Si4455 and ARIB STD-T108 Compliance at 920 MHz

1. Introduction

This document demonstrates the compliance of the Si4455 (B0, B1, C0, C1, C2) RFIC with the regulatory requirements of ARIB STD-T108 in the 920 MHz band. The measurements within this document were taken with an Si4455-B1 RFIC mounted on a 4455-PCE10D915M / 4455CPCE10D915M / 4455-PCE13D915M / 4455CPCE13D915M Direct-tie RF Pico Board (see the Reference Design Schematics in Section 5). The compliance investigations were taken with a fundamental output power of +13, +10 and 0 dBm.

1.1. Summary of Measured Results

A summary of measured results is provided in Table 1. An overview of the measured results may be stated as follows:

- For **+13 dBm** fundamental output power:
  - Selection of a modulation protocol with DR=100 kbps and Deviation=50 kHz makes the Si4455 RFIC not compliant with the ARIB STD-T108 standard, when using one unit radio channel (N=1)
  - Selection of a modulation protocol with DR=80 kbps and Deviation=40 kHz makes the Si4455 RFIC compliant in the 922.4 to 928.0 MHz frequency band with the ARIB STD-T108 standard with acceptable margins when using one unit radio channel (N=1)
  - Selection of a modulation protocol with DR=200 kbps and Deviation=100 kHz makes the Si4455 RFIC compliant in the 922.4 to 928.0 MHz frequency band with the ARIB STD-T108 standard with practically no margins when using two unit radio channels (N=2)
  - Selection of a modulation protocol with DR=180 kbps and Deviation=90 kHz makes the Si4455 RFIC compliant in the 922.4 to 928.0 MHz frequency band with the ARIB STD-T108 standard with acceptable margins when using two unit radio channels (N=2)
  - Selection of a modulation protocol with DR=80 kbps and Deviation=40 kHz makes the Si4455 RFIC compliant in the 920.6 to 922.2 MHz frequency band with the ARIB STD-T108 standard with no margins when using one unit radio channel (N=1)
  - Selection of a modulation protocol with DR=70 kbps and Deviation=35 kHz makes the Si4455 RFIC compliant in the 920.6 to 922.2 MHz frequency band with the ARIB STD-T108 standard with acceptable margins when using one unit radio channel (N=1)
  - Selection of a modulation protocol with DR=200 kbps and Deviation=100 kHz makes the Si4455 RFIC not compliant in the 920.6 to 922.2 MHz frequency band with the ARIB STD-T108 standard when using two unit radio channels (N=2)
  - Selection of a modulation protocol with DR=150 kbps and Deviation=75 kHz makes the Si4455 RFIC compliant in the 920.6 to 922.2 MHz frequency band with the ARIB STD-T108 standard with practically no margins when using two unit radio channels (N=2)
  - Selection of a modulation protocol with DR=120 kbps and Deviation=60 kHz makes the Si4455 RFIC compliant in the 920.6 to 922.2 MHz frequency band with the ARIB STD-T108 standard with acceptable margins when using two unit radio channels (N=2)
- For **+10 dBm** fundamental output power:
  - Selection of a modulation protocol with DR=100 kbps and Deviation=50 kHz makes the Si4455 RFIC compliant with the ARIB STD-T108 standard, but with practically no margins when using one unit radio channel (N=1)
  - Selection of a modulation protocol with DR=80 kbps and Deviation=40 kHz makes the Si4455 RFIC compliant with the ARIB STD-T108 standard with acceptable margins when using one unit radio channel (N=1)
  - Lumping two units of radio channels (N=2) in the 920.6 to 922.2 MHz frequency band compliance can be achieved with acceptable margins with selecting the data rate up to 150 kbps with 75 kHz deviation
  - Lumping two units of radio channels (N=2) in the 922.4 to 928.0 MHz frequency band compliance can be achieved with acceptable margins with selecting the data rate up to 200 kbps with 100 kHz deviation
- For **0 dBm** fundamental output power:
  - Selection of a modulation protocol with DR=100 kbps and Deviation=50 kHz makes the Si4455 RFIC compliant with

the ARIB STD-T108 standard in the 916.0 to 916.8 Hz and 920.6 to 928.0 MHz bands, but with practically no margins when using one unit radio channel (N=1)

