radiated test items 9.2 Radiated transmit power and 10.2 OTA sensitivity.



Type1-O

This base station design has a transmitter and receiver as well as integrated antennas. Since the antennas cannot be separated, it supports Radiated tests.



Additionally, the standards describe two types of measurement methods—the Conducted method, and the Radiated method assuming OTA measurements.

Comparison of Base Station Types and Measurement Items

Conducted Tx Test

38.104 Item	BS type 1-C	BS type 1-H	BS type 1-O
6.2 BS Output power	✔	✔	-
6.3 Output power dynamics	✔	✔	
6.3.2 RE power control dynamic range	✔	✔	
6.3.3 Total power dynamic range	✔	✔	
6.4 Transmit ON/OFF power	✔	✔	
6.4.1 Transmitter OFF power	✔	✔	
6.4.2 Transmitter transient period	✔	✔	
6.5 Transmitted signal quality	✔	✔	
6.5.1 Frequency error	✔	✔	
6.5.2 Modulation quality	✔	✔	
6.5.3 Time alignment error	✔	✔	
6.6.2 Occupied bandwidth	✔	✔	
6.6.3 ACLR	✔	✔	
6.6.4 Operating band unwanted emissions	✔	✔	
6.6.5 Transmitter spurious emissions	✔	✔	
6.7 Transmitter intermodulation	✔	✔	

Conducted Rx Test

38.104 Item	BS type 1-C	BS type 1-H	BS type 1-O
7.2 Reference sensitivity level	✔	✔	-
7.3 Dynamic range	✔	✔	
7.4 In-band selectivity and blocking	✔	✔	
7.5 Out-of-band blocking	✔	✔	
7.6 Receiver spurious emissions	✔	✔	
7.7 Receiver intermodulation	✔	✔	
7.8 In-channel selectivity	✔	✔	

Radiated Tx Test

38.104 Item	BS type 1-C	BS type 1-H	BS type 1-O
9.2 Radiated transmit power	-	✔	✔
9.3 OTA base station output power		-	✔
9.4 OTA output power dynamics			✔
9.5 OTA transmit ON/OFF power			✔
9.6 OTA transmitted signal quality			✔
9.7.2 OTA occupied bandwidth			✔
9.7.3 OTA ACLR			✔
9.7.4 OTA out-of-band emission			✔
9.7.5 OTA transmitter spurious emission			✔
9.8 OTA transmitter intermodulation			✔

Radiated Rx Test

38.104 Item	BS type 1-C	BS type 1-H	BS type 1-O
10.2 OTA sensitivity	-	✔	✔
10.3 OTA reference sensitivity level		-	✔
10.4 OTA dynamic range			✔
10.5 OTA in-band selectivity and blocking			✔
10.6 OTA out-of-band blocking			✔
10.7 OTA receiver spurious emission			✔
10.8 OTA receiver intermodulation			✔
10.9 OTA in-channel selectivity			✔

2.2 5G Requirements in Japan

In FY2018, the Next-Generation Mobile Communications Systems Committee Report of the Communication Technology Subcommittee of the Council for Information and Communications recommended the following conditions for introducing 5G to Japan.
Measurements are to be made using a measuring instrument such as a spectrum analyzer.

<table>
<tr><td></td><td>Technology (5G NR TDD) using 3.7 GHz and 4.5 GHz bands</td></tr>
<tr><td>Permissible Frequency Error</td><td>Within ±(0.05 ppm + 12 Hz)
With antenna connector and max. antenna power >38 dBm
Without antenna connector and max. antenna power >47 dBm
Within ±(0.1 ppm + 12 Hz)
With antenna connector and max. antenna power <38 dBm
Without antenna connector and max. antenna power <47 dBm
Within ±(0.05 ppm + 12 Hz)
With antenna connector in combination with active antenna and max. antenna power >38 dBm + 10log(N)
Within ±(0.1 ppm + 12 Hz)
Max. antenna power <38 dBm + 10log(N)</td></tr>
<tr><td>Unwanted Emissions in Spurious Domain</td><td>
<table>
<tr><th rowspan="2">Frequency Range</th><th colspan="2">Permissible Value</th><th rowspan="2">Reference BW</th></tr>
<tr><th>With Antenna Connector</th><th>Without Antenna Connector</th></tr>
<tr><td>> 9 kHz ≤ 150 kHz</td><td>-13 dBm</td><td>-</td><td>1 kHz</td></tr>
<tr><td>> 150 kHz ≤ 30 MHz</td><td>–13 dBm</td><td>-</td><td>10 kHz</td></tr>
<tr><td>> 30 MHz ≤ 1000 MHz</td><td>–13 dBm</td><td>–4 dBm</td><td>100 kHz</td></tr>
<tr><td>> 1000 MHz ≤ 12.75 GHz</td><td>–13 dBm</td><td>–4 dBm</td><td>1 MHz</td></tr>
<tr><td>> 12.75 GHz ≤ 5 times upper frequency</td><td>–13 dBm</td><td>–4 dBm</td><td>1 MHz</td></tr>
</table>
<table>
<tr><th rowspan="2">Frequency Range</th><th colspan="2">Permissible Value</th><th rowspan="2">Reference BW</th></tr>
<tr><th>With Antenna Connector</th><th>Without Antenna Connector</th></tr>
<tr><td>> 1884.5 MHz ≤ 1915.7 MHz</td><td>–41 dBm</td><td>–32 dBm</td><td>300 kHz</td></tr>
</table>
</td></tr>
<tr><td>Adjacent Leakage Power</td><td>100 MHz BW
<table>
<tr><th rowspan="2">System</th><th rowspan="2">Regulation Type</th><th rowspan="2">Detuning Frequency</th><th colspan="2">Permissible Value</th><th rowspan="2">Reference BW</th></tr>
<tr><th>With Antenna Connector</th><th>Without Antenna Connector</th></tr>
<tr><td rowspan="4">100 MHz System</td><td>Absolute</td><td>100 MHz</td><td>–13 dBm/MHz</td><td>–4 dBm/MHz</td><td>98.28 MHz</td></tr>
<tr><td>Relative</td><td>100 MHz</td><td>–44.2 dBc</td><td>–44.2 dBc</td><td>98.28 MHz</td></tr>
<tr><td>Absolute</td><td>200 MHz</td><td>–13 dBm/MHz</td><td>–4 dBm/MHz</td><td>98.28 MHz</td></tr>
<tr><td>Relative</td><td>200 MHz</td><td>–44.2 dBc</td><td>–44.2 dBc</td><td>98.28 MHz</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>Spectrum Mask</td><td>100 MHz BW
<table>
<tr><th rowspan="2">Offset Frequency|Δf |(MHz)</th><th colspan="2">Permissible Value</th><th rowspan="2">Reference BW</th></tr>
<tr><th>With Antenna Connector</th><th>Without Antenna Connector</th></tr>
<tr><td>> 0.05 MHz ≤ 5.05MHz</td><td>–4.8 dBm – 7/5 × (Δf – 0.05) dB</td><td>+4.2 dBm – 7/5 × (Δf – 0.05) dB</td><td>100 kHz</td></tr>
<tr><td>> 5.05 MHz ≤ 10.05 MHz</td><td>–11.8 dBm</td><td>–2.8 dBm</td><td>100 kHz</td></tr>
<tr><td>< 10.5 MHz</td><td>–13 dBm</td><td>– 4 dBm</td><td>1 MHz</td></tr>
</table></td></tr>
<tr><td>Occupied Bandwidth</td><td>100 MHz BW
<table>
<tr><th>System</th><th>99% BW</th></tr>
<tr><td>100 MHz System</td><td><100 MHz</td></tr>
</table></td></tr>
<tr><td>Antenna Power</td><td>The permissible antenna power for base stations with an antenna connector must be within ±3.5 dB of the rated antenna power.
The permissible antenna power for base stations without an antenna connector must be within ±3.5 dB of the total rated antenna power.</td></tr>
<tr><td>Tx Intermodulation</td><td>Interference waveforms are defined as follows:
• Adjacent Channel Leakage Power
• Spectrum Mask
• Measured Unwanted Emissions in Spurious Domain

Interference waveforms specifications are:
3.7 GHz Band
Output level: Maximum rated power at antenna connector – 30 dB
Bandwidth: 10 MHz
Detuning frequency: ±5 MHz, ±15 MHz, ±25 MHz

4.5 GHz Band
Output level: Maximum rated power at antenna connector – 30 dB
Bandwidth: 40 MHz
Detuning frequency: ±20 MHz, ±60 MHz, ±100 MHz</td></tr>
</table>

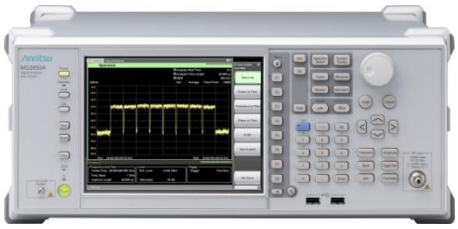
3 Measuring Instruments

This introduces the measuring instruments used in this Application Note.

Signal Analyzer MS2850A

This signal analyzer has the required resolution bandwidth and excellent flatness for development and manufacturing of next-generation wideband communication systems, such as 5G.

Frequency range	9 kHz to 32 GHz or 44.5 GHz (two models)
Analysis bandwidth	255 MHz (standard), 510 MHz (option), 1 GHz (option)
Flatness performance	In-band frequency characteristics (amplitude flatness): ±1.2 dB (nom.) In-band phase linearity (phase flatness): 5˚p-p (nom.)
Measurement software	5G, LTE, LTE-Advanced, W-CDMA, TD-SCDMA, GSM, Vector modulation analysis, etc.



Vector Signal Generator MG3710A/MG3710E

This Vector signal generator with unique functions, such as two-waveform addition function and two RF outputs.

Frequency range	100 kHz to 6 GHz
Baseband bandwidth	160 MHz*/120 MHz (*using built-in baseband generator)
Waveform generation software	5G, LTE, LTE-Advanced, W-CDMA, TD-SCDMA, etc.

Each item can be measured using the MS2850A and MG3710A/MG3710E.

Conducted Tx test

38.104 item	MS2850A	MG3710A/MG3710E
6.2 BS output power	✔	-
6.3.2 RE power control dynamic range	✔	-
6.3.3 Total power dynamic range	✔	-
6.4.1 Transmitter OFF power	✔	-
6.4.2 Transmitter transient period	✔	-
6.5.1 Frequency error	✔	-
6.5.2 Modulation quality	✔	-
6.5.3 Time alignment error	✔	-
6.6.2 Occupied bandwidth	✔	-
6.6.3 ACLR	✔	-
6.6.4 Operating band unwanted emissions	✔	-
6.6.5 Transmitter spurious emissions	✔	-
6.7 Transmitter intermodulation	✔	✔(NR-FR1-TM1.1)

Conducted Rx test

38.104 item	MS2850A	MG3710A/MG3710E
7.2 Reference sensitivity level	-	✔
7.3 Dynamic range	-	✔
7.4 In-band selectivity and blocking	-	✔
7.5 Out-of-band blocking	-	✔
7.6 Receiver spurious emissions	✔	-
7.7 Receiver intermodulation	-	✔
7.8 In-channel selectivity	-	✔

4 Measurements

This section explains the measurement contents in concrete terms for the Conducted Tx Tests in the 3GPP standards.

