NXDN®

NXDN Technical Specifications

Part 2:
Conformance Test

Sub-part A:
Transceiver Performance Test

NXDN TS 2-A Version 1.1

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1. Introduction

This document describes the method of performance evaluation and the recommended performance for transmitters and receivers of Repeater Units and Subscriber Units. The performance of transmitters or receivers can be fairly compared by measuring according to the measurement methods specified in this document.

The measurement method defined in this document is intended to describe the performance for transmitters and receivers. The measurement methods for describing the performance of interoperability or link behavior related to Air Interface specifications are defined in other documents.

This document defines two performance levels. Class B performance levels are recommended minimum performance for transceivers. Class A performance levels are recommended performance for transceivers with enhanced interference protection characteristics.

2. References

Reference documents are listed below:

REF [1]	Part 1-A Common Air Interface	Version 1.3
REF [2]	Part 1-B Basic Operation	Version 1.3
REF [3]	Part 1-C Trunking Procedures	Version 1.3

3. Abbreviations

To help understand this document, abbreviations are listed below.

BCCH	Broadcast Control Channel
CAC	Common Access Channel
CAI	Common Air Interface
CCCH	Common Control Channel
CR	Conventional Repeater
CRS	Conventional Repeater Site
DMO	Direct Mode Operation
FACCH1	Fast Associated Control Channel 1
FACCH2	Fast Associated Control Channel 2
FS	Fixed Station
FSW	Frame Sync Word
FDMA	Frequency Division Multiple Access
L1	Layer 1
L2	Layer 2
L3	Layer 3
LICH	Link Information Channel
MS	Mobile Station
PBX	Private Branch Exchange
PSTN	Public Switched Telephone Network
RU	Repeater Unit
RCCH	RF Control Channel
RDCH	RF Direct Traffic Channel
RTCH	RF Traffic Channel
SCPC	Single Channel Per Carrier
SACCH	Slow Associated Control Channel

SU	Subscriber Unit
TC	Trunking Controller
TR	Trunking Repeater
TRS	Trunking Repeater Site
UDCH	User Data Channel
UPCH	User Packet Channel
USC	User Specific Channel
VCH	Voice Channel

4. Standard Definition and Standard Test Condition

4.1. Definition for Unit Under Test

This section describes definitions for the characteristics and measurements of a radio under test. Refer to REF [1] for standard items. Refer to the TIA-603-C for other terms.

4.1.1. Standard Modulation Speed

The standard modulation speed is 2.4 ksps or 4.8 ksps.

4.1.2. Standard Modulation Data Stream

The standard modulation data is a 511-bit pseudo-random binary sequence defined by ITU-T.

4.1.3. Interfering Modulation Data Stream

The interfering modulation data is a 32767-bit pseudo-random binary sequence defined by ITU-T.

4.1.4. Standard Modulation State, Formatted Standard Modulation State

The standard modulation state is the state of modulating by the 4-Level FSK method the standard modulation data at the standard modulation speed.

The formatted standard modulation state is the state of modulating by the 4-Level FSK method the standard modulation data by using a frame format on the radio channel of RTCH or RDCH. Either of two following frame formats can be used.

- The frame format arranging the standard modulation data into VCHs. The standard modulation data shall be arranged with consecutive phases in consecutive frames.
- The frame format arranging the standard modulation data into LICH, SACCH and VCHs except for FSW. The standard modulation data shall be arranged with consecutive phases in consecutive frames.

4.1.5. Interfering Modulation State

The interfering modulation state is the state of modulating by the 4-Level FSK method the interfering modulation data at the standard modulation speed.

4.1.6. Non-modulation State

Non-modulation state indicates a state where 4-Level FSK modulation is not used and only a carrier wave exists. This state does not occur in a usual communication.

4.1.7. Maximum Frequency Deviation Symbol Stream

A state in which the following consecutive modulation symbols are used: +3, +3, -3, -3.

4.1.8. 1/3 Frequency Deviation Symbol Stream

A state in which the following consecutive modulation symbols are used: +1, +1, -1, -1.

4.2. Radio Equipment Category

RU and SU are defined with reference to functions of radio equipment in REF [1]. The following categories exist for SU: MS (Vehicle type), MS (Portable type) and FS.

The performance of radio equipment varies depending on the operating voltage and power consumption. Therefore, the following terms are used in the chapters describing measurement methods and requested standard values instead of the terms defined by REF [1].

4.2.1. Portable Radio Equipment (PE)

Portable Radio Equipment (PE) represents MS (Portable type) in the SU category.

4.2.2. Mobile Radio Equipment (ME)

Mobile Radio Equipment (ME) represents MS (Vehicle type) in the SU category.

4.2.3. Base Radio Equipment (BE)

Base Radio Equipment (BE) represents an RU (TC + RU, TR or CR) comprising a TRS or a CRS, and an FS. If the measurement items are applied only for RU, the radio equipment is described as BE (RU). If the measurement items are applied only for FS, the radio equipment is described as BE (FS).

4.3. Definitions for Environmental Testing

4.3.1. Degradation from Standard (DFS)

DFS is degradation from the standard or the manufacturer's specification, whichever is more stringent. This is not a degradation from a measured value.

4.4. Standard Test Conditions

4.4.1. Standard Atmospheric Conditions

The standard atmospheric condition is a temperature of 25 °C at an atmospheric pressure of 1013 hPa (1013 mbar). Measurements, however, may be carried out at any combination of temperature, pressure, and relative humidity within the following limits:

Temperature: 20 °C to 35 °C

Relative Humidity: 45% to 75%

Atmospheric Pressure: 860 hPa to 1060 hPa (860 mbar to 1060 mbar)

5. Measurement Methods and Recommended / Required Values

5.1. Measurement Methods of Receiver Performance

5.1.1. Radiated Spurious Emission

5.1.1.1. Definition

The radiated spurious emission is a measure of the power of spurious signals radiated from the receiver.

5.1.1.2. Method of Measurement and Requirement

The measurement must comply with the measurement method and limits specified in the Code of Federal Regulations Title 47, Part 15, Section 109.
The receiver under test shall be set in a continuously receiving condition during the test.

5.1.2. Conductive Spurious Emission

5.1.2.1. Definition

The conductive spurious emission is a measure of the power of spurious signals which appear at the antenna of the receiver.

5.1.2.2. Method of Measurement and Requirement

The measurement must comply with the measurement method and limits specified in the Code of Federal Regulations Title 47, Part 15, Section 111.
The receiver under test shall be set in a continuously receiving condition during the test.

5.1.3. Power Line Conductive Spurious Voltage

5.1.3.1. Definition

The power line conductive spurious voltage is a measure of the spurious voltage conducted from a device using AC power to the AC power line in the frequency range 150 kHz to 30 MHz.

5.1.3.2. Method of Measurement and Requirement

The measurement must comply with the measurement method and limits specified in the Code of Federal Regulations Title 47, Part 15, Section 107.
The receiver under test shall be set in a continuously receiving condition during the test.

5.1.4. Reference Sensitivity (Static)

5.1.4.1. Definition

The reference sensitivity is the level of input signal when the bit error rate is 3%.

5.1.4.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-1.

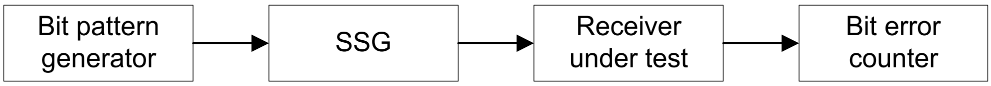

Figure 5.1-1 Reference Sensitivity (Static)

(b) Set a signal generator to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed. Apply the signal to the receiver input terminals.

(c) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.

(d) Adjust the output level of the signal generator until a bit error rate of 3% is obtained in collected data of 2556 bits or more, and record the output level of the signal generator as the reference sensitivity.

(e) It is recommended that the maximum input level for reference sensitivity does not exceed the values shown in the following table.

Channel Spacing	Class	BE	ME	PE
6.25 kHz	A	-117dBm	-117dBm	-117dBm
(4800 bps)	B	-114dBm	-114dBm	-114dBm
12.5 kHz	A	-115dBm	-115dBm	-115dBm
(9600 bps)	B	-112dBm	-112dBm	-112dBm

Table 5.1-1 Reference Sensitivity (Static) Limits

5.1.5. Reference Sensitivity (Faded)

5.1.5.1. Definition

The faded reference sensitivity is the level of input signal when the bit error rate is 3%. A flat faded signal is applied to the receiver input terminals through the Rayleigh fading simulator. This document does not define the measurement method for a receiver with a diversity function.

5.1.5.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-2.