- Selection of a modulation protocol with DR=80 kbps and Deviation=40 kHz makes the Si4455 RFIC compliant with the ARIB STD-T108 standard in the 916.0 to 916.8 MHz and 920.6 to 928.0 MHz bands with great margins when using one unit radio channel (N=1)
- Selection of a modulation protocol with DR=50 kbps and Deviation=25 kHz makes the Si4455 RFIC compliant with the ARIB STD-T108 standard in the 928.15 to 929.65 MHz band, but with practically no margins when using one unit radio channel (N=1)
- Selection of a modulation protocol with DR=40 kbps and Deviation=20 kHz makes the Si4455 RFIC compliant with the ARIB STD-T108 standard in the 928.15 to 929.65 MHz band with great margins when using one unit radio channel (N=1)

Table 1. Summary of Measured Results

Spec Par	Parameter	Condition	Limit	Measured	Margin
3.2(1)	TX Antenna Power	920.6 to 923.4 MHz	+24 dBm	13.00 dBm	11.00 dB
		920.6 to 923.4 MHz	+24 dBm	10.31 dBm	13.69 dB
		923.6 to 928.0 MHz	+13 dBm	13.00 dBm	0.00 dB
		923.6 to 928.0 MHz	+13 dBm	10.31 dBm	2.69 dB
		916.0 to 916.8 MHz 928.15 to 929.65 MHz	0 dBm	–0.02 dBm	0.02 dB
3.2(2)	Tolerance of Antenna Power		+20%/–80%	+0.5/–1.5 dB	Comply
3.2(3)	Radio Channel		N=1 to 5		Comply
3.2(4)	Frequency Tolerance		±20 ppm	N/A	N/A
3.2(5)	Modulation Method		N/A	N/A	N/A
3.2(6)	Occupied Frequency Bandwidth	916.0 to 916.8 MHz 920.6 to 928.0 MHz DR=100 kbps, N=1	200 kHz	177.7 kHz	22.3 kHz
		916.0 to 916.8 MHz 920.6 to 928.0 MHz DR=80 kbps, N=1	200 kHz	141.0 kHz	59.0 kHz
		916.0 to 916.8 MHz 920.6 to 928.0 MHz DR=200 kbps, N=2	400 kHz	341.8 kHz	58.2 kHz
		928.15 to 929.65 MHz DR=50 kbps, N=1	100 kHz	87.25 kHz	12.75 kHz
		928.15 to 929.65 MHz DR=100 kbps, N=2	200 kHz	177.2 kHz	22.8 kHz

Note: "Purple text indicates that if the margin on the given parameter is low (less than 3 dB), compare to the standard limit. Red text indicates that the given parameter fails the standard limit."

Table 1. Summary of Measured Results (Continued)

Spec Par	Parameter	Condition	Limit	Measured	Margin
3.2(7)	Adjacent Channel Leakage Power	920.6 to 928.0 MHz 10 dBm, DR=100 kbps, N=1	–15 dBm	–15.33 dBm	0.33 dB
		920.6 to 928.0 MHz 10 dBm, DR=80 kbps, N=1	–15 dBm	–24.26 dBm	9.26 dB
		920.6 to 928.0 MHz 10 dBm, DR=100 kbps, N=2	–15 dBm	–38.86 dBm	23.86 dB
		920.6 to 928.0 MHz 10 dBm, DR=200 kbps, N=2	–15 dBm	–18.01 dBm	3.01 dB
		916.0 to 916.8 MHz 0 dBm, DR=100 kbps, N=1	–26 dBm	–26.01 dBm	0.01 dB
		916.0 to 916.8 MHz 0 dBm, DR=100 kbps, N=2	–26 dBm	–49.6 dBm	23.6 dB
		916.0 to 916.8 MHz 0 dBm, DR=80 kbps, N=1	–26 dBm	–35.17 dBm	9.17 dB
		928.15 to 929.65 MHz 0 dBm, DR=50 kbps, N=1	–26 Bm	–26.34 dBm	0.34 dB
		928.15 to 929.65 MHz 0 dBm, DR=50 kbps, N=2	–26 dBm	–51.07 dBm	25.07 dB
		928.15 to 929.65 MHz 0 dBm, DR=40 kbps, N=1	–26 dBm	–35.53 dBm	9.53 dB
		920.6 to 928.0 MHz 13 dBm, DR=100 kbps, N=1	–15 dBm	–12.9 dBm	-2.1 dB
		920.6 to 928.0 MHz 13 dBm, DR=80 kbps, N=1	–15 dBm	–22.03 dBm	7.03 dB
		920.6 to 928.0 MHz 13 dBm, DR=100 kbps, N=2	–15 dBm	–36.04 dBm	21.04 dB
		920.6 to 928.0 MHz 13 dBm, DR=200 kbps, N=2	–15 dBm	–15.48 dBm	0.48 dB
		920.6 to 928.0 MHz 13 dBm, DR=180 kbps, N=2	–15 dBm	–19.43 dBm	4.43 dB