4.1 Conducted Tx Tests

4.1.1 BS Output Power

Measurement Outline

The maximum output power from the base station is measured.

Measurement Standards

The deviation from the maker's specifications is found and evaluated against the standards.

Normal test environment	f ≤ 3.0 GHz	±2.7 dB
	3.0 GHz <f≤ 6.0 GHz	±3.0 dB
Extreme test environment	f ≤ 3.0 GHz	±3.2 dB
	3.0 GHz < f ≤ 6.0 GHz	±3.5 dB

Measurement Conditions

Test Model	NR-FR1-TM1.1
Signal Analyzer Application Software	5G NR sub-6 GHz Downlink Software

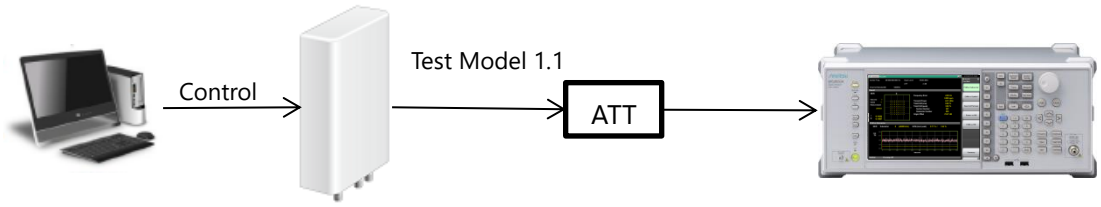
Measurement Method

(1) Output NR-FR1-TM1.1 from the base station.
(2) Measure the Mean Power.
(3) Measure each of the upper, middle, and lower frequencies in the assigned frequency range.

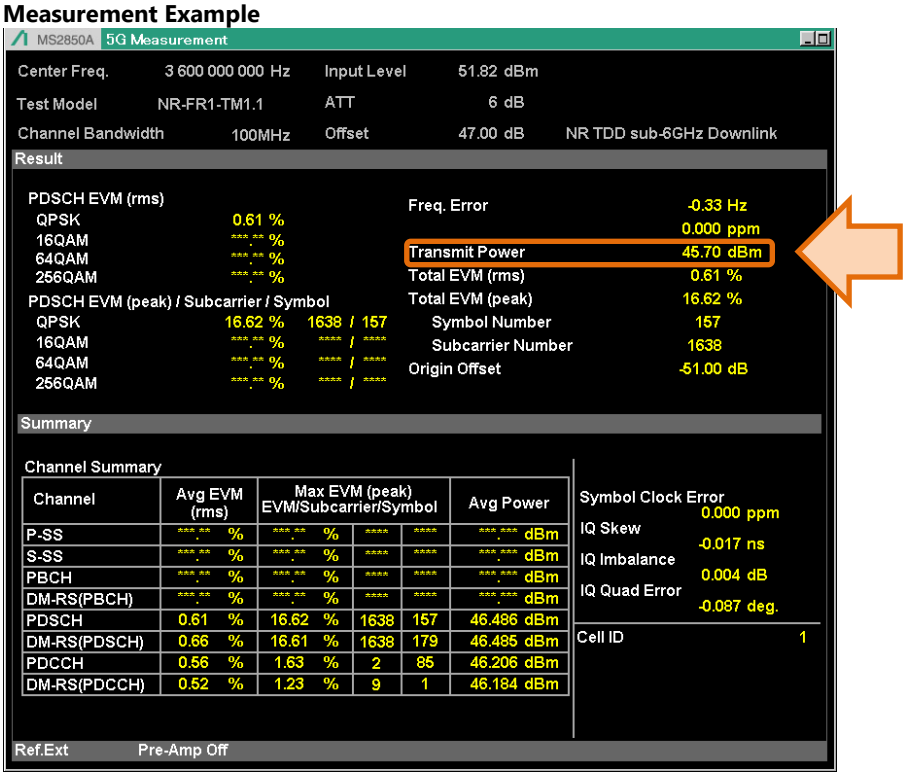
Key Points

• Insert an attenuator between the base station and the signal analyzer and adjust the power to the signal analyzer.
• With multiple ports, terminate all output ports except the port being measured.

Setup



Measurement Example



4.1.2 RE Power Control Dynamic Range

Measurement Outline

The difference between the actually measured value and the set RE power is measured.
This measurement is included in the Modulation Quality items, so refer to section 4.1.5. Transmitted signal quality.

Specifications

RE Modulation Scheme	RE Power Control Dynamic Range (dB)	
	(Down)	(Up)
QPSK (PDCCH)	–6	+4
QPSK (PDSCH)	–6	+3
16QAM (PDSCH)	–3	+3
64QAM (PDSCH)	0	0
256QAM (PDSCH)	0	0
Note: The output power per carrier shall always be less or equal to the maximum output power of the base station.		

4.1.3 Total Power Dynamic Range

Measurement Outline

The difference between the power in the Full RB condition (Test Model 3.1) and the power in the Signal RB condition (Test Model 2) is measured.
This is expected to be supported by future analysis software because OFDM symbols for comparison are still undefined at present.

Specifications

BS Channel Bandwidth (MHz)	Total Power Dynamic Range (dB)		
	15 kHz SCS	30 kHz SCS	60 kHz SCS
5	13.5	10	N/A
10	16.7	13.4	10
15	18.5	15.3	12.1
20	19.8	16.6	13.4
25	20.8	17.7	14.5
30	21.6	18.5	15.3
40	22.9	19.8	16.6
50	23.9	20.8	17.7
60	N/A	21.6	18.5
70	N/A	22.3	19.2
80	N/A	22.9	19.8
90	N/A	23.4	20.4
100	N/A	23.9	20.9

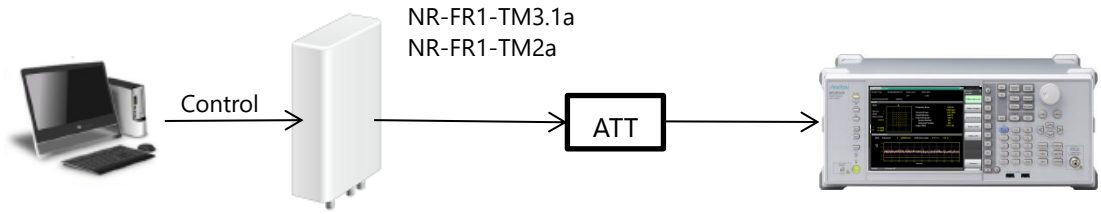
Measurement Conditions

Test Model	When 256QAM supported without power back-off NR-FR1-TM3.1a NR-FR1-TM2a When 256QAM not supported NR-FR1-TM3.1 NR-FR1-TM2 When 256QAM supported with power back-off NR-FR1-TM3.1 NR-FR1-TM2a
Signal Analyzer Application Software	5G NR sub-6 GHz Downlink Software

Measurement Methods

(1) Output NR-FR1-TM3.1a from the base station.
(2) Measure the averaged OFDM symbol power.
(3) Output NR-FR1-TM2a from the base station.
(4) Measure the averaged OFDM symbol power.
(5) Compare the values obtained in step (2) and (4).

Setup



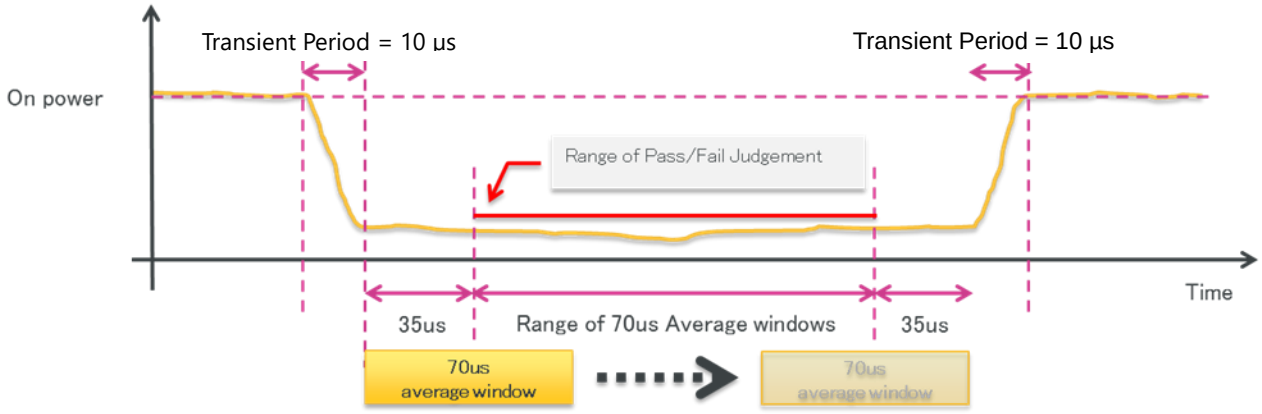
4.1.4 Transmit ON/OFF Power

Measurement Outline

There are two measurement types as follows:

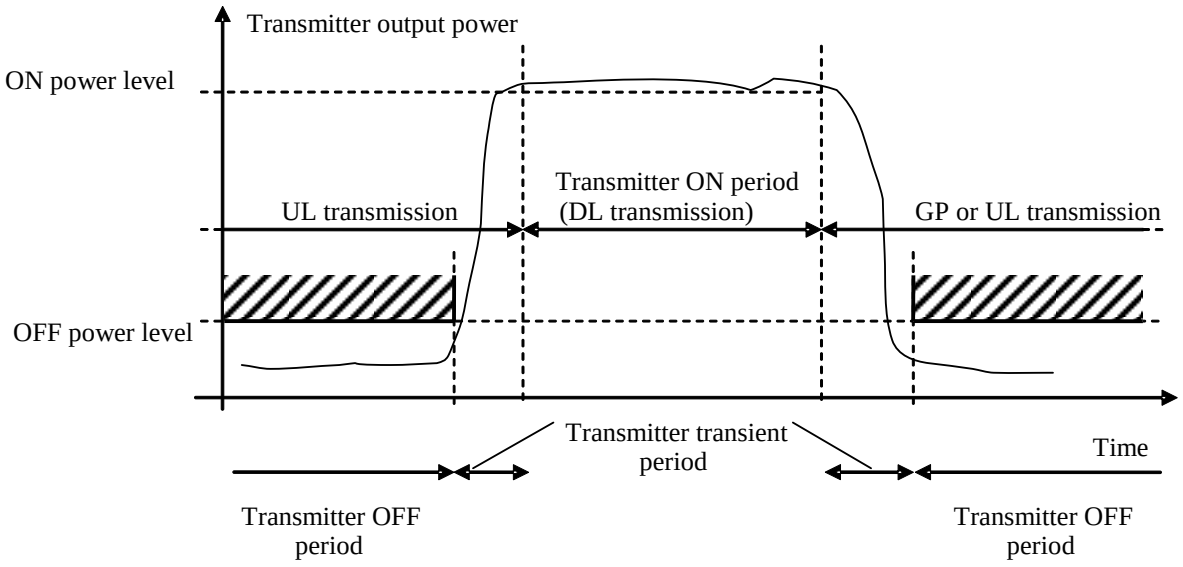
- Transmit OFF power
  Average power at base station OFF period
- Transmitter transient period
  Transition time from OFF to ON, or ON to OFF period

The average power at the OFF period is measured as the average of the 70/N μs period (N: SCS/15, SCS: Sub Carrier Spacing (kHz)) filtered by a wideband filter equal to the bandwidth around the center of the channel frequency assigned during the base station OFF period. For example, at SCS 15 kHz, N = 1 and the average power is measured for 70 μs.