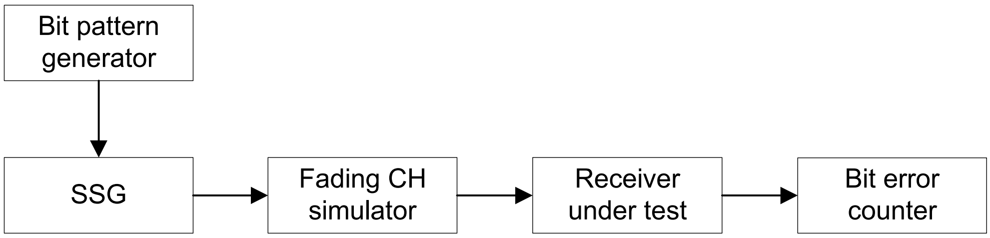

Figure 5.1-2 Reference Sensitivity (Faded)

(b) Set a signal generator to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed. The fading simulator is set to a vehicle speed of 8 km/h.
(c) Apply the faded signal to the receiver input terminals. Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.
(d) Adjust the output level of a signal generator until a bit error rate of 3% is obtained. This level is the reference sensitivity in a faded condition.
(e) Repeat step (d) with the fading simulator set to a vehicle speed of 100 km/h.
(f) It is recommended that the maximum input level for faded reference sensitivity does not exceed the values shown in the following table.

Channel Spacing	Class	BE	ME	PE
6.25 kHz (4800 bps)	A	-109dBm	-109dBm	-109dBm
	B	-106dBm	-106dBm	-106dBm
12.5 kHz (9600 bps)	A	-107dBm	-107dBm	-107dBm
	B	-104dBm	-104dBm	-104dBm

Table 5.1-2 Reference Sensitivity (Faded) Limits

5.1.6. Adjacent Channel Rejection

5.1.6.1. Definition

The adjacent channel rejection is a measure of the capability to reject an unwanted signal applied to adjacent channels of ±6.25 kHz and ±12.5 kHz.

5.1.6.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in the Figure 5.1-3.

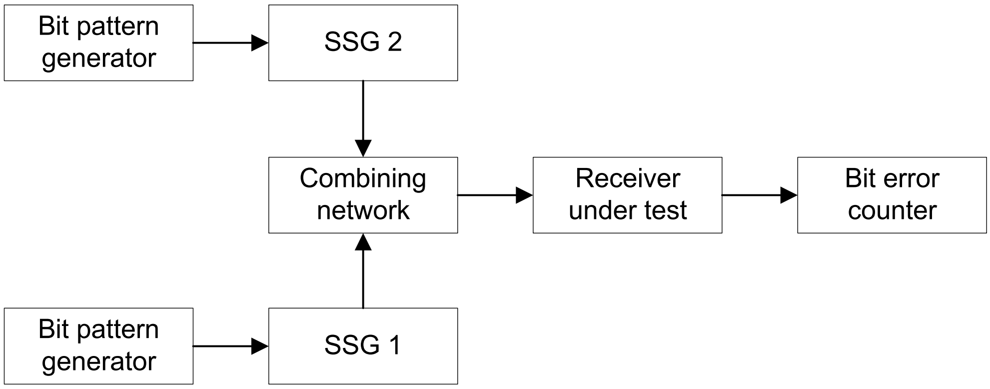

Figure 5.1-3 Adjacent Channel Rejection

(b) Set signal generator 1 to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed and to apply a signal level 3 dB above the reference sensitivity at the receiver input terminals.
(c) Set the frequency of signal generator 2 to the adjacent channel above the frequency of signal generator 1. Signal generator 2 shall be set to the interfering modulation state according to the modulation speed.
(d) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.
(e) Adjust the output level of signal generator 2 until a bit error rate of 3% is obtained in collected data of 2556 bits or more, and record the output level of signal generator 2 at the receiver input terminals.
(f) The adjacent channel rejection is the value obtained by subtracting the reference sensitivity from the level of signal generator 2 at the receiver input terminals measured at step (e).
(g) Set signal generator 2 to the adjacent channel below the frequency of signal generator 1. Repeat steps (d), (e) and (f).
(h) It is recommended that the adjacent channel rejection is equal to or more than the values shown in the following table.

Channel Spacing	Class	BE	ME	PE
6.25 kHz	A	50dB	50dB	50dB
	B	45dB	45dB	45dB
12.5 kHz	A	55dB	55dB	55dB
	B	55dB	55dB	50dB

Table 5.1-3 Adjacent Channel Rejection Limits

5.1.7. Co-channel Rejection

5.1.7.1. Definition

The co-channel rejection is a measure of the capability to reject an unwanted signal applied to the same channel.

5.1.7.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-4.

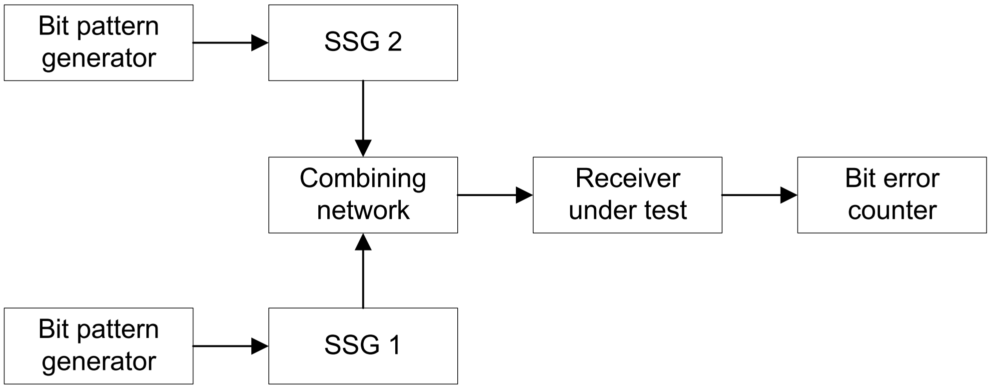

Figure 5.1-4 Co-channel Rejection

(b) Set signal generator 1 to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed and to apply a signal level 3 dB above the reference sensitivity at the receiver input terminals.

(c) Set the frequency of signal generator 2 to the same frequency as signal generator 1. Signal generator 2 shall be set to the interfering modulation state according to the modulation speed.

(d) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.

(e) Adjust the output level of signal generator 2 until a bit error rate of 3% is obtained in collected data of 2556 bits or more, and record the output level of signal generator 2 at the receiver input terminals.

(f) The co-channel rejection is the value obtained by subtracting the level of signal generator 2 at the receiver input terminals from the reference sensitivity.

(g) It is recommended that the co-channel rejection is 12 dB or less.

5.1.8. Spurious Rejection

5.1.8.1. Definition

The frequency of the unwanted signal shall be varied over a range from half of the lowest IF frequency of the receiver under test to twice the highest receiver frequency or 1000 MHz, whichever is higher. The frequency range that is within ±50 kHz of the frequency of the wanted signal of the receiver under test is excluded. The spurious rejection is a measure of the capability to reject the specified unwanted signal applied to the receiver under test.

5.1.8.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-5.

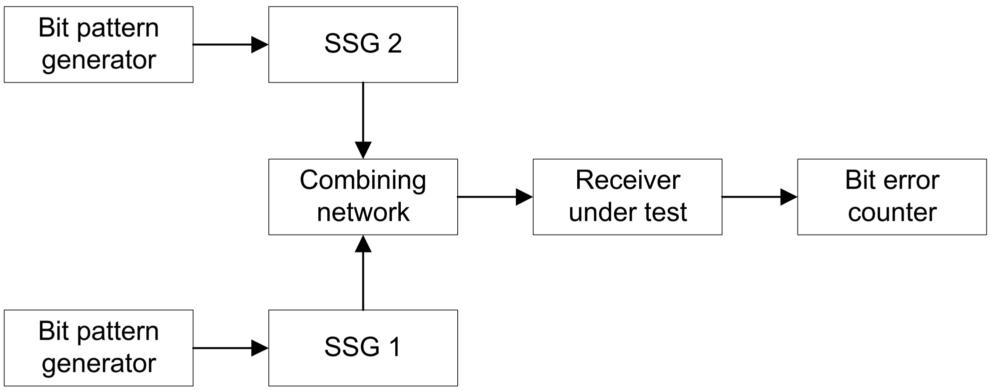

Figure 5.1-5 Spurious Rejection

(b) Set signal generator 1 to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed of the receiver and to apply a signal level 3 dB above the reference sensitivity at the receiver input terminals.

(c) Set signal generator 2 to the interfering modulation state according to the modulation speed.

(d) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.

(e) Adjust the output level of signal generator 2 at the receiver input terminals according to the following equation.

$P_U = P_{REF} + SRR + 6$ dB

P_U is the level of the signal generator 2 [dBm]

P_{REF} is the level of reference sensitivity [dBm]

SRR is the manufacturer specified limit for spurious rejection [dB]

Change the frequency of signal generator 2 within the frequency range of the unwanted signal to find a frequency where the bit error rate increases. Adjust the output level of signal generator 2 until a bit error rate of 3% is obtained in collected data of 2556 bits or more at each frequency found in the previous step and record the output level of signal generator 2 at the receiver input terminals.

(f) The spurious rejection is the value obtained by subtracting the reference sensitivity from the level of signal generator 2 at the receiver input terminals measured at step (e).
(g) It is recommended that the spurious rejection is equal to or more than the values shown in the following table.

Class	BE	ME	PE
A	75dB	75dB	70dB
B	70dB	70dB	60dB

Table 5.1-4 Spurious Rejection Limits

5.1.9. Intermodulation Rejection

5.1.9.1. Definition

The intermodulation rejection is a measure of capability to reject intermodulation caused by unwanted signals which have an offset frequency of +50 kHz/+100 kHz or -50 kHz/-100 kHz.

5.1.9.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-6.