Note: "Purple text indicates that if the margin on the given parameter is low (less than 3 dB), compare to the standard limit. Red text indicates that the given parameter fails the standard limit."

Table 1. Summary of Measured Results (Continued)

Spec Par	Parameter	Condition	Limit	Measured	Margin
3.2(7)	Spectral Mask	922.4 to 928.0 MHz 10 dBm, DR=100 kbps, N=1	–36 dBm/100 kHz	–41.81 dBm	5.81 dB
		922.4 to 928.0 MHz 10 dBm, DR=100 kbps, N=2	–36 dBm/100 kHz	–44.75 dBm	8.75 dB
		922.4 to 928.0 MHz 10 dBm, DR=200 kbps, N=2	–36 dBm/100 kHz	–39.27 dBm	3.27 dB
		920.6 to 922.2 MHz 10 dBm, DR=100 kbps, N=1	–36 dBm/100 kHz		0.87 dB
		920.6 to 922.2 MHz 10 dBm, DR=80 kbps, N=1	–36 dBm/100 kHz	–38.93 dBm	2.93 dB
		920.6 to 922.2 MHz 10 dBm, DR=100 kbps, N=2	–36 dBm/100 kHz	–41.53 dBm	5.53 dB
		920.6 to 922.2 MHz 10 dBm, DR=150 kbps, N=2	–36 dBm/100 kHz	–39.09 dBm	3.09 dB
		920.6 to 922.2 MHz 10 dBm, DR=200 kbps, N=2	–36 dBm/100 kHz		–18.88 dB
		916.0 to 916.8 MHz 0 dBm, DR=100 kbps, N=1	–36 dBm/100 kHz	–52.07 dBm	16.07 dB
		928.15 to 929.65 MHz 0 dBm, DR=50 kbps, N=1	–36 dBm/100 kHz	–49.97 dBm	13.97 dB
		922.4 to 928.0 MHz 13 dBm, DR=100 kbps, N=1	–36 dBm/100 kHz		2.85 dB
		922.4 to 928.0 MHz 13 dBm, DR=80 kbps, N=1	–36 dBm/100 kHz	–39.30 dBm	3.30 dB
		922.4 to 928.0 MHz 13 dBm, DR=100 kbps, N=2	–36 dBm/100 kHz	–42.70 dBm	6.70 dB
		922.4 to 928.0 MHz 13 dBm, DR=200 kbps, N=2	–36 dBm/100 kHz	–36.72 dBm	0.72 dB
		922.4 to 928.0 MHz 13 dBm, DR=180 kbps, N=2	–36 dBm/100 kHz	–38.38 dBm	2.38 dB
3.2(7)	Spectral Mask	920.6 to 922.2 MHz 13 dBm, DR=100 kbps, N=1	–36 dBm/100 kHz		–1.72 dB
		920.6 to 922.2 MHz 13 dBm, DR=80 kbps, N=1	–36 dBm/100 kHz	–36.60 dBm	0.60 dB
		920.6 to 922.2 MHz 13 dBm, DR=70 kbps, N=1	–36 dBm/100 kHz	–39.21 dBm	3.21 dB

Note: "Purple text indicates that if the margin on the given parameter is low (less than 3 dB), compare to the standard limit. Red text indicates that the given parameter fails the standard limit."