The 70 μs Average windows are arranged with no gap (can overlap) from [ON period + 10 μs + 35 μs] to [Next ON period – 10 μs – 35 μs]

OFF 区間から ON 区間または ON 区間から OFF 区間への遷移時間は、以下の図のように規定されています。



Relation between Transmitter ON Period, Transmitter OFF Period and Transmitter Transient Period

Definition of Transient Period

In this Application Note, the measured transient time is defined as follows:

- Transition from Tx ON period to Tx OFF period (Ramp down):

This is the time from the end of the downlink subframe based on the frame header to the point lower than the Tx OFF power threshold value.

- Transition from Tx OFF period to Tx ON period (Ramp up):

This is the time from the point higher than the Tx OFF power threshold value to the start of the next downlink subframe based on the frame header.

Specifications

Transmit OFF Power

BS Type	BS Output Power
1-C	≤–85 dBm/MHz per antenna connector
1-H	≤–85 dBm/MHz per TAB connector

Transient Period

Transition	Transient Period Length (μs)
OFF to ON	10
ON to OFF	10

OFF Power Level at Transient Period Measurement

BS Type	BS Output Power
1-C	–83 dBm/MHz for carrier frequency f ≤ 3.0 GHz –82.5 dBm/MHz for carrier frequency 3.0 GHz < f ≤ 6.0 GHz
1-H	–83 dBm/MHz for carrier frequency f ≤ 3.0 GHz. –82.5 dBm/MHz for carrier frequency 3.0 GHz < f ≤ 6.0 GHz

Measurement Conditions

Signal Analyzer Application Software	Signal Analyzer Mode
Signal Analyzer Settings	Mode: Power vs Time Trigger Source: External 1 Span: 125 MHz Detector: RMS RBW Filter Type: Rect Trace Points: 10001 Boost Average Power Function Pre-amplifier: On Storage: Lin Average Average Count: 100

Measurement Method

(1) Output a signal from the base station.

(2) Set Marker 1 and Marker 2 to the 70/N μs period and measure the Tx OFF power. Since the Filter BW is 100 MHz, calculate the value by conversion to 1 MHz. For example, –67 dBm at Filter BW of 100 MHz converts to –87 dBm at Filter BW of 1 MHz.

(3) Set Marker 1 to the downlink subframe end time and Marker 2 to the point lower than the Tx OFF power threshold value to measure the transition time from the Tx ON period to the OFF period.
Calculate the threshold value by conversion to Filter BW of 100 MHz. For example, –83 dBm at Filter BW of 1 MHz converts to –63 dBm at Filter BW of 100 MHz.

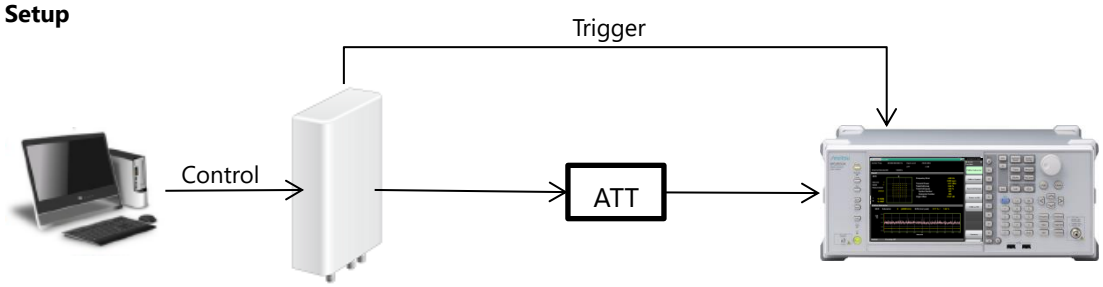
(4) Set Marker 1 to the point lower than the Tx OFF power threshold and Marker 2 to the start of the next downlink subframe to measure the transition time from the Tx OFF period to the ON period.
Calculate the threshold value by conversion to Filter BW of 100 MHz. For example, –83 dBm at Filter BW of 1 MHz converts to –63 dBm at Filter BW of 100 MHz.

Key Points

• Input the trigger signal from the base station to the measuring instrument to control the measurement timing.

• At single-band use, measure at the center frequency in the assigned frequency range. At multi-band use, measure at the upper, middle, and lower frequencies in the assigned frequency range.

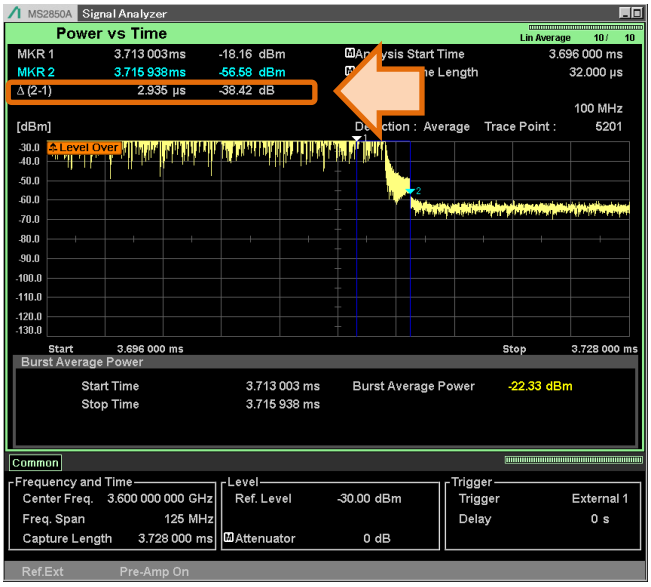
Setup



Measurement Examples

Tx OFF Power

Transient Time



4.1.5 Transmitted Signal Quality

Measurement Outline

The frequency error and EVM are measured.
This is performed by measuring the RE power control dynamic range and Total power dynamic range simultaneously.

Specifications

Frequency Error

BS Class	Frequency Error Accuracy
Wide Area BS	±(0.05 ppm + 12 Hz)
Medium Range BS	±(0.1 ppm + 12 Hz)
Local Area BS	±(0.1 ppm + 12 Hz)

EVM

PDSCH Modulation Scheme	Required EVM
QPSK	18.5%
16QAM	13.5%
64QAM	9%
256QAM	4.5%

Measurement Conditions

Test Model	At Frequency Error Measurement NR-FR1-TM2, NR-FR1-TM2a, NR-FR1-TM3.1, NR-FR1-TM3.1a, NR-FR1-TM3.2, NR-FR1-TM3.3 At EVM Measurement NR-FR1-TM3.1, NR-FR1-TM3.1a, NR-FR1-TM3.2, NR-FR1-TM3.3
Signal Analyzer Application Software	5G NR sub-6 GHz Downlink Software

Relationship between Base Station Modulation Scheme and Test Model

Base Station Modulation Scheme	Test Model					
	TM3.1a	TM3.1	TM3.2	TM3.3	TM2a	TM2
256QAM without power back-off	✔				✔	
256QAM with power back-off		✔			✔	
64QAM			✔			✔
16QAM				✔		✔
QPSK						✔

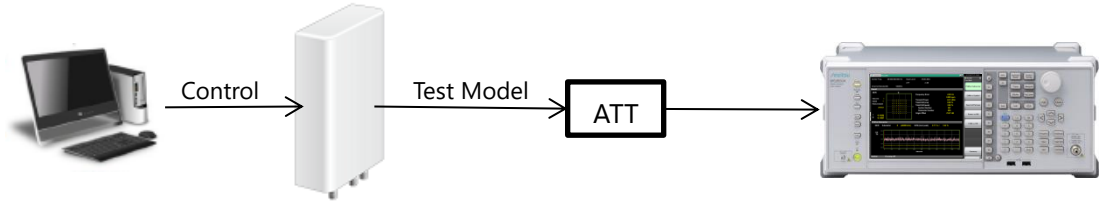
Measurement Methods

(1) Output NR-FR1-TM3.1a from the base station.
(2) Measure the frequency error and EVM.
(3) Output NR-FR1-TM2a from the base station.
(4) Measure the frequency error and EVM.
(5) Measure at each of the upper, middle, and lower frequencies in the assigned frequency range.

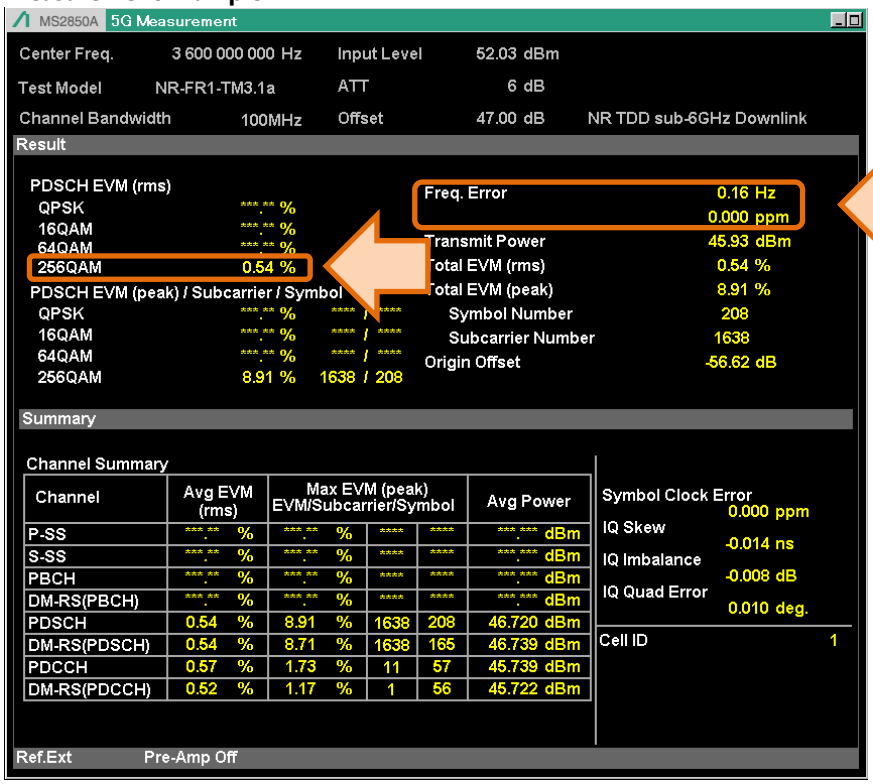
Key Point

• The window length must be set at EVM measurement.
The measurement software is set to ON by default.