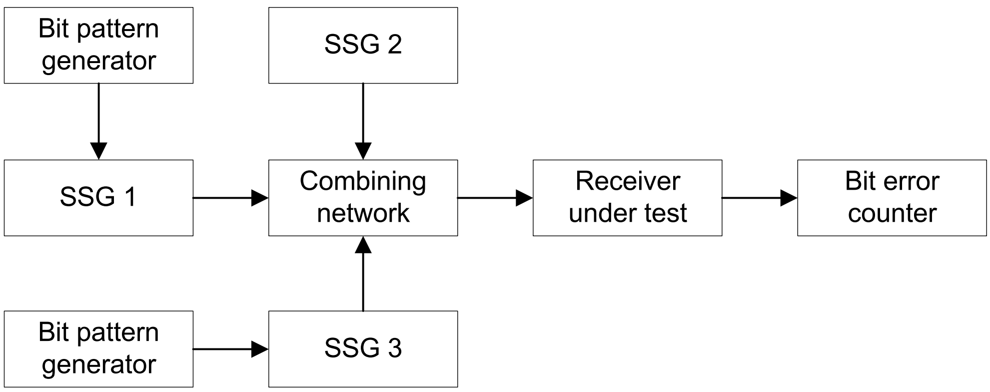

Figure 5.1-6 Intermodulation Rejection

(b) Set signal generator 1 to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed and to apply a signal level 3 dB above the reference sensitivity at the receiver input terminals.
(c) Set the frequency of signal generator 2 to a frequency 50 kHz above the frequency of signal generator 1. Signal generator 2 shall be in the non-modulation state. Set signal generator 3 to a frequency 100 kHz above the frequency of signal generator 1. Signal generator 3 shall be in the interfering modulation state according to the modulation speed.
(d) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.

(e) Configure the same output level for both signal generator 2 and signal generator 3. Adjust the output level of signal generator 2 and signal generator 3 simultaneously, and record the output level of signal generator 2 or signal generator 3 at the receiver input terminals when a bit error rate of 3% is obtained in collected data of 2556 bits or more.

(f) The intermodulation rejection is the value obtained by subtracting the reference sensitivity from the level of signal generator 2 or signal generator 3 at the receiver input terminals measured at step (e).

(g) Set signal generator 2 to a frequency 50 kHz below the frequency of signal generator 1. Set signal generator 3 to a frequency 100 kHz below the frequency of signal generator 1. Repeat steps (d), (e) and (f).

(h) It is recommended that the intermodulation rejection is equal to or more than the values shown in the following table.

Class	BE	ME	PE
A	75dB	70dB	65dB
B	70dB	65dB	50dB

Table 5.1-5 Intermodulation Rejection Limits

5.1.10. Sensitivity of Frequency Offset

5.1.10.1. Definition

The sensitivity of frequency offset is a measure of capability to receive a signal in standard modulation state that has the specified offset frequency from the nominal frequency.

5.1.10.2. Method of Measurement and Recommended Value

(a) Connect the receiver under test and the measuring instruments as shown in Figure 5.1-7.

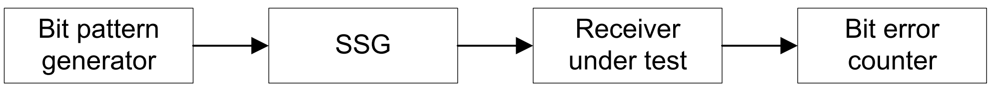

Figure 5.1-7 Sensitivity of Frequency Offset

(b) Set a signal generator to generate a signal of standard modulation state or formatted standard modulation state according to the modulation speed and to apply a signal level 6 dB above the reference sensitivity.

(c) Connect a bit error counter to the receiver in order to count the number of errors within the standard modulation data received by the receiver.

(d) Shift the frequency of the signal generator until a bit error rate of 3% is obtained in collected data of 2556 bits or more.

(e) It is recommended that the frequency offset is equal to or more than the values shown in the following table.

Channel Spacing	Frequency Offset
6.25 kHz	+/- 500 Hz
12.5 kHz	+/- 1000 Hz

Table 5.1-6 Sensitivity of Frequency Offset Limits

(f) The following measurement method can be used instead of the above method.
If the channel spacing is 6.25 kHz, the frequency of the signal generator is configured to +500 Hz offset from the receive frequency. If the channel spacing is 12.5 kHz, the frequency of the signal generator is configured to +1000 Hz offset from the receive frequency. It is recommended that the bit error rate is 3% or less when a signal from the signal generator which is in the standard modulation state according to the modulation speed and has an output level 6 dB above the reference sensitivity is applied to the receiver input terminals. Also it is recommended that the bit error rate is 3% or less when the frequency of the signal generator has -500 Hz or -1000 Hz offset according to the channel spacing.

5.2. Measurement Methods of Transmitter Performance

Unless otherwise specified, the measurement of the transmitter under test shall be conducted in the standard modulation state by using an external standard modulation data generator. The measurement of the transmitter under test can also be conducted in the standard modulation state by using a built-in standard modulation data generator.

Unless otherwise specified, the AFC function shall not be used in measurements for PE and ME.

5.2.1. Transmit Power

5.2.1.1. Definition

The transmit power is the power consumed in the standard load when the output terminal of the transmitter is connected to the standard load. The measured transmit power shall meet the power specified by the manufacturer.

5.2.1.2. Method of Measurement

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-1.

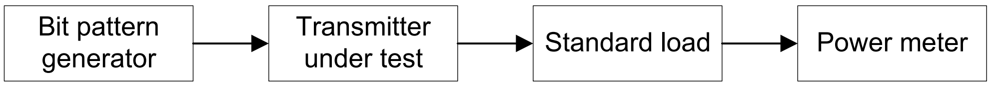

Figure 5.2-1 Transmit Power

(b) The transmitter under test shall continuously transmit in the non-modulation state, standard modulation state or formatted modulation state according to the modulation speed.

(c) The value measured by the power meter is the transmit power.

5.2.2. Frequency Error

5.2.2.1. Definition

The frequency error is a measure of transmit frequency deviation of the transmitter.

5.2.2.2. Method of Measurement and Requirement

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-2.

Figure 5.2-2 Frequency Error

(b) Operate the transmitter under test in standby conditions for at least 15 minutes before proceeding. If a time for standby condition is defined for the transmitter, the defined time shall be used. The transmitter shall continuously transmit in a state modulated with a 1/3 frequency deviation symbol stream or in the non-modulation state.

(c) Recode the frequency counter value. Configure the recorded value for Fr, and the frequency assigned to the transmitter under test for Fa. Calculate the frequency deviation described in ppm by using the following formula.

$$FrequencyError = \left(\frac{F_r}{F_a} - 1 \right) \times 10^6$$

(d) The deviation shall be within the frequency stability specified by 47 CFR 90.213.

5.2.3. Transient Behavior

5.2.3.1. Definition

The transient behavior is a measure of the deviation of the transmit frequency for the specified period when the transmit power is switched on or off.

5.2.3.2. Method of Measurement and Requirements

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-3.

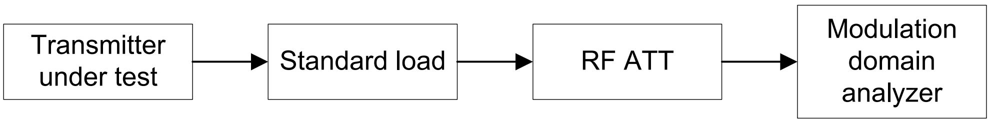

Figure 5.2-3 Transient Behavior

(b) The transmitter under test shall be in the non-modulation state. Attenuate the output power of the transmitter via the RF attenuator so that the modulation domain analyzer is able to have the maximum dynamic range.

(c) Set the envelope trigger of the modulation domain analyzer to the minimum level. Set the modulation domain analyzer to trigger on the rising edge of the waveform in single sweep state.

(d) Turn on the transmitter under test. The period t1 is the time period from the instant when trigger of the modulation domain analyzer is activated until the time specified in the following table elapses. The period t2 is the time period from the end of period t1 until the time specified in the following table elapses. During the period t1 and t2, the frequency difference measured by the modulation domain analyzer shall meet the values in Table 5.2-1 specified in 47 CFR 90.214.

(e) Set the modulation domain analyzer to trigger on the falling edge of the waveform.

(f) Turn off the transmitter under test. The period t3 is the time period before the time specified in the following table from the trigger point of the modulation domain analyzer. During the period t3, the frequency difference measured by the modulation domain analyzer shall meet the values in Table 5.2-1 specified in 47 CFR 90.214. If the transmit power rating is 6 watts or less, the frequency differences during t1 and t3 are not specified.

Time Intervals	6.25 kHz Ch. Spacing 12.5 kHz Ch. Spacing	Frequency Range (MHz)		
		30~174	406~512	806~940
t1	+/- 6.25 kHz +/- 12.5 kHz	5ms	10ms	20ms
t2	+/- 3.125 kHz +/- 6.25 kHz	20ms	25ms	50ms
t3	+/- 6.25 kHz +/- 12.5 kHz	5ms	10ms	10ms

Table 5.2-1 Transient Frequency Behavior

5.2.4. Spectrum Mask

5.2.4.1. Definition

The spectrum mask is a measure of the spectrum of the modulation signal emitted from the transmitter in the standard modulation state.