Table 1. Summary of Measured Results (Continued)

Spec Par	Parameter	Condition	Limit	Measured	Margin
		920.6 to 922.2 MHz 13 dBm, DR=100 kbps, N=2	–36 dBm/100 kHz	–39.27 dBm	3.27 dB
		920.6 to 922.2 MHz 13 dBm, DR=200 kbps, N=2	–36 dBm/100 kHz	–14.66 dBm	–21.34 dB
		920.6 to 922.2 MHz 13 dBm, DR=150 kbps, N=2	–36 dBm/100 kHz	–36.70 dBm	0.70 dB
		920.6 to 922.2 MHz 13 dBm, DR=120 kbps, N=2	–36 dBm/100 kHz		3.33 dB
3.2(8)	Spurious Emissions TX, 10 mW	F ≤ 710 MHz	–36 dBm/100 kHz	–67.08 dBm	31.08 dB
		710 MHz < F ≤ 900 MHz	–55 dBm/1 MHz	–62.62 dBm	7.62 dB
		900 MHz < F ≤ 915 MHz	–55 dBm/100 kHz	–74.52 dBm	19.52 dB
		915 MHz < F ≤ 920.3 MHz	–36 dBm/100 kHz	–68.17 dBm	32.17 dB
		920.3 MHz < F ≤ 924.3 MHz	–36 dBm/100 kHz	–56.19 dBm	20.19 dB
		924.3 MHz < F ≤ 930 MHz	–36 dBm/100 kHz	–41.6 dBm	5.6 dB
		930 MHz < F ≤ 1 GHz	–55 dBm/100 kHz	–63.08 dBm	8.08 dB
		1 GHz < F ≤ 1.215 GHz	–48 dBm/1 MHz	–66.04 dBm	18.04 dB
		F > 1.215 GHz	–30 dBm/1 MHz	–39.44 dBm	9.44 dB
3.2(8)	Spurious Emissions TX, 20 mW	F ≤ 710 MHz	–36 dBm/100 kHz	–73.77 dBm	37.77 dB
		710 MHz < F ≤ 900 MHz	–55 dBm/1 MHz	–61.80 dBm	6.80 dB
		900 MHz < F ≤ 915 MHz	–55 dBm/100 kHz	–72.92 dBm	17.92 dB
		915 MHz < F ≤ 920.3 MHz	–36 dBm/100 kHz	–66.00 dBm	30.00 dB
3.2(8)	Spurious Emissions TX, 20 mW	920.3 MHz < F ≤ 924.3 MHz	–36 dBm/100 kHz	–53.69 dBm	17.69 dB
		924.3 MHz < F ≤ 930 MHz	–36 dBm/100 kHz	–39.24 dBm	3.24 dB
		930 MHz < F ≤ 1 GHz	–55 dBm/100 kHz	–60.73 dBm	5.73 dB
		1 GHz < F ≤ 1.215 GHz	–48 dBm/1 MHz	–64.13 dBm	16.13 dB
		F > 1.215 GHz	–30 dBm/1 MHz	–39.69 dBm	9.69 dB

Note: "Purple text indicates that if the margin on the given parameter is low (less than 3 dB), compare to the standard limit. Red text indicates that the given parameter fails the standard limit."

Table 1. Summary of Measured Results (Continued)

Spec Par	Parameter	Condition	Limit	Measured	Margin
3.3	RX Conducted Spurious Emissions 10 mW schematic	F ≤ 710 MHz	–54 dBm/100 kHz	–85.21 dBm	31.21 dB
		710 MHz < F ≤ 900 MHz	–55 dBm/1 MHz	–80.38 dBm	25.38 dB
		900 MHz < F ≤ 915 MHz	–55 dBm/100 kHz	–93.17 dBm	38.17 dB
		915 MHz < F ≤ 930 MHz	–54 dBm/100 kHz	–93.15 dBm	39.15 dB
		930 MHz < F ≤ 1 GHz	–55 dBm/100 kHz	–91.13 dBm	36.13 dB
		F > 1 GHz	–47 dBm/1 MHz	–72.71 dBm	25.71 dB
3.3	RX Conducted Spurious Emissions 20 mW schematic	F ≤ 710 MHz	–54 dBm/100 kHz	–88.30 dBm	34.30 dB
		710 MHz < F ≤ 900 MHz	–55 dBm/1 MHz	–80.24 dBm	25.24 dB
		900 MHz < F ≤ 915 MHz	–55 dBm/100 kHz	–92.83 dBm	37.83 dB
		915 MHz < F ≤ 930 MHz	–54 dBm/100 kHz	–92.88 dBm	38.88 dB
		930 MHz < F ≤ 1 GHz	–55 dBm/100 kHz	–90.85 dBm	35.85 dB
		F > 1 GHz	–47 dBm/1 MHz	–69.68 dBm	22.68 dB

Note: "Purple text indicates that if the margin on the given parameter is low (less than 3 dB), compare to the standard limit. Red text indicates that the given parameter fails the standard limit."