Setup



Measurement Example



4.1.6 Time Alignment Error

Measurement Outline

The timing difference between the frame timing at each antenna is measured for Tx diversity, MIMO, and carrier aggregation (CA), and for each combination of these.

Specifications

MIMO, etc., Combination	Specification
MIMO or TX diversity transmissions, at each carrier frequency	65 ns
Intra-band contiguous carrier aggregation, with or without MIMO or TX diversity	260 ns
Intra-band non-contiguous carrier aggregation, with or without MIMO or TX diversity	3 µs
Inter-band carrier aggregation, with or without MIMO or TX diversity	3 µs

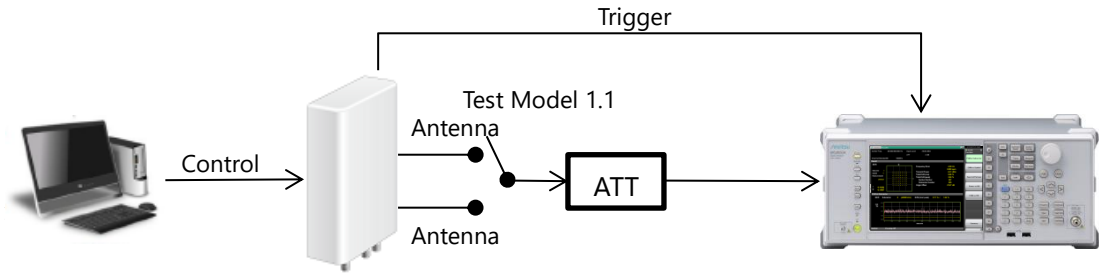
Measurement Conditions

Test Model	NR-FR1-TM 1.1
Signal Analyzer Application Software	5G NR sub-6 GHz Downlink Software

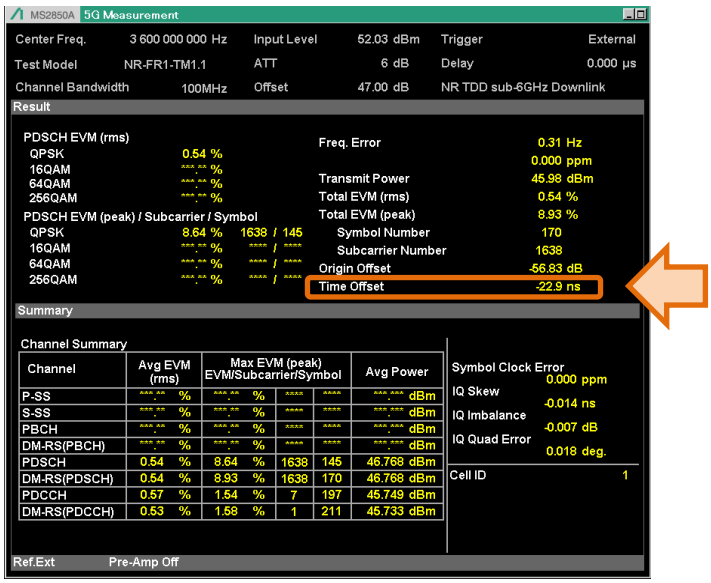
Measurement Methods

(1) Output the signal from Antenna Port 1 of the base station.
(2) Measure the Time Offset.
(3) Output the signal from Antenna Port 2 of the base station.
(4) Measure the Time Offset.
(5) Use the external PC to calculate the difference in the results between Antenna Port 1 and Antenna Port 2.

Setup



Measurement Example



4.1.7 Occupied Bandwidth

Measurement Outline

The frequency bandwidth occupying 0.5% of the total Tx power for each of the upper and lower frequency bands is measured.

Specifications

The occupied bandwidth for each NR Carrier wave must be smaller than the BS channel bandwidth. For in-band contiguous CA, the occupied bandwidth must be less than the aggregate BS channel bandwidth.

Measurement Conditions

Test Model	NR-FR1-TM1.1
Signal Analyzer Application Software	Spectrum Analyzer
Signal Analyzer Settings	Measurement Mode: OBW measurement function, 99% rule (using template) Span: Twice spectrum bandwidth RBW: 100 kHz VBW: 300 kHz Detector: Positive Trace Points: 10001 Storage: Max Hold Average Count: 100

Span and Measurement Points Settings

Bandwidth	BS Channel Bandwidth BWChannel (MHz)				Aggregated BS Channel Bandwidth BWChannel_CA（MHz）
	5	10	15	>20	>20
Span (MHz)	10	20	30	$2 \times BW_{Channel}$	$2 \times BW_{Channel\_CA}$
Minimum number of measurement points	400	400	400	$\left\lceil \frac{2 \times BW_{Channel}}{100kHz} \right\rceil$	$\left\lceil \frac{2 \times BW_{Channel\_CA}}{100kHz} \right\rceil$

Measurement Methods

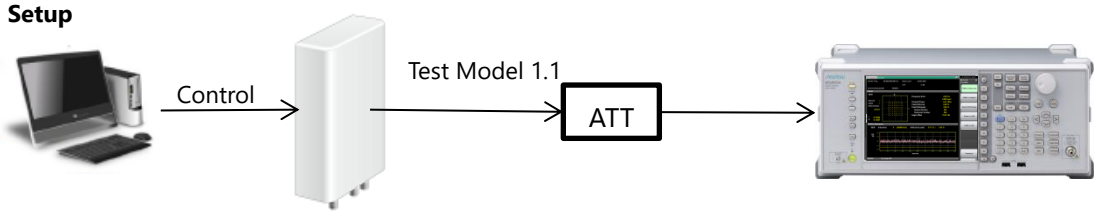
(1) Output NR-FR1-TM1.1 from the base station

(2) Measure the OBW using the OBW measurement function.

Key Point

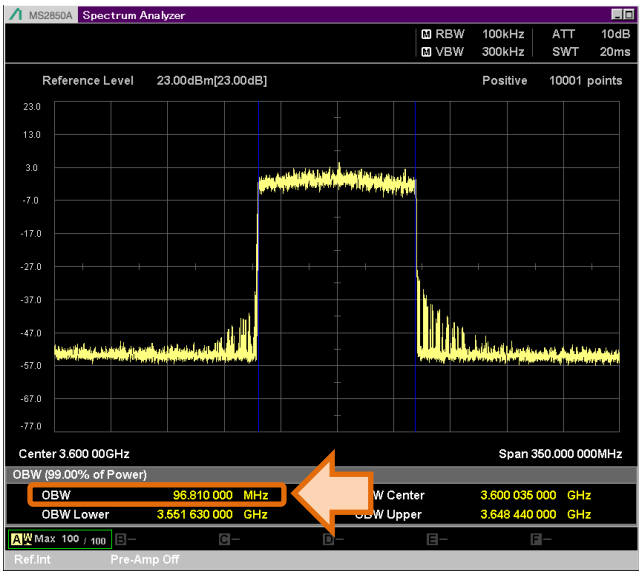
• When using a single carrier, measure at the center frequency in the assigned frequency range. When using contiguous multi-carriers, measure at the center frequency in the assigned frequency range.

Setup

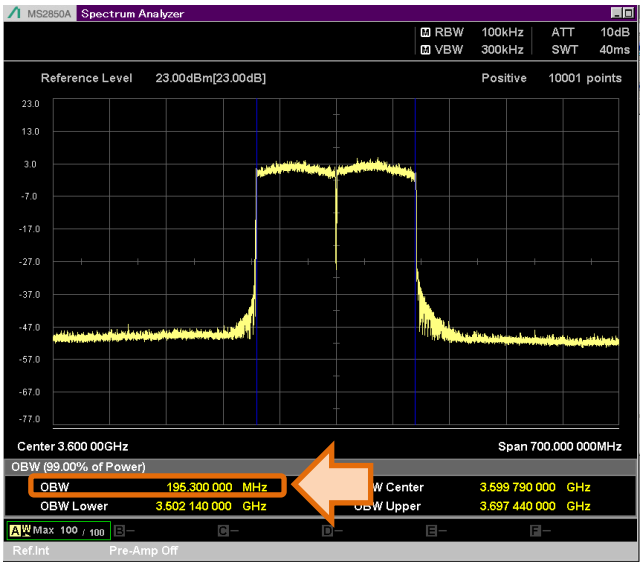


Measurement Examples

Single Carrier Measurement



Contiguous Multi-carrier Measurement



4.1.8 Adjacent Channel Leakage Power Ratio

Measurement Outline

The ratio between the adjacent channel average power and the average power of the assigned frequency band is measured.

Specifications

BS channel bandwidth of lowest/highest NR carrier transmitted BWChannel (MHz)	BS adjacent channel center frequency offset below lowest or above highest carrier center frequency transmitted	Assumed adjacent channel carrier (informative)	Filter on adjacent channel frequency and corresponding filter bandwidth	ACLR limit
5, 10, 15, 20	$BW_{Channel}$	NR of same BW (Note 2)	Square (BW_{Config})	44.2 dB
	2 x $BW_{Channel}$	NR of same BW (Note 2)	Square (BW_{Config})	44.2 dB
	$BW_{Channel}$ /2 + 2.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	44.2 dB (Note 3)
	$BW_{Channel}$ /2 + 7.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	44.2 dB (Note 3)
25, 30, 40, 50, 60, 70, 80, 90, 100	$BW_{Channel}$	NR of same BW (Note 2)	Square (BW_{Config})	43.8 dB
	2 x $BW_{Channel}$	NR of same BW (Note 2)	Square (BW_{Config})	43.8 dB
	$BW_{Channel}$ /2 + 2.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	43.8 dB (Note 3)
	$BW_{Channel}$ /2 + 7.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	43.8 dB (Note 3)
Note 1: $BW_{Channel}$ and BW_{Config} are the BS channel bandwidth and transmission bandwidth configuration of the lowest/highest NR carrier transmitted on the assigned channel frequency. Note 2: With SCS providing largest transmission bandwidth configuration (BW_{Config}). Note 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.				

The following specifications are the absolute values and are applied when the above specifications are severe.