5.2.4.2. Method of Measurement and Requirement

The measurement shall comply with the measurement method and limits specified in 47 CFR 90.210. Following is an example of the measurement method.

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-4.

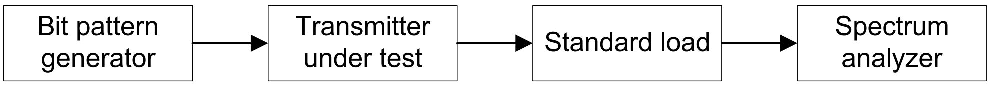

Figure 5.2-4 Spectrum Mask

(b) The transmitter under test shall transmit continuously in the standard modulation state.

(c) Adjust the spectrum analyzer for the following settings to obtain the reference level:
Resolution Bandwidth = 30 kHz
Video Bandwidth = 30 kHz
Sweep Speed = 2 kHz/s
Detector Mode = Positive peak with peak hold

(d) Set the center frequency of the spectrum analyzer to the transmit frequency and start a sweep. The maximum value measured is configured for the reference level (0 dB).

(e) Adjust the spectrum analyzer for the following settings to measure the spectrum mask:
Resolution bandwidth = 100 kHz
Video Bandwidth = 1 kHz
Sweep Speed = 2 kHz/s
Detector Mode = Positive peak with peak hold

(f) Sweep and measure the attenuation from 0 dB at the specified offset frequencies using the spectrum analyzer.

5.2.5. Radiated Spurious Emission

5.2.5.1. Definition

The radiated spurious emission is a measure of the power of the spurious signals radiated from the chassis when the antenna terminal of the transmitter is connected to the standard load.

5.2.5.2. Method of Measurement and Requirement

The measurement shall comply with the measurement method and limits specified in 47 CFR 90.210.

The measurement shall be conducted while the transmitter under test transmits continuously in the non-modulation state. The measurement shall be conducted at the transmit power with the highest radiated spurious in the output power range specified by the transmitter.

5.2.6. Conductive Spurious Emission

5.2.6.1. Definition

The conductive spurious emission is a measure of the power of spurious signals radiated from the antenna terminal of the transmitter.

5.2.6.2. Method of Measurement and Requirements

The measurement shall comply with the measurement method and limits specified in 47 CFR 90.210.

The measurement shall be conducted while the transmitter under test transmits continuously in the non-modulation state. The measurement shall be conducted at the transmit power with the highest conducted spurious in the output power range specified by the transmitter.

5.2.7. Adjacent Channel Power Ratio

5.2.7.1. Definition

The adjacent channel power ratio is a measure of the ratio of the total power of a transmitter in the standard modulation state to the leakage power that falls within a bandwidth of adjacent channels.

5.2.7.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-5.

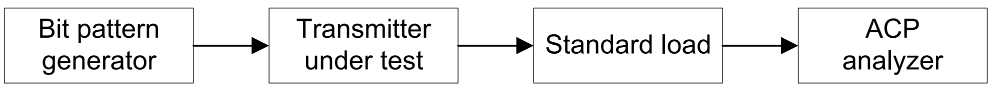

Figure 5.2-5 Adjacent Channel Power Ratio

(b) The transmitter under test shall transmit continuously in the standard modulation state.

(c) Adjust the ACP analyzer for the following settings:
Resolution Bandwidth = 100 Hz
Video Bandwidth ≥ 1 kHz
Span ≥ 20 kHz for 6.25 kHz channel spacing or 40 kHz for 12.5 kHz channel spacing
Detector Mode = average power detection (sample or rms detector)
(d) Set the center frequency of ACP analyzer to the transmit frequency and start a sweep.
(e) Measure the transmit power with the ACP analyzer in a passband where 6 dB bandwidth is the transmitter authorized bandwidth. The value measured is configured for Pout.
(f) Measure the leakage power on the ACP analyzer in the specified measurement 6 dB bandwidth centered at both the upper and lower specified frequency offsets from the carrier frequency as shown in the following table. The higher of the two values for the measured leakage power is configured for Padj.
Pout/Padj is the adjacent channel leakage power ratio.
(g) It is recommended that the adjacent channel power ratio is equal to or more than the values shown in the following table.

Channel Spacing	Measurement Bandwidth	Adjacent Channel Power Ratio
6.25 kHz	4.0 kHz	55dB
12.5 kHz	8.3 kHz	55dB

Table 5.2-2 Adjacent Channel Power Ratio Limits

5.2.8. Intermodulation Attenuation

5.2.8.1. Definition

The intermodulation attenuation is a measure of the capability of a transmitter to avoid the generation of the intermodulation components caused by the carrier signal and an interfering signal entering the transmitter antenna of BE (RU).

5.2.8.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-6.

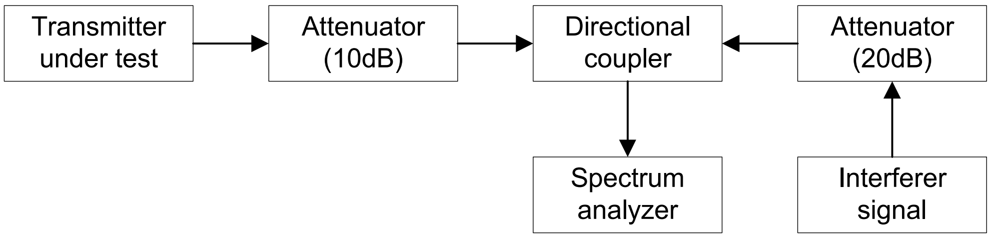

Figure 5.2-6 Intermodulation Attenuation

(b) The transmitter under test shall transmit in the non-modulation state. A 10 dB attenuator is used to reduce the influence of mismatch errors of the transmitter. The interfering signal source is the same transmit power as the transmitter under test. The interfering signal source may be a transmitter providing the same transmit power as the transmitter under test. The directional coupler connects the transmitter under test and the spectrum analyzer, and allows the spectrum analyzer to measure the power output from the transmitter under test. The output power of the transmitter under test measured in this connection condition is configured for the reference value.

(c) Set the frequency of the interfering signal source to within 50 kHz to 100 kHz above the frequency of the transmitter under test. The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious components.

(d) Measure the power of the third order intermodulation product generated by the carrier signal of the transmitter under test and the interfering signal source by using the spectrum analyzer.

(e) Set the frequency of the interfering signal source to within 50 kHz to 100 kHz below the frequency of the transmitter under test. The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious components. Repeat the measurement in step (d).

(f) It is recommended that the ratio of the power of the third order intermodulation product in step (d) and (e) to the reference value of the transmitter under test is 40 dB or more.

5.2.9. Transmitter Attack Time

5.2.9.1. Definition

The transmitter attack time is a measure of the rise time of transmit power after changing the state of the transmitter from standby to transmit.

5.2.9.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-7.

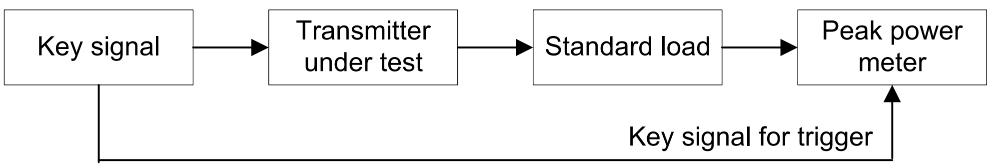

Figure 5.2-7 Transmitter Attack Time

(b) The transmitter under test activates the transmit operation by the key signal. The peak power meter triggers the measurement by the key signal. The transmitter under test uses the formatted standard modulation state.

(c) It is recommended that the transmitter attack time does not exceed 100 ms. It is recommended that the measured transmit power is within +0.8 dB and -3 dB of the rated transmit power after 100 ms from the trigger point of the peak power meter. Refer to Figure 5.2-8.

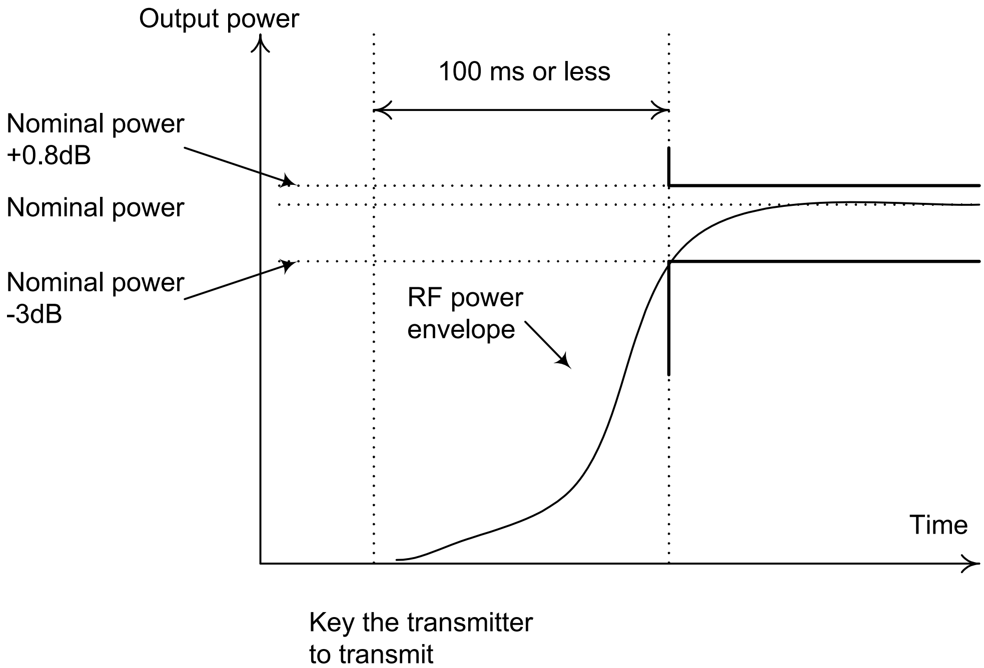

Figure 5.2-8 Transmitter Attack Timing

5.2.10. Maximum Frequency Deviation

5.2.10.1. Definition

The maximum frequency deviation is a measure of the frequency deviation when modulating with the maximum frequency deviation symbol stream.