2. Summary ARIB STD-T108 Requirements in the 920 MHz Band

The main requirements of ARIB STD-T108 in the 920 MHz band are summarized in this section.

2.1. ARIB STD-T108 3.2(1) Antenna Power

The antenna power shall be less than or equal to 250 mW (+24 dBm). However, the antenna power shall be less than or equal to 1 mW (0 dBm) for radio channels consisting of only unit radio channel with center frequencies ranging from 916.0 MHz to 916.8 MHz and from 928.15 MHz to 929.65 MHz, and shall be less than or equal to 20 mW (+13 dBm) with center frequencies ranging from 923.6 MHz to 928.0 MHz.

2.2. ARIB STD-T108 3.2(2) Tolerance of Antenna Power

The tolerance of the antenna power shall be within +20% to –80%.

2.3. ARIB STD-T108 3.2(3) Radio Channel

A radio channel shall consist of up to five consecutive unit radio channels. Unit radio channels are channels with bandwidths of 200 kHz with center frequencies of 916.0 MHz + 200 kHz x n (with n = positive integer greater than or equal to zero) for center frequencies between 916.0 MHz to 916.8 MHz, or center frequencies of 920.6 MHz + 200 kHz x n for center frequencies between 920.6 MHz to 928.0 MHz. Within the frequency range of 928.15 MHz to 929.65 MHz, the channel bandwidth is 100 kHz and the center frequency shall be set at 928.15 MHz + 100 kHz x n.

2.4. ARIB STD-T108 3.2(4) Frequency Tolerance

The frequency tolerance shall be within ±20 ppm.

2.5. ARIB STD-T108 3.2(5) Modulation Method

The modulation method is not specified. All measurements performed in this document were taken with 2GFSK modulation.

2.6. ARIB STD-T108 3.2(6) Occupied Frequency Bandwidth

The occupied frequency bandwidth shall be less than or equal to 200 kHz x n (with n = the number of unit radio channels constituting the radio channel and is an integer from 1 to 5). However, the occupied frequency bandwidth shall be less than 100 kHz x n when the center frequencies are within the range of 928.15 MHz to 929.65 MHz.

2.7. ARIB STD-T108 3.2(7) Adjacent Channel Leakage Power

The standard provides for a variety of adjacent channel leakage power spectral masks as a function of channel center frequency and output power level.

2.7.1. Antenna Power=1 mW, Freq. Band=916.0 to 916.8 MHz and 920.6 to 928.0 MHz

Within the frequency bands of 916.0 to 916.8 MHz and 920.6 to 928.0 MHz, the channel spectral mask shall be as shown in Figure 1 when operating with antenna power of less than or equal to 1 mW. The adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –26 dBm.

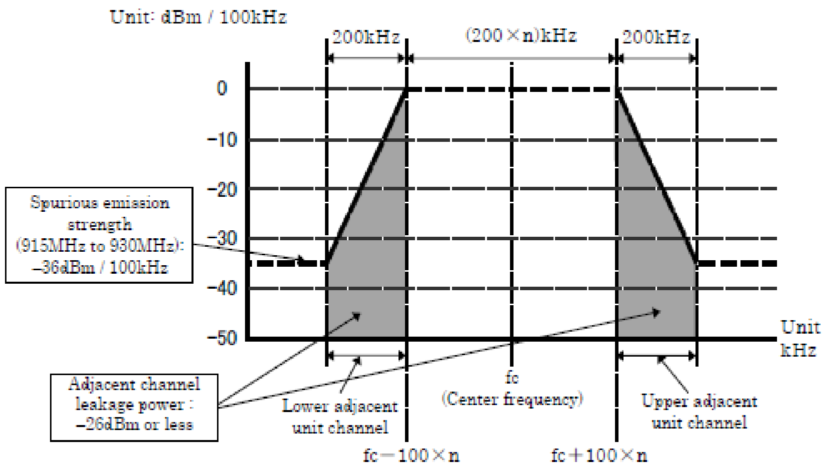

Figure 1. Channel Spectral Mask (1 mW, 916.0 to 916.8 MHz and 920.6 to 928.0 MHz)

2.7.2. Antenna Power=20 mW, Freq. Band=922.4 to 928.0 MHz

Within the frequency band of 922.4 to 928.0 MHz, the channel spectral mask shall be as shown in Figure 2 when operating with antenna power of more than 1 mW and