BS Category/BS Class	ACLR Absolute Basic Limit
Category A Wide Area BS	–13 dBm/MHz
Category B Wide Area BS	–15 dBm/MHz
Medium Range BS	–25 dBm/MHz
Local Area BS	–32 dBm/MHz

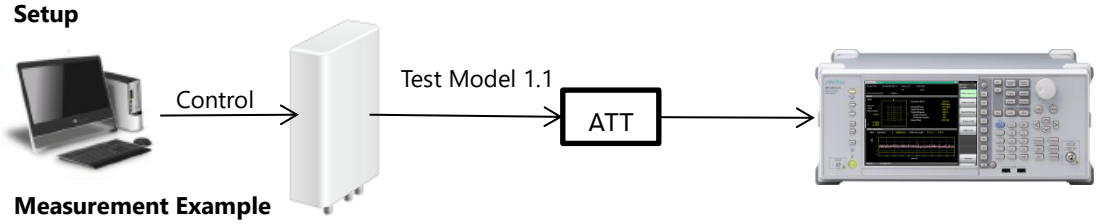
Measurement Conditions

Test Model	NR-FR1-TM1.1
Signal Analyzer Application Software	Spectrum Analyzer
Signal Analyzer Settings	Measurement Mode: ACP measurement function (using template) RBW: 100 kHz RBW Filter Type: Rect (RBW filter type setting is unnecessary because Rect is standard.) Detector: RMS Trace Point: 10001 Storage: Lin Average Average Count: 100

Measurement Methods

(1) Output NR-FR1-TM1.1 from the base station.
(2) Measure ACLR using the ACP measurement function.
(3) Measure at each of the upper, middle, and lower frequencies in the assigned frequency range.

Setup



Measurement Example

4.1.9 Operating Band Unwanted Emissions

Measurement Outline

The spurious near the assigned frequency range is measured.

Specifications

Wide Area BS Operating Band Unwanted Emission Limits (NR bands >3 GHz) for Category A

Frequency Offset of Measurement Filter 3 dB Point, Δf	Frequency Offset of Measurement Filter Center Frequency, f_offset	Basic Limit (Note 1, 2)	Measurement Bandwidth
0 MHz ≤ Δf < 5 MHz	0.05 MHz ≤ f_offset < 5.05 MHz	$-5.2dBm-\frac{7}{5}\cdot\left(\frac{f\_offset}{MHz}-0.05\right)dB$ –5.2 dBm@f_offset 0.05 MHz –12.2 dBm@ f_offset 5.05 MHz	100 kHz
5 MHz ≤ Δf < Min (10 MHz, Δfmax)	5.05 MHz ≤ f_offset < Min (10.05 MHz, f_offsetmax)	–12.2 dBm	100 kHz
10 MHz ≤ Δf ≤ Δfmax	10.5 MHz ≤ f_offset < f_offsetmax	–13 dBm (Note 3)	1MHz

Note 1: For a BS supporting non-contiguous spectrum operation within any operating band, the emission limits within sub-block gaps are calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the sub-block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. The exception is Δf ≥ 10 MHz from both adjacent sub-blocks on each side of the sub-block gap, where the emission limits within sub-block gaps shall be –13 dBm/1 MHz.

Note 2: For a multi-band connector with Inter RF Bandwidth gap < 2*ΔfOBUE, the emission limits within the Inter RF Bandwidth gaps are calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or RF Bandwidth.

Note 3: The requirement is not applicable when Δfmax < 10 MHz.

Maximum Offset of Operating Band Unwanted Emissions Outside Downlink Operating Band

BS Type	Operating Band Characteristics	Δfmax (MHz)
BS type 1-C	Assigned frequency range ≤ 200 MHz	10
	200 MHz < Assigned frequency range ≤ 900 MHz	40
BS type 1-H	Assigned frequency range ≤ 200 MHz	10
	200 MHz < Assigned frequency range ≤ 900 MHz	40

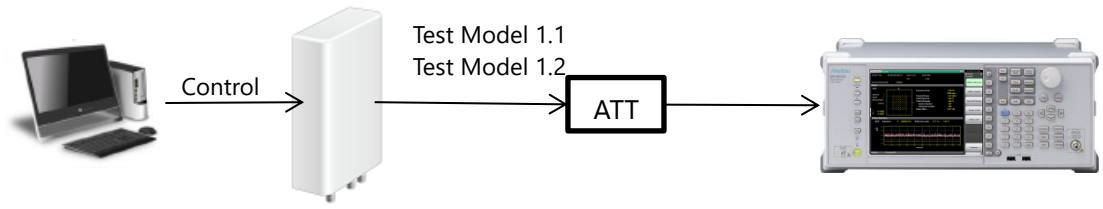
Measurement Conditions

Test Model	NR-FR1-TM1.1, NR-FR1-TM1.2
Signal Analyzer Application Software	Spectrum Analyzer
Signal Analyzer Settings	Measurement Mode: SEM measurement function (using template) Detector: RMS

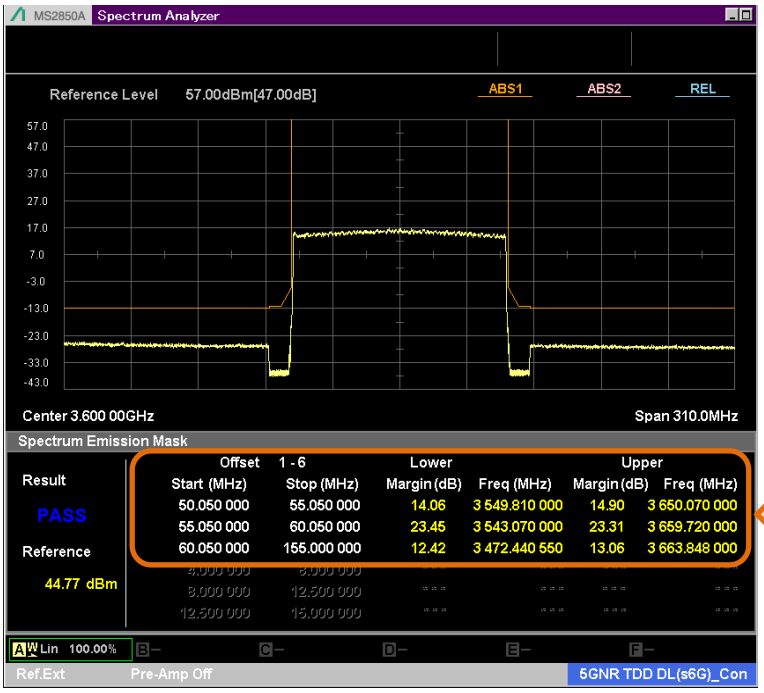
Measurement Methods

(1) Output NR-FR1-TM1.1 from the base station.
(2) Measure the spurious using the SEM measurement function.
(3) Measure at each of the upper, middle, and lower frequencies in the assigned frequency range.

Setup



Measurement Example



4.1.10 Transmitter Spurious Emissions

Measurement Outline

Spurious measurement is performed from 9 kHz to the fifth harmonic excluding the operating bandwidth unwanted emission measurement range.

Specifications

Tx General BS Transmitter Spurious Emission Limits in FR1, Category A

Spurious Frequency Range	Basic Limit	Measurement Bandwidth	Notes
9 kHz to 150 kHz	–13 dBm	1 kHz	Note 1, Note 4
150 kHz to 30 MHz		10 kHz	Note 1, Note 4
30 MHz to 1 GHz		100 kHz	Note 1
1 GHz to 12.75 GHz		1 MHz	Note 1, Note 2
12.75 GHz to 5th harmonic of upper frequency edge of DL operating band in GHz		1 MHz	Note 1, Note 2, Note 3
Note 1: Measurement bandwidths as in ITU-R SM.329 [2], s4.1. Note 2: Upper frequency as in ITU-R SM.329 [2], s2.5 Table 1. Note 3: This spurious frequency range applies only for operating bands for which the 5th harmonic of the upper frequency edge of the DL operating band exceeds 12.75 GHz. Note 4: This spurious frequency range applies only to BS type 1-C and BS type 1-H.			

Rx

BS Class	Frequency Range	Basic Limit	Measurement Bandwidth
Wide Area BS	Assigned uplink frequency range	–96 dBm	100 kHz
Medium Range BS		–91 dBm	
Local Area BS		–88 dBm	

Measurement Conditions

Test Model	NR-FR1-TM1.1
Signal Analyzer Application Software	Spectrum Analyzer
Signal Analyzer Settings	Detector: RMS Trace Points: 10001 Storage: Lin Average Average Count: 100

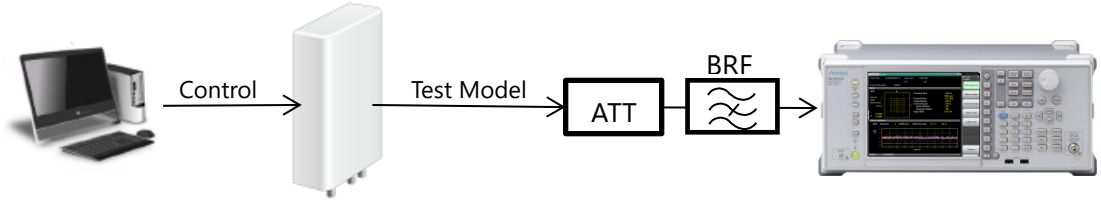
Measurement Methods

(1) Output NR-FR1-TM1.1 from the base station.
(2) Set the spectrum analyzer measurement range.
(3) Measured the spurious in the measurement range.

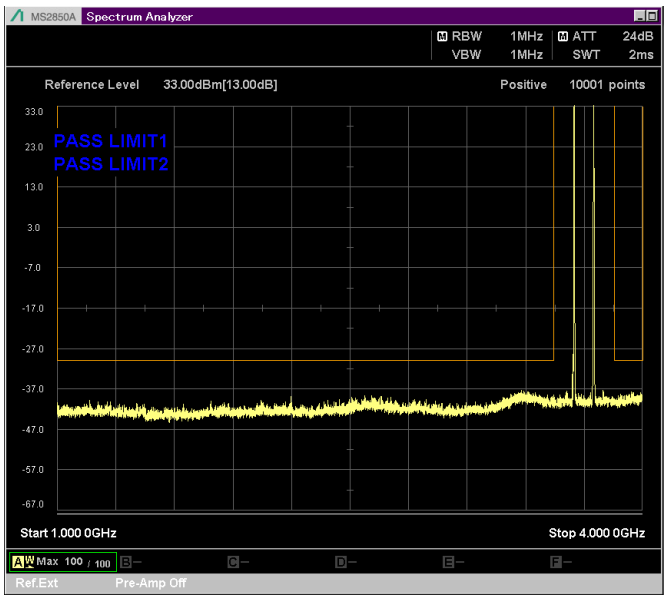
Key Point

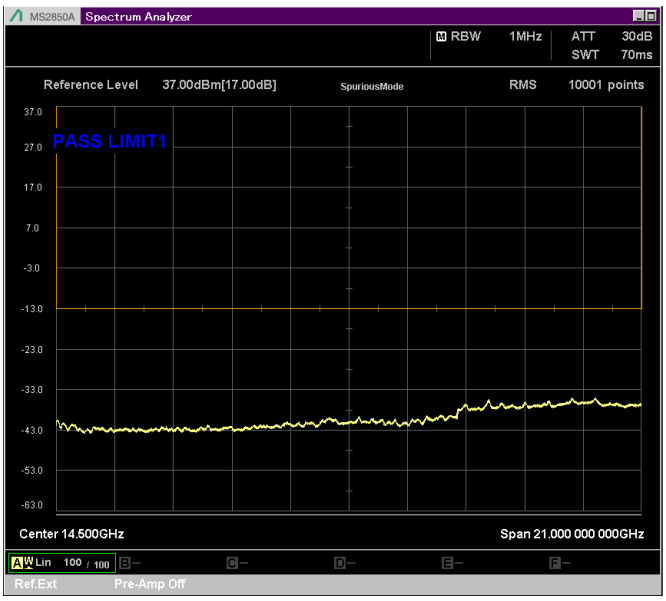
• Insert a band rejection filter (BRF) into the measurement system to cut the carrier.