5.2.10.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-9.

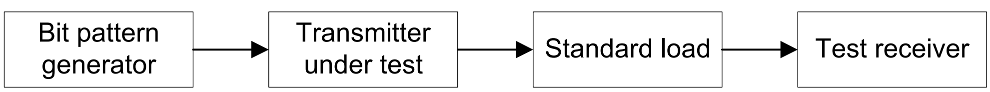

Figure 5.2-9 Maximum Frequency Deviation

(b) Modulate the transmitter under test with the maximum frequency deviation symbol stream and set it in continuously transmitting mode.

(c) Set the audio bandwidth of the test receiver 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.

(d) Record the positive peak frequency deviation and negative peak frequency deviation.
(e) It is recommended that the positive peak frequency deviation is within 1203 Hz and 1471 Hz in case of 4800 bps, and is within 2750 Hz and 3362 Hz in case of 9600 bps.
It is recommended that the negative peak frequency deviation is within -1203 Hz and -1471 Hz in case of 4800 bps, and is within -2750 Hz and -3362 Hz in case of 9600 bps.

5.2.11. 1/3 Frequency Deviation

5.2.11.1. Definition

The 1/3 frequency deviation is a measure of the frequency deviation when modulating with a 1/3 frequency deviation symbol stream.

5.2.11.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-10.

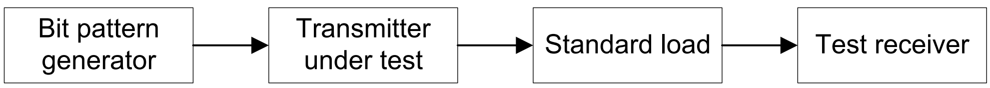

Figure 5.2-10 1/3 Frequency Deviation

(b) Modulate the transmitter under test with a 1/3 frequency deviation symbol stream and set it in the continuously transmitting mode.
(c) Set the audio bandwidth of the test receiver 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.
(d) Record the positive peak frequency deviation and negative peak frequency deviation.
(e) It is recommended that the positive peak frequency deviation is within 401 Hz and 490 Hz in case of 4800 bps, and is within 917 Hz and 1121 Hz in case of 9600 bps.
It is recommended that the negative peak frequency deviation is within -401 Hz and -490 Hz in case of 4800 bps, and is within -917 Hz and -1121 Hz in case of 9600 bps.

5.2.12. Modulation Accuracy

5.2.12.1. Definition

The modulation accuracy is a measure of the FSK error of a modulated signal with the standard modulation state.

5.2.12.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-11.

Figure 5.2-11 Modulation Accuracy

(b) The transmitter under test shall transmit continuously in the standard modulation state.
(c) Capture the transmitted data of at least 511 symbols into the modulation fidelity analyzer and measure the rms FSK error.
(d) It is recommended that the modulation accuracy does not exceed the values shown in the following table.

Class	Modulation Accuracy
A	5 %
B	10 %

Table 5.2-3 Modulation Accuracy Limits

5.2.13. Modulation Symbol Speed

5.2.13.1. Definition

The modulation symbol speed is a measure of the accuracy of the modulation speed of the transmitter.

5.2.13.2. Method of Measurement and Recommended Value

(a) Connect the transmitter under test and the measuring instruments as shown in Figure 5.2-12.

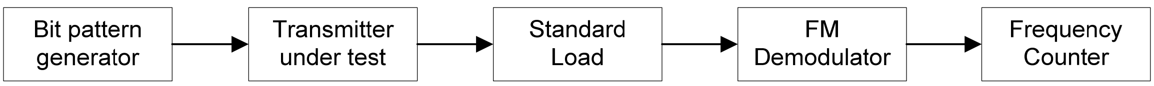

Figure 5.2-12 Modulation Symbol Speed

(b) The transmitter under test shall be modulated with the maximum frequency deviation symbol stream and transmit continuously.

(c) Record the value measured by the frequency counter as Fr.

(d) For 4800 bps, the modulation symbol speed error shall be calculated with the following formula. It is recommended that the calculated result is within ±10 ppm. .

$$ModulationSymbolSpeedError = \left(\frac{F_r}{600[Hz]} - 1 \right) \times 10^6$$

(e) For 9600 bps, the modulation symbol speed error shall be calculated with the following formula. It is recommended that the calculated result is within ±10 ppm.

$$ModulationSymbolSpeedError = \left(\frac{F_r}{1200[Hz]} - 1 \right) \times 10^6$$

5.3. Measurement Methods of Trunked system

This section describes the methods and definitions for the timing measurements of PE and ME in a Type-C trunked system. PE and ME are hereinafter represented as SU since they are applied to the common timing.

The timing parameters and their relationship for each measurement item are shown in the following figures.

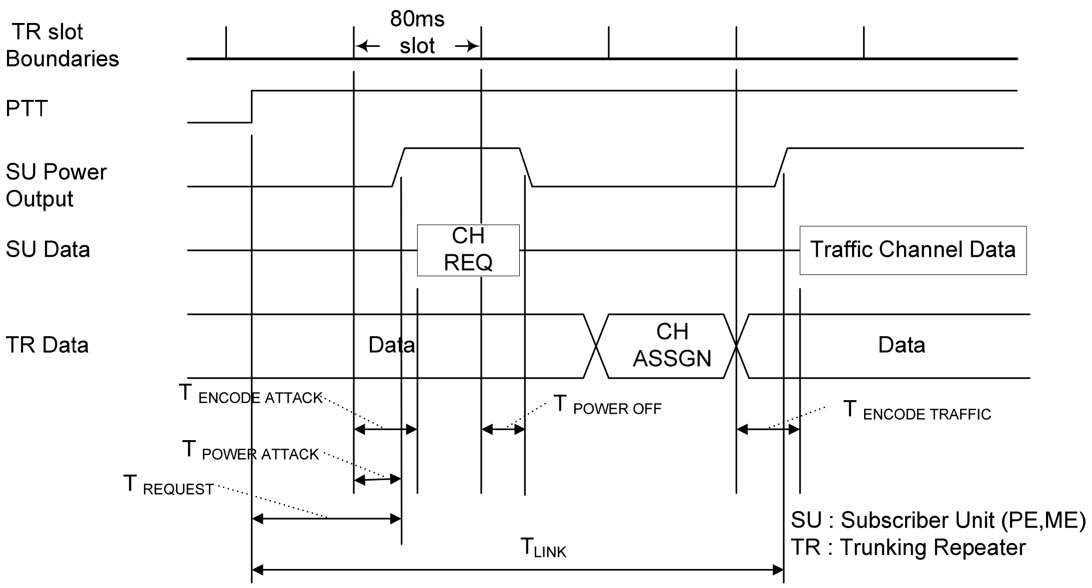

Figure 5.3-1 Trunked System Timing Parameters (4800bps)

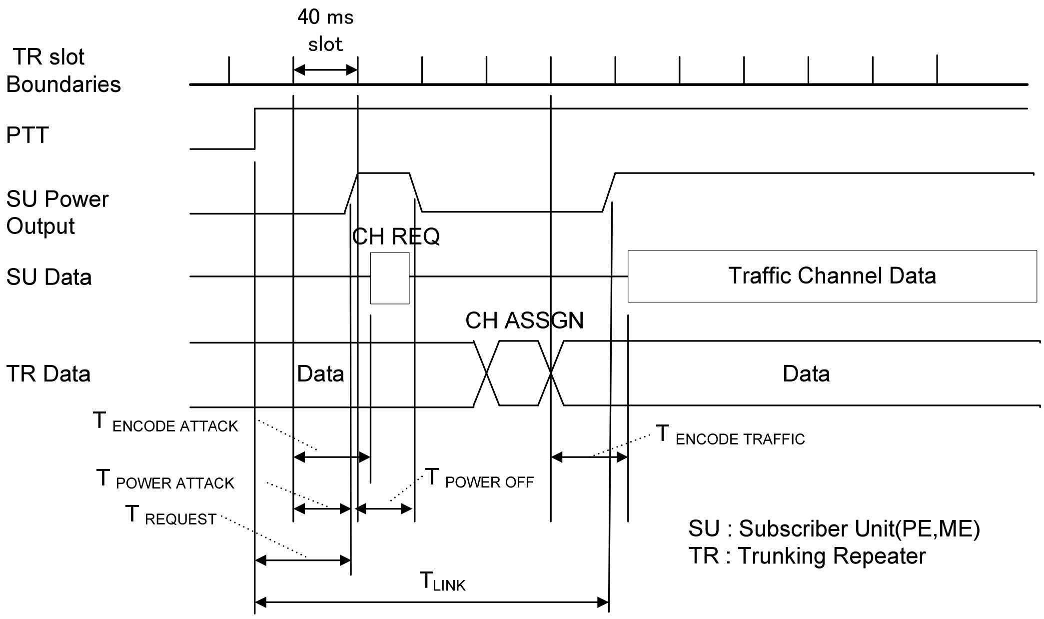

Figure 5.3-2　Trunked System Timing Parameters (9600bps)

5.3.1. Trunking Control Channel Slot Times

5.3.1.1. Definition

The trunking control channel slot time is a measure of the timing accuracy of inbound transmission of SU to the slot timing on a control channel.

There are 3 measurement items for timing.

- Trunking Encode Attack Time ($T_{ENCODE\ ATTACK}$)
- Trunking Power Attack Time ($T_{POWER\ ATTACK}$)
- Trunking Power Off Time ($T_{POWER\ OFF}$)

5.3.1.2. Method of Measurement and Recommended Value

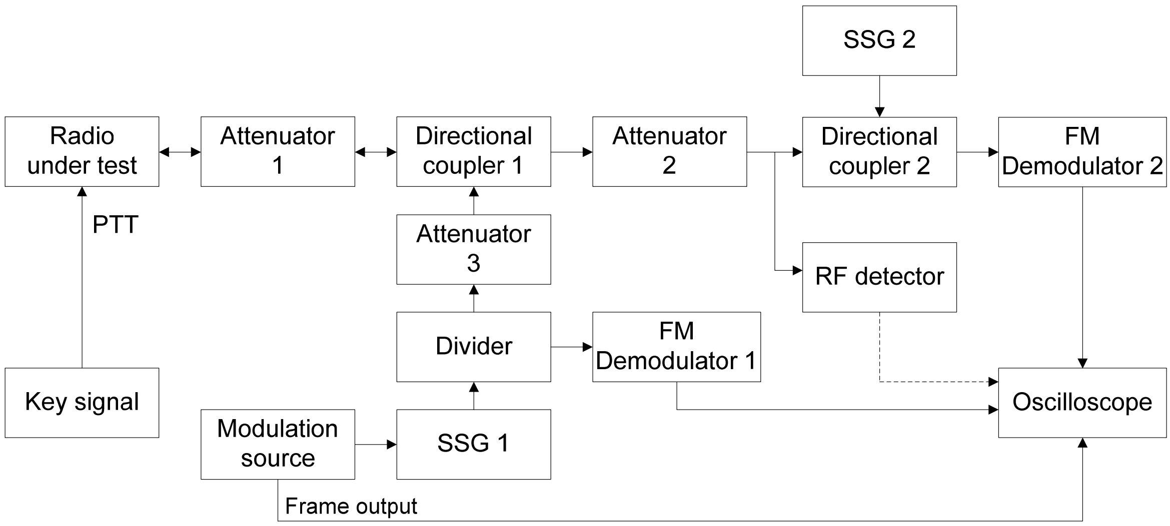

Figure 5.3-3 Trunking Control Channel Slot Times

(a) Connect the radio under test and the measuring instruments as shown in Figure 5.3-3. The radio under test turns on or off its transmitter by the key signal. The radio under test shall be set for trunking operation. Connect the output ports of FM demodulators 1 and 2 to input channels of the oscilloscope.

(b) Connect the Frame output signal of the modulation source to an input channel of the oscilloscope. The modulation source stores frame data of the outbound control channel. The frame output signal of the modulation source indicates the slot boundary of the outbound control channel and synchronizes with the beginning of frames. Set signal generator 1 to the frequency of the outbound control channel and adjust appropriately the output so that the input level to FM demodulator 1 does not exceed the maximum allowed input level. Adjust attenuators 1 and 3 so that the radio under test has a sufficient input level.

(c) Set appropriately the audio bandwidth of FM demodulators 1 and 2 in consideration of delay time.

(d) Set signal generator 2 to the frequency of the inbound control channel and to an unmodulated condition. Set appropriately attenuator 2 so that the input level to FM demodulator 2 does not exceed the maximum allowed input level, and set the output of signal generator 2 to about 20 dB below the input level which originates from the radio under test and to above the minimum input level of FM demodulator 2.
(e) Turn on the radio under test and set it in standby.
(f) Turn the transmitter on. Capture the waveform by triggering the oscilloscope with the changing point of the demodulated signal from FM demodulator 2. Adjust the delay time of the oscilloscope so that the oscilloscope can display the beginning of FSW of the inbound control channel that appeared on the output of FM demodulator 2 and the beginning of FSW of the outbound control channel that appeared on the output of FM demodulator 1 40 ms before that, and measure the time interval between the peak impulse response of the first symbols of each FSW.
The time interval is the Trunking Encode Attack Time ($T_{ENCODE\ ATTACK}$).
(g) Turn the transmitter off.
(h) Connect the signal of the RF detector to the oscilloscope instead of the output of FM demodulator 1.
(i) Turn the transmitter on. Capture the waveform by triggering the oscilloscope with the changing point of the demodulated signal from FM demodulator 2. Adjust the display so that the oscilloscope can display the Frame output signal and the rising edge of the RF detector as shown in Figure 5.3-4 or Figure 5.3-6, and measure the time interval from the Frame output signal until the output of the RF detector reaches a value of 3 dB below the nominal level.
The time interval is the Trunking Power Attack Time ($T_{POWER\ ATTACK}$).
(j) Turn the transmitter off.
(k) Turn the transmitter on. Capture the waveform by triggering the oscilloscope with the changing point of the demodulated signal from FM demodulator 2. Adjust the display so that the oscilloscope can display the Frame output signal and the falling edge of the RF detector as shown in Figure 5.3-5 or Figure 5.3-7, and measure the time interval from the Frame output signal until the output of the RF detector reaches a value of 3 dB below the nominal level.
The time interval is the Trunking Power Off Time ($T_{POWER\ OFF}$).
(l) Turn the transmitter off.
(m) The allowable ranges of each measurement are shown in the following tables.

	Minimum	Maximum
$T_{ENCODE\ ATTACK}$	40 ms - 1 symbol time	40 ms + 1 symbol time
$T_{POWER\ ATTACK}$	22 ms *1	$T_{ENCODE\ ATTACK}$
$T_{POWER\ OFF}$	20 ms	38 ms *2

Table 5.3-1 Trunking Control Channel Slot Times (4800bps)

	Minimum	Maximum
$T_{ENCODE\ ATTACK}$	40 ms - 1 symbol time	40 ms + 1 symbol time
$T_{POWER\ ATTACK}$	31 ms *1	$T_{ENCODE\ ATTACK}$
$T_{POWER\ OFF}$	30 ms	39 ms *2

Table 5.3-2 Trunking Control Channel Slot Times (9600bps)

*1: The output power in the rising edge shall not exceed a value of 60 dB below the nominal power.
*2: The output power in the falling edge shall not exceed a value of 60 dB below the nominal power.

The waveforms in the rising and falling edge for each condition are shown in Figure 5.3-4 to Figure 5.3-7.

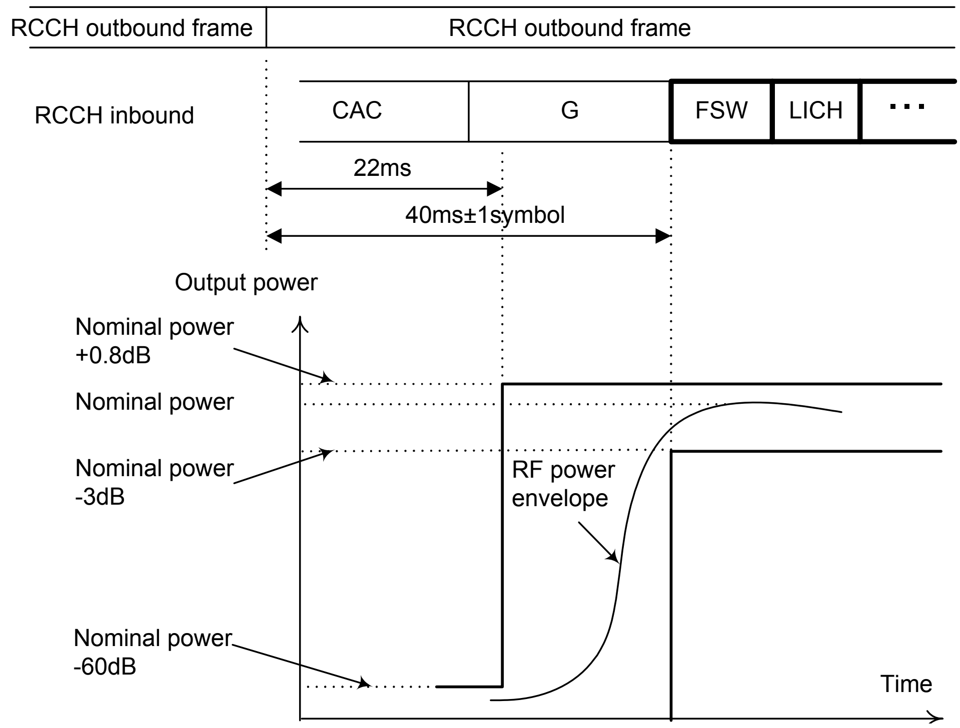

Figure 5.3-4 $T_{POWER\ ATTACK}$ (4800 bps)