Setup



Measurement Examples





4.1.11 Transmitter Intermodulation

Measurement Outline

The intermodulation performance when receiving an interfering signal (6.6.3 ACLR, 6.6.4 Unwanted Emissions, 6.6.5 Spurious Emissions) is measured.

Measurements

- Adjacent Channel Leakage Power Ratio
- Operating Band Unwanted Emissions
- Transmitter Spurious Emissions

Interfering Signal Specifications

Parameter	Value
Interfering signal type	NR signal, supported minimum BS channel bandwidth ($BW_{Channel}$) with 15 kHz SCS of band
Interfering signal level	Rated total output power (P rated, t, AC) in operating band –30 dB
Interfering signal center frequency offset from lower/upper edge of wanted signal or edge of sub-block inside sub-block gap	$f_{offset} = \pm BW_{Channel}\left(n - \frac{1}{2}\right)$, for n = 1, 2, and 3 When BWChannel = 100 MHz 100 MHz/2 + 50 MHz, 100 MHz/2 – 50 MHz 100 MHz/2 + 150 MHz, 100 MHz/2 – 150 MHz 100 MHz/2 + 250 MHz, 100 MHz/2 – 250 MHz
Note: Interfering signal positions that are partially or completely outside any downlink operating band of the base station are excluded from the requirement, unless the interfering signal positions fall within the frequency range of adjacent downlink operating bands in the same geographical area. When none of the interfering signal positions fall completely within the frequency range of the downlink operating band, 3GPP TS 38.141-1 [5] provides further guidance regarding appropriate test requirements.	

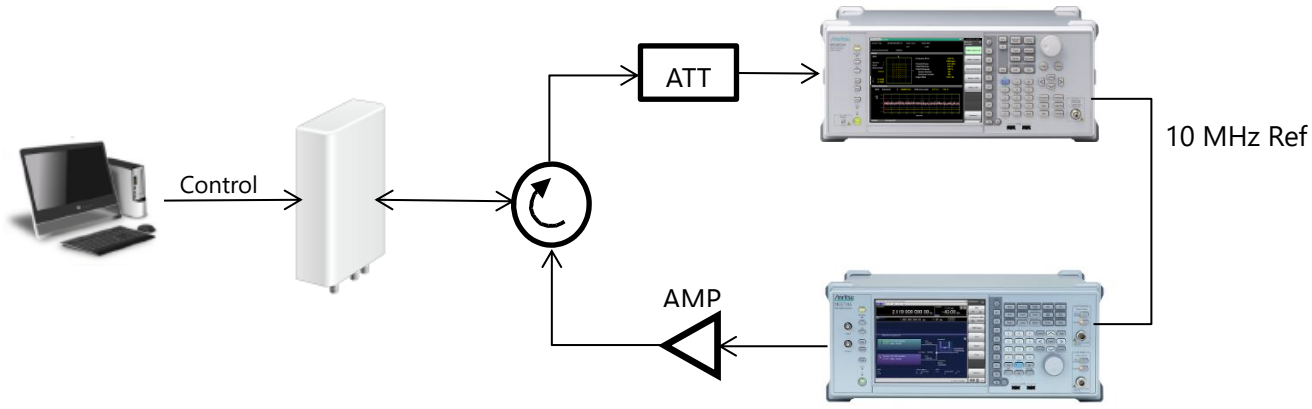
Measurement Methods

(1) Output NR-FR1-TM1.1 from the base station.
(2) Output the NR-FR1-TM1.1 interfering wave from this signal generator
(3) Measure the ACLR, unwanted emissions, and spurious emissions.

Key Point

• At measurement, input the interfering wave using a directional coupler to couple the signals. Choose the part so that the DUT signal does not affect the interfering wave signal generator.

Setup



4.2 Conducted Rx Test

4.2.1 Reference sensitivity level

Measurement outline

This measures throughput even when the wanted signal level is low.

Specifications

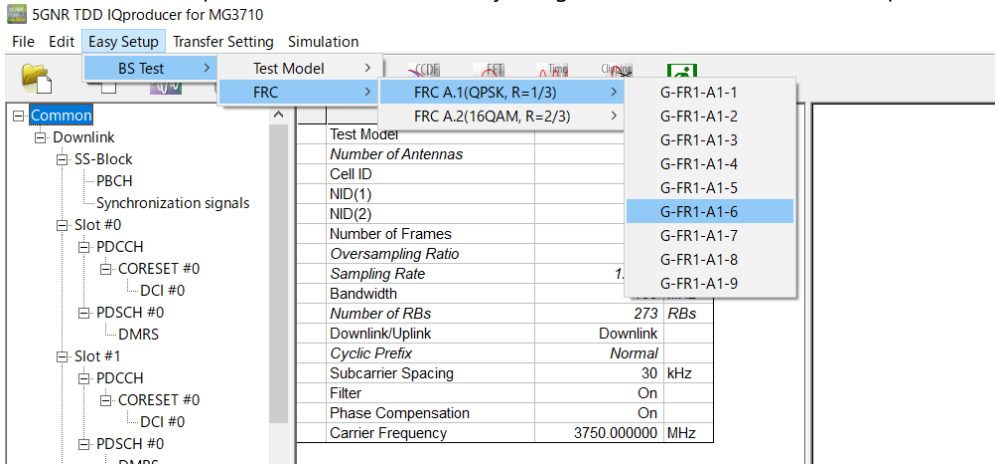
NR Wide Area BS reference sensitivity levels

BS channel bandwidth (MHz)	Sub-carrier spacing (kHz)	Reference measurement channel	Reference sensitivity power level, $P_{REFSENS}$ (dBm)		
			≤ 3.0 GHz	3.0 GHz < f ≤ 4.2 GHz	4.2 GHz < f ≤ 6.0 GHz
5, 10, 15	15	G-FR1-A1-1	–101	–100.7	–100.5
10, 15	30	G-FR1-A1-2	–101.1	–100.8	–100.6
10, 15	60	G-FR1-A1-3	–98.2	–97.9	–97.7
20, 25, 30, 40, 50	15	G-FR1-A1-4	–94.6	–94.3	–94.1
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	–94.9	–94.6	–94.4
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	–95	–94.7	–94.5

Measurement conditions

FRC (Fixed Reference Channel)	Select from the above table according to the base-station bandwidth and SCS.

The FRC waveform pattern can be created easily using the 5G NR sub-6 GHz TDD IQproducer Easy Setup mode.



Measurement method

(1) Set the waveform pattern signal output from the signal generator.
(2) Set the output level.
(3) Measure the Throughput at the base station and confirm that it is ≥95%.
(4) Measure the Throughput at each of the upper, middle, and lower frequencies of the allocated frequency range.

Setup

4.2.2 Dynamic range

Measurement outline
This measures the Throughput in the presence of an interference signal.

Specifications
Wide Area BS dynamic range

BS channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interference signal mean power (dBm)/BWConfig	Type of interference signal
5	15	G-FR1-A2-1	–70.4	–82.5	AWGN
	30	G-FR1-A2-2	–71.1		
10	15	G-FR1-A2-1	–70.4	–79.3	AWGN
	30	G-FR1-A2-2	–71.1		
	60	G-FR1-A2-3	–68.1		
15	15	G-FR1-A2-1	–70.4	–77.5	AWGN
	30	G-FR1-A2-2	–71.1		
	60	G-FR1-A2-3	–68.1		
20	15	G-FR1-A2-4	–64.2	–76.2	AWGN
	30	G-FR1-A2-5	–64.2		
	60	G-FR1-A2-6	–64.5		
25	15	G-FR1-A2-4	–64.2	–75.2	AWGN
	30	G-FR1-A2-5	–64.2		
	60	G-FR1-A2-6	–64.5		
30	15	G-FR1-A2-4	–64.2	–74.4	AWGN
	30	G-FR1-A2-5	–64.2		
	60	G-FR1-A2-6	–64.5		
40	15	G-FR1-A2-4	–64.2	–73.1	AWGN
	30	G-FR1-A2-5	–64.2		
	60	G-FR1-A2-6	–64.5		
50	15	G-FR1-A2-4	–64.2	–72.2	AWGN
	30	G-FR1-A2-5	–64.2		
	60	G-FR1-A2-6	–64.5		
60	30	G-FR1-A2-5	–64.2	–71.4	AWGN
	60	G-FR1-A2-6	–64.5		
70	30	G-FR1-A2-5	–64.2	–70.8	AWGN
	60	G-FR1-A2-6	–64.5		
80	30	G FR1-A2-5	–64.2	–70.1	AWGN
	60	G-FR1-A2-6	–64.5		
90	30	G-FR1-A2-5	–64.2	–69.6	AWGN
	60	G-FR1-A2-6	–64.5		
100	30	G-FR1-A2-5	–64.2	–69.1	AWGN
	60	G-FR1-A2-6	–64.5		

Measurement conditions

FRC (Fixed Reference Channel)	Generate with 5G NR TDD sub-6 GHz IQproducer and choose from the above table according to the base-station frequency band and SCS.
AWGN	Generate with AWGN IQproducer (Standard). Set the bandwidth so that AWGN BW(B)/Wanted Signal BW(A) is 1.5.

Measurement method

(1) Use the two-waveform addition function to save the wanted-signal (G-FR1-A2-1) waveform file to memory 1 and the AWGN-waveform file to memory 2.
(2) Set the output level for each of the wanted and interference signals.
(3) Output the signal from the signal generator.
(4) Measure the Throughput at the base station and confirm that it is ≥95%.
(5) Measure the Throughput at the center frequency of the allocated frequency range.

Setup

4.2.3 Adjacent Channel Selectivity (ACS)

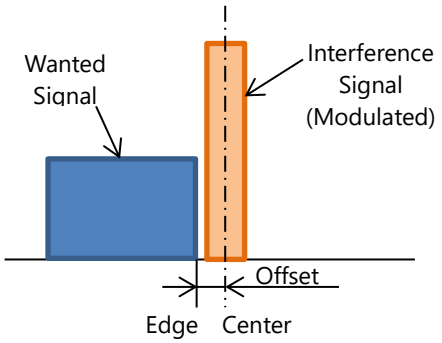
Measurement outline

This measures the throughput of the wanted signal in the presence of an interference signal.