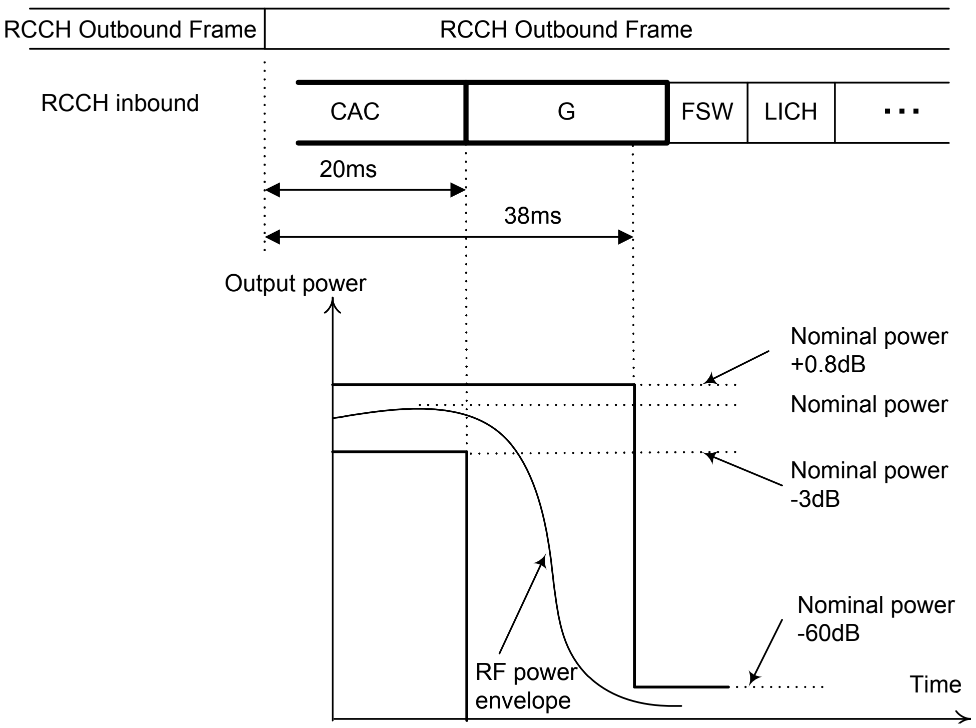

Figure 5.3-5 $T_{POWER\ OFF}$ (4800 bps)

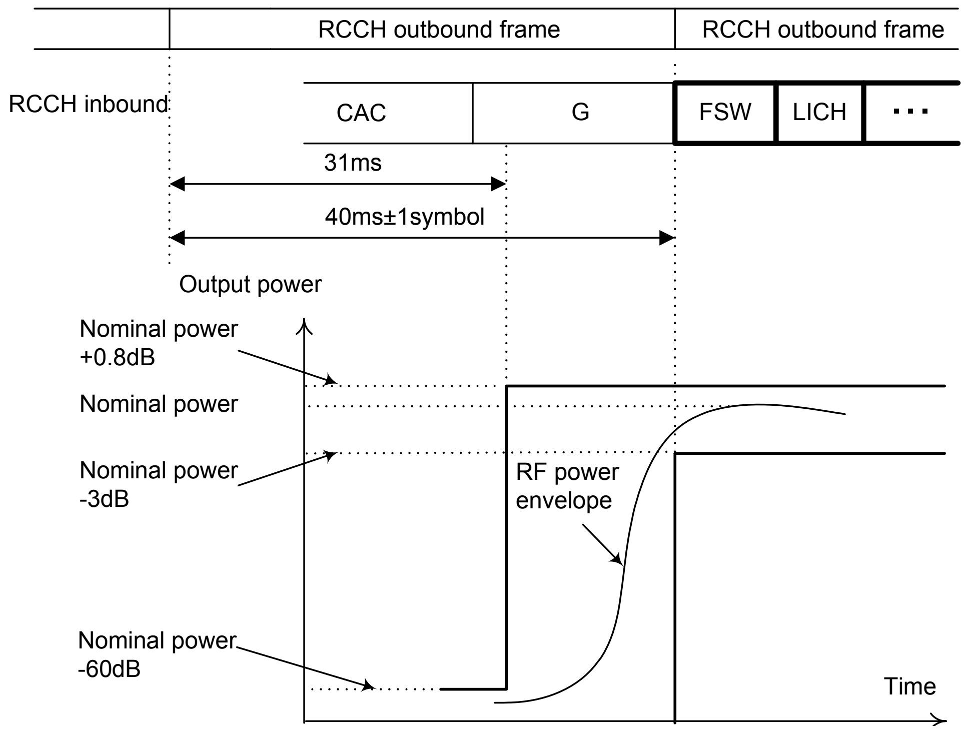

Figure 5.3-6 $T_{POWER\ ATTACK}$ (9600 bps)

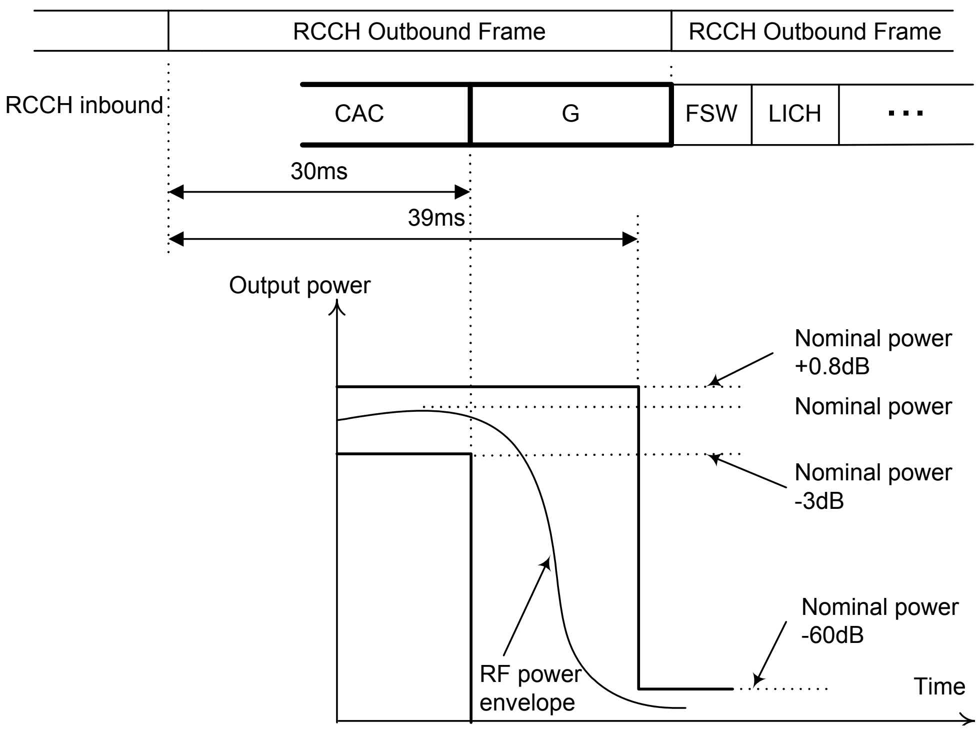

Figure 5.3-7 $T_{POWER\ OFF}$ (9600 bps)

5.3.2. Trunking Request Time

5.3.2.1. Definition

The trunking request time is a measure of the time from when the PTT of an SU is activated until a channel assignment request is sent on the control channel.

5.3.2.2. Method of Measurement and Recommended Value

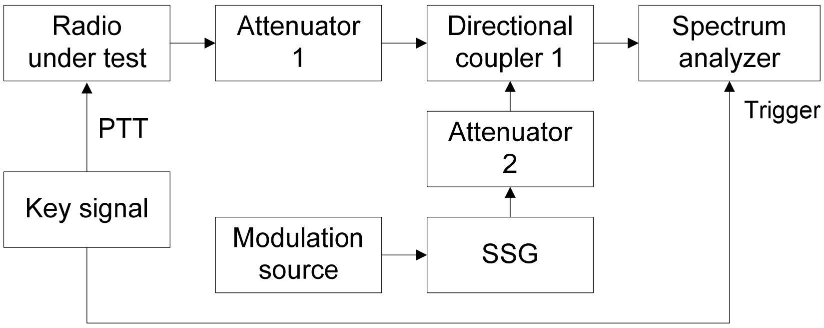

Figure 5.3-8 Trunking Request Time

(a) Connect the radio under test and the measuring instruments as shown in Figure 5.3-8. The radio under test shall be set for trunking operation. The modulation source previously stores frame data of the outbound control channel. Set the signal generator to the frequency of the outbound control channel and adjust attenuators 1 and 2 so that the input level to the radio under test is a sufficient level for reception.

(b) Connect the key signal to the external trigger of the spectrum analyzer. Set the center frequency of the spectrum analyzer to the frequency of the inbound control channel, and set it to the zero span mode.