Specifications

BS channel bandwidth of lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)	Interference signal mean power (dBm)
5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 (Note 1)	PREFSENS + 6dB	Wide Area: –52 Medium Range: –47 Local Area: –44

BS channel bandwidth of lowest/highest carrier received (MHz)	Interference signal center frequency offset from lower/upper base station RF bandwidth edge or sub-block edge inside sub-block gap (MHz)	Type of interference signal
5	±2.5025	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
10	±2.5075	
15	±2.5125	
20	±2.5025	
25	±9.535	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB
30	±9.585	
40	±9.535	
50	±9.485	
60	±9.585	
70	±9.535	
80	±9.485	
90	±9.585	
100	±9.535	



Relationship between wanted and interference signals

Measurement conditions

Wanted signal	Generate with 5G NR TDD sub-6 GHz IQproducer. Generate by selecting base-station bandwidth and SCS.
Interference signal	Generate with 5G NR TDD sub-6 GHz IQproducer. 5 MHz DFT-s-OFDM, SCS: 15 kHz, 25 RB 20 MHz DFT-s-OFDM, SCS: 15 kHz, 100 RB

Measurement method

(1) Use the two-waveform addition function to save the wanted-signal waveform file to memory 1.
(2) Save the interference signal in memory 2, and set the offset frequency.
(3) Output the signal from the signal generator.
(4) Measure the Throughput at the base station and confirm that it is ≥95%.

Measure the Throughput at the center frequency of the allocated frequency range.

Setup

4.2.4 In-band blocking

Measurement outline
This measures the Throughput of the wanted signal in the presence of an interference signal.

Specifications
Applicable range

BS type	Operating band characteristics	ΔfOOB (MHz)	Range (MHz)
BS type 1-C	FUL, high – FUL, low ≤ 200 MHz	20	FUL, low –20 ≤ ≤UL, high + 20
	200 MHz < FUL, high – FUL, low ≤ 900 MHz	60	FUL, low –60 ≤ ≤UL, high + 60
BS type 1-H	FUL, high – FUL, low < 100 MHz	20	FUL, low –20 ≤ ≤UL, high + 20
	100 MHz ≤ FUL, high – FUL, low ≤ 900 MHz	60	FUL, low –60 ≤ ≤UL, high + 60

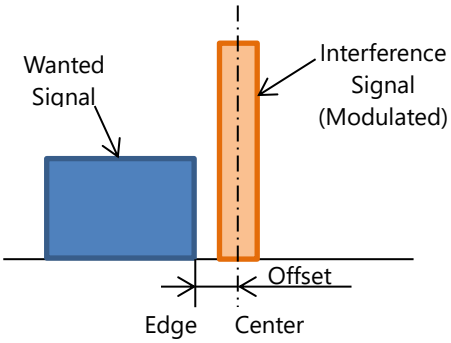
General blocking

BS channel bandwidth of lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)	Interference signal mean power (dBm)	Interference signal center frequency minimum offset from lower/upper base station RF bandwidth edge or sub-block edge inside sub-block gap (MHz)	Type of interference signal
5, 10, 15, 20	PREFSENS + 6 dB	Wide Area: –43 Medium Range: –38 Local Area: –35	±7.5	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
25, 30, 40, 50, 60, 70, 80, 90, 100	PREFSENS + 6 dB	Wide Area: –43 Medium Range: –38 Local Area: –35	±30	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB

Narrowband blocking

BS channel bandwidth of the lowest/highest carrier received (MHz)	Wanted signal mean power (dBm)	Interference signal mean power (dBm)	Interference RB center frequency offset to lower/upper base station RF bandwidth edge or sub-block edge inside sub-block gap (kHz)	Type of interference signal
5	$P_{REFSENS}$ + 6 dB	Wide Area: –49 Medium Range: –44 Local Area: –41	±([342.5]+m*180), m = 0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz DFT-s-OFDM NR signal, 1 RB SCS: 15 kHz
10			±([347.5]+m*180), m = 0, 1, 2, 3, 4, 9, 14, 19, 24	
15			±([352.5]+m*180), m = 0, 1, 2, 3, 4, 9, 14, 19, 24	
20			±([342.5]+m*180), m = 0, 1, 2, 3, 4, 9, 14, 19, 24	
25			±([557.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	20 MHz DFT-s-OFDM NR signal, 1 RB SCS: 15 kHz
30			±([562.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
40			±([557.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
50			±([552.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
60			±([562.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
70			±([557.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
80			±([552.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	
90			±([562.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	

100			±([557.5]+m*180), m = 0, 1, 2, 3, 4, 29, 54, 79, 100	



Relationship between wanted and interference signals

Measurement Conditions

Wanted signal	Generate with 5G NR TDD sub-6 GHz IQproducer. Generate by selecting the base-station bandwidth and SCS.
Interference signal	Generate with 5G NR TDD sub-6 GHz IQproducer. • 5 MHz DFT-s-OFDM SCS: 15 kHz, 1 RB • 20 MHz DFT-s-OFDM SCS: 15 kHz, 1 RB

Measurement method

(1) Use the two-waveform addition function to save the wanted-signal waveform file to memory 1.
(2) Save the interference signal in memory 2, and set the offset frequency.
(3) Output the signal from the signal generator.
(4) Measure the Throughput at the base station and confirm that it is ≥95%.
(5) Measure the Throughput at the center frequency of the allocated frequency range.

Setup

4.2.5 Out-of-band blocking

Measurement outline

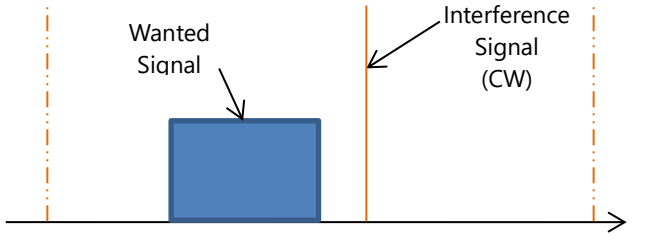
This measures the Throughput of the wanted signal in the presence of an interference signal.

Specifications

General

Wanted signal mean power (dBm)	Interference signal mean power (dBm)	Type of interference signal	Interference signal frequency range
$P_{REFSENS}$ +6 dB (Note)	–15	CW carrier	1 MHz to FUL, low - ΔfOOB and from FUL, high + ΔfOOB up to 12750 MHz

NOTE: $P_{REFSENS}$ depends on the BS channel bandwidth as specified in TS 38.104 [2], Table 7.2.2-1, 7.2.2-2 and 7.2.2-3.



Relationship between interference and wanted signals

Measurement conditions

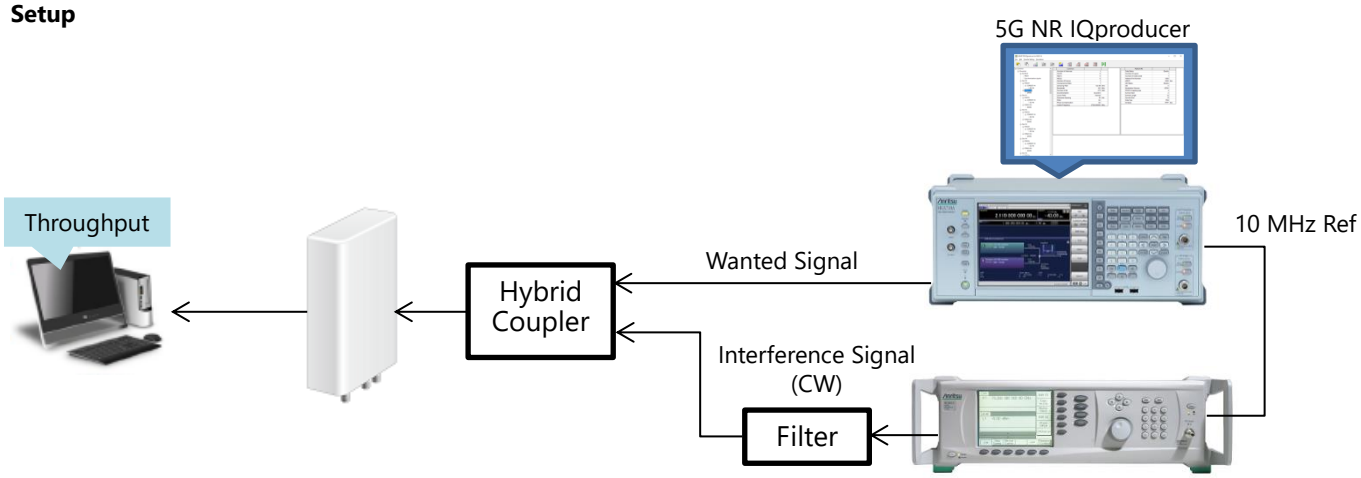
Wanted signal	Generate with 5G NR TDD sub-6 GHz IQproducer. Generate by selecting base-station bandwidth and SCS.
Interference signal	CW Signal

Measurement Method

(1) Set the wanted signal waveform file at SG1.
(2) Set the CW interference signal setting at SG2.
(3) Output the signal from the signal generator.
(4) Measure the Throughput at the base station and confirm that it is ≥95%.

Measure the Throughput at the center of frequency of the allocated frequency range.

Setup



4.2.6 Receiver spurious emissions

Measurement outline
This measures the Rx spurious.

Specifications

Spurious frequency range	Basic limits	Measurement bandwidth	Note
30 MHz to 1 GHz	–57 dBm	100 kHz	Note 1
1 GHz to 12.75 GHz	–47 dBm	1 MHz	Note 1, Note 2
12.75 GHz – 5th harmonic of upper frequency edge of UL operating band in GHz	–47 dBm	1 MHz	Note 1, Note 2, Note 3

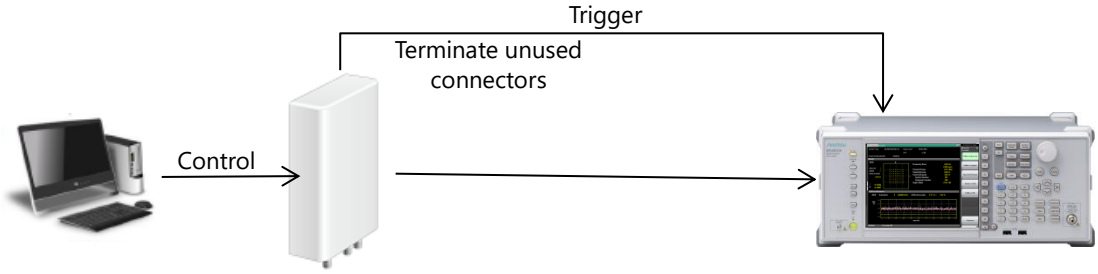
Note 1: Measurement bandwidths as in ITU-R SM.329 [2], s4.1.
Note 2: Upper frequency as in ITU-R SM.329 [2], s2.5 Table 1.
Note 3: This spurious frequency range applies only for operating bands for which the 5th harmonic of the upper frequency edge of the UL operating band reaches beyond 12.75 GHz.

Measurement conditions

Signal analyzer application software	Spectrum analyzer
Signal analyzer settings	Detector: RMS Trace Point: 10001 Storage: Lin Average Average Count: 100

Measurement method
(1) Set the NR-FR1-TM1.1 signal at the base station.
(2) Set the signal-analyzer measurement range.
(3) Measure the spurious in the measurement range.

Setup



4.2.7 Receiver intermodulation

Measurement outline

This measures the Rx performance when reception is impacted by intermodulation between two signals.

Specifications

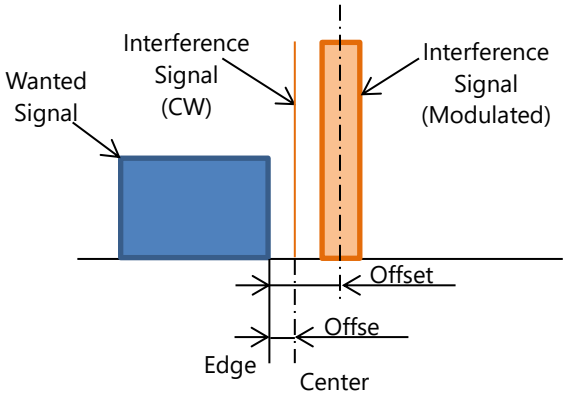
General

Base station type	Wanted signal mean power (dBm)	Mean power of interference signals (dBm)
Wide Area BS	PREFSENS + 6 dB	–52
Medium Range BS	PREFSENS + 6 dB	–47
Local Area BS	PREFSENS + 6 dB	–44

Interference signals for General

BS channel bandwidth of lowest/highest carrier received (MHz)	Interference signal center frequency offset from lower/upper base station RF bandwidth edge (MHz)	Type of interference signal
5	±7.5	CW
	±17.5	5 MHz DFT-s-OFDM NR signal, (Note 1)
10	±7.45	CW
	±17.5	5 MHz DFT-s-OFDM NR signal, (Note 1)
15	±7.43	CW
	±17.5	5 MHz DFT-s-OFDM NR signal, (Note 1)
20	±7.38	CW
	±17.5	5 MHz DFT-s-OFDM NR signal, (Note 1)
25	±7.45	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
30	±7.43	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
40	±7.45	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
50	±7.35	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
60	±7.49	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
70	±7.42	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
80	±7.44	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
90	±7.43	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)
100	±7.45	CW
	±25	20MHz DFT-s-OFDM NR signal, (Note 2)

Note 1: For the 15-kHz subcarrier spacing, the RB number is 25. For the 30-kHz subcarrier spacing, the RB number is 10.
Note 2: For the 15-kHz subcarrier spacing, the RB number is 100. For the 30-kHz subcarrier spacing, the RB number is 50. For the 60-kHz subcarrier spacing, the RB number is 24.



Relationship between wanted and interference signals

Narrowband

Base station type	Wanted signal mean power (dBm)	Mean power of interference signal (dBm)
Wide Area BS	PREFSENS + 6 dB	–52
Medium Range BS	PREFSENS + 6 dB	–47
Local Area BS	PREFSENS + 6 dB	–44

Interference signals for Narrowband

BS channel bandwidth of lowest/highest carrier received (MHz)	Interference RB center frequency offset from lower/upper base station RF bandwidth edge or sub-block edge inside sub-block gap (kHz)	Type of interference signal
5	±360	CW
	±1420	5 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
10	±325	CW
	±1780	5 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
15 (Note 2)	±380	CW
	±1600	5 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
20 (Note 2)	±345	CW
	±1780	5 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
25 (Note 2)	±325	CW
	±1990	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
30 (Note 2)	±320	CW
	±1990	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
40 (Note 2)	±310	CW
	±2710	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
50 (Note 2)	±330	CW
	±3250	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
60 (Note 2)	±350	CW
	±3790	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
70 (Note 2)	±400	CW
	±4870	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
80 (Note 2)	±390	CW
	±4870	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
90 (Note 2)	±340	CW
	±5770	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)
100 (Note 2)	±340	CW
	±5770	20 MHz DFT-s-OFDM NR signal, 1 RB (Note 1)

Note 1: Interference signal consisting of one RB positioned at the stated offset; the BS channel bandwidth of the interference signal is located adjacent to the lower/upper base station RF Bandwidth edge or sub-block edge inside a sub-block gap.
Note 2: This requirement shall apply only for a G-FRC mapped to the frequency range at the channel edge adjacent to the interference signals.

Measurement conditions

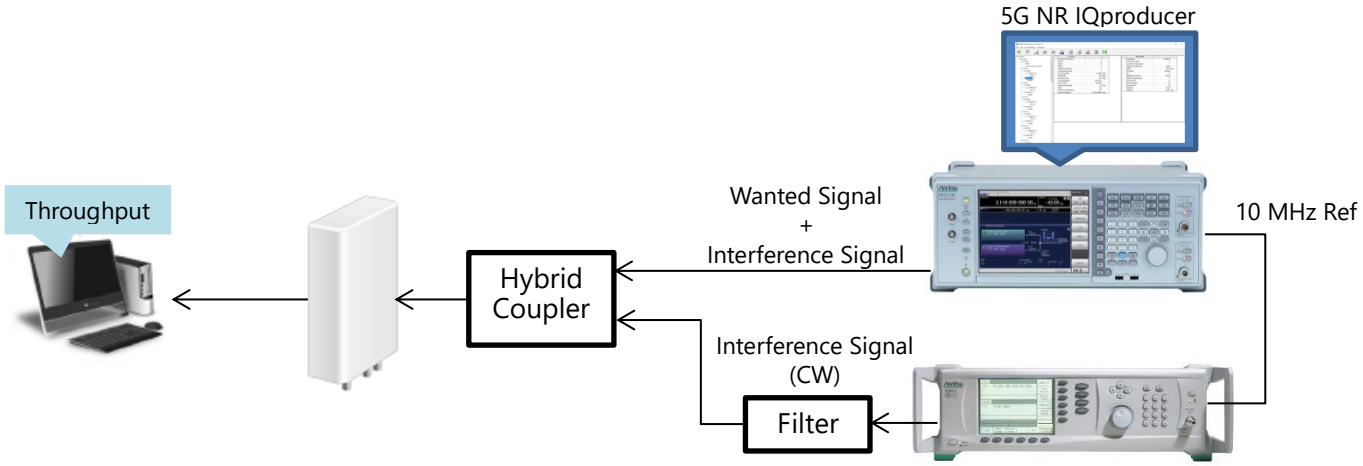
Wanted signal	Generate with 5G NR TDD sub-6 GHz IQproducer. Generate by selecting the base-station bandwidth and SCS.
Interference signal	Generate with 5G NR TDD sub-6 GHz IQproducer. 5 MHz DFT-s-OFDM NR signal, 1 RB 20 MHz DFT-s-OFDM NR signal, 1 RB

Measurement method

(1) Use the two-waveform addition function to save the wanted waveform file to memory 1.
(2) Save the modulation interference waveform to memory 2 and set the offset frequency.
(3) Set the CW interference signal setting at SG2.
(4) Output each signal from the signal generator.
(5) Measure the Throughput at the base station and confirm that it is ≥95%.

Measure the throughput at the center frequency of the allocated frequency range.

Setup



4.2.8 In-channel selectivity

Measurement outline

This measures the Rx power of the allocated resource block (RB) in the presence of the interference signal.

Specifications

Wide Area BS

BS channel bandwidth (MHz)	Subcarrier spacing (kHz)	Reference measurement channel	Wanted signal mean power (dBm)	Interference signal mean power (dBm)	Type of interference signal
5	15	G-FR1-A1-7	–100.6	–81.4	DFT-s-OFDM NR signal, SCS 15 kHz,10 RB
10, 15, 20, 25, 30	15	G-FR1-A1-1	–98.7	–77.4	DFT-s-OFDM NR signal, SCS 15 kHz,25 RB
40, 50	15	G-FR1-A1-4	–92.3	–71.4	NR signal, SCS 15 kHz, 100 RB
5	30	G-FR1-A1-8	–101.3	–81.4	DFT-s-OFDM NR signal, SCS 30 kHz,5 RB
10, 15, 20, 25, 30	30	G-FR1-A1-2	–98.8	–78.4	DFT-s-OFDM NR signal, SCS 30 kHz,10 RB
40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5	–92.6	–71.4	DFT-s-OFDM NR signal, SCS 30 kHz,50 RB
10, 15, 20, 25, 30	60	G-FR1-A1-9	–98.2	–78.4	DFT-s-OFDM NR signal, SCS 60 kHz,5 RB
40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6	–92.7	–71.6	DFT-s-OFDM NR signal, SCS 60 kHz,24 RB

Measurement conditions

Wanted signal	Generate with 5G NR TDD sub-6 GHz IQproducer. Generate by selecting the base-station bandwidth and SCS
Interference signal	Generate with 5G NR TDD sub-6 GHz IQproducer. • DFT-s-OFDM SCS: 60 kHz, 24 RB

Measurement method

(1) Use the two-waveform addition function to save the wanted waveform file in memory 1.
(2) Set the interference waveform file at memory 2.
(3) Output the signal from the signal generator.
(4) Measure the Throughput at the base station and confirm that it is ≥95%.

Measure the Throughput at the center frequency of the allocated frequency range.

Setup

5 Summary

This Application Note explains some 5G measurement methods, using the MS2850A with wide resolution bandwidth to facilitate development and manufacturing of 5G products.

6 Ordering Information

Signal Analyzer
Main Unit

Model	Name	Remarks
MS2850A	Signal Analyzer	The standard resolution bandwidth is 255 MHz.

Basic Configuration Options

Model	Name	Remarks
MS2850A-047	32GHz Signal Analyzer	Choose the maximum frequency; the frequency range cannot be upgraded by retrofit.
MS2850A-046	44.5GHz Signal Analyzer	
MS2850A-068	Microwave Preamplifier	
MX285051A	5G Measurement Software (Basic License)	Requires one of MX285051A-011/021 /061/071 options
MX285051A-011	NR TDD sub-6GHz Downlink	For sub-6 GHz downlink signal analysis

Signal generator
Main Unit

Model	Name	Remarks
MG3710E *	Vector Signal Generator	The baseband bandwidth is 160 MHz*/ 120 MHz (*using built-in baseband generator)

Basic Configuration Options

Model	Name	Remarks
MG3710E-036	1stRF 100kHz to 6GHz	Choose the frequency; the frequency range cannot be added by retrofit.
MG3710E-045 *	ARB Memory Upgrade 256 Msample for 1stRF	
MG3710E-048 *	Combination of Baseband Signal for 1stRF	
MX370113A *	5G NR TDD sub-6GHz IQproducer	

*: MG3710A and its hardware options were discontinued in June 2019. However, MG3710A-145 and MG3710A-148, which are the retrofit of the options above, and MX370113A can be added on the existing MG3710A. Please note MG3760A-036 cannot be added on the MG3710A by retrofit.

Main Unit

Model	Name	Remarks
MG3692C	2 GHz to 20 GHz Signal Generator	

Basic Configuration Options

Model	Name	Remarks
MG3690C/5	8 MHz to 2 GHz RF Coverage	Uses an analog down converter.
MG3690C/22	0.1 Hz to 10 MHz Audio coverage	Uses a DDS for coverage down to approximately DC.

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Specifications are subject to change without notice.

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