(c) The radio under test migrates to a standby state when it is turned on while the signal generator is sending signals.

(d) Check that the spectrum analyzer is triggered with the key signal, and prepare to capture the display.

(e) Turn the key signal on and adjust the delay time of the spectrum analyzer so that the spectrum analyzer can display the rising edge of output power of the radio under test on the control channel.

(f) Measure the time interval from the initiation of the key signal until the output power of the radio under test reaches a value of 3 dB below the nominal power on the display of the spectrum analyzer.

(g) The average of the 10 samples recorded in step (f) is the Trunking Request Time ($T_{REQUEST}$).

(h) It is recommended that the Trunking Request Time ($T_{REQUEST}$) is 120 ms or less for 4800 bps or 80 ms or less for 9600 bps.

5.3.3. Trunking Link Time

5.3.3.1. Definition

The trunking link time is a measure of the time required from when the PTT of an SU is activated until the SU has begun to transmit on a traffic channel which is assigned on the control channel. This measurement includes the processing time for both the SU and the TR.

5.3.3.2. Method of Measurement and Recommended Value

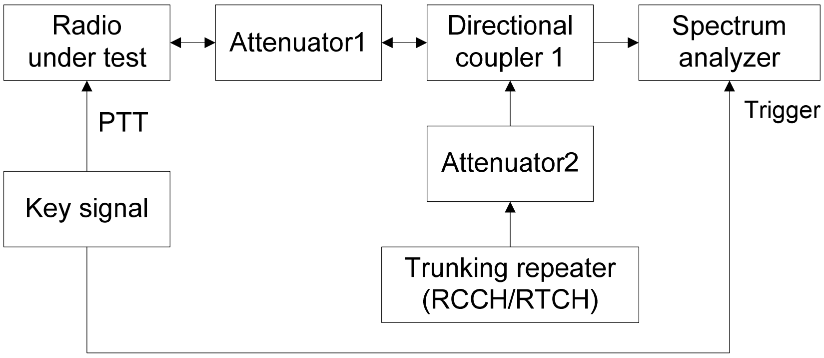

Figure 5.3-9 Trunking Link Time

(a) Connect the radio under test and the measuring instruments as shown in Figure 5.3-9. The radio under test shall be set for trunking operation. Adjust attenuators 1 and 2 so that the input level to the radio under test is a sufficient level for reception.
(b) Connect the key signal to the external trigger of the spectrum analyzer. Set the center frequency of the spectrum analyzer to the frequency of the inbound traffic channel, and set it to the zero span mode.
(c) Activate the trunking operation of the TR, and turn on power of the radio under test.
(d) Check that the spectrum analyzer is triggered with the key signal and prepare to capture the display.
(e) Turn the key signal on and adjust the delay time of the spectrum analyzer so that the spectrum analyzer can display the rising edge of output power of the radio under test on the traffic channel.
(f) Measure the time interval from the initiation of the key signal until the output power of the radio under test reaches a value of 3 dB below the nominal power on the display of the spectrum analyzer.
(g) The average of the 10 samples recorded in step (f) is the Trunking Link Time (T_{LINK}).
(h) It is recommended that the Trunking Link Time (T_{LINK}) is 360 ms or less for 4800 bps or 240 ms or less for 9600 bps. The TR is subject to send a channel assignment at 40 ms after receiving a channel assignment request from the SU.

5.3.4. Trunking Encode Time on a Traffic Channel

5.3.4.1. Definition

The trunking encode time on a traffic channel is a measure of the accuracy of the transmission timing of SU on an inbound traffic channel.

5.3.4.2. Method of Measurement and Recommended Value

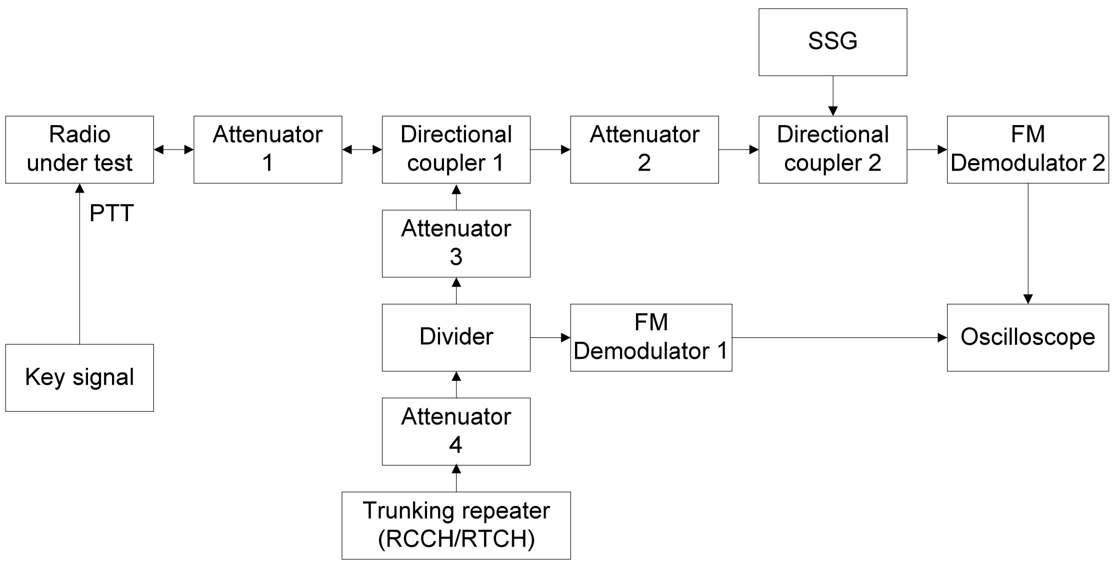

Figure 5.3-10 Trunking Encode Time on a Traffic Channel

(a) Connect the radio under test and the measuring instruments as shown in Figure 5.3-10. The radio under test shall be set for trunking operation. Connect the output ports of FM demodulators 1 and 2 to input channels of the oscilloscope.

(b) Adjust attenuator 4 so that the input level to FM demodulator 1 does not exceed the maximum allowed input level when the trunking repeater is transmitting. Adjust attenuators 1 and 3 so that the input level to the radio under test is a sufficient level for reception.

(c) Set appropriately the audio bandwidth of FM demodulators 1 and 2 in consideration of delay time.

(d) Set the signal generator to the frequency of the inbound traffic channel and to an unmodulated condition. Set appropriately attenuator 2 so that the input level to FM demodulator 2 does not exceed the maximum allowed input level, and set the output of the signal generator to about 20 dB below the input level which originates from the radio under test and above the minimum input level of FM demodulator 2.

(e) Turn on the radio under test and set it in standby.

(f) Turn the transmitter on. Capture the waveform by triggering the oscilloscope with the changing point of the demodulated signal from FM demodulator 2. Adjust the delay time of the oscilloscope so that the oscilloscope can display the beginning of FSW of the inbound traffic channel that appeared on the output of FM demodulator 2 and the beginning of FSW of the outbound control channel that appeared on the output of FM demodulator 1 40 ms before that, and measure the time interval between the peak impulse response of the first symbols of each FSW.

The time interval is the Trunking Encode Time on a Traffic Channel ($T_{ENCODE\ TRAFFIC}$).

(g) Turn the transmitter off.

(h) The allowable ranges of the Trunking Encode Time on a Traffic Channel ($T_{ENCODE\ TRAFFIC}$) are shown in the following table.

	Minimum	Maximum
$T_{ENCODE\ TRAFFIC}$	40 ms - 1 symbol time	40 ms + 1 symbol time

Table 5.3-3 Trunking Encode Time on a Traffic Channel (4800/9600bps)

5.4. Unit Characteristic

This section defines allowed degradation from standards (DFS) in Sections 5.1 and 5.2, in accordance with Section 4.3 for performance under specific environmental parameter conditions. “No DFS” means no degradation from the standard is allowed. Unless otherwise specified, all tests shall be done at the standard atmospheric conditions specified in Section 4.4.1.

5.4.1. Temperature Range

(a) The lower temperature limit for all equipment is -30 ºC.
(b) The upper temperature limit for all equipment is +60 ºC.

The following table includes the measurement items to be performed and allowed limits at both the lower and upper temperature limits.

Measurement Items	Limits
5.1.4 Reference Sensitivity (Static)	6 dB DFS
5.1.6 Adjacent Channel Rejection	12 dB DFS
5.1.7 Co-channel Rejection	2 dB DFS
5.1.8 Spurious Rejection	10 dB DFS
5.1.9 Intermodulation Rejection	6 dB DFS
5.2.1 Transmit Power	3 dB DFS
5.2.2 Frequency Error	No DFS
5.2.10 Maximum Frequency Deviation	No DFS
5.2.11 1/3 Frequency Deviation	No DFS
5.2.12 Modulation Accuracy	No DFS
5.2.13 Modulation Symbol Speed	No DFS

Table 5.4-1 Extreme Temperature Tests and DFS Limits

6. Revision History

Version	Date	Revised Contents
0.1	Nov 6 2008	Version 0.1 (draft) release
1.0	Mar 19 2009	Version 1.0 release
1.1	Mar 31 2012	Section 2; Add the version number Section 5.1.4.1; Correct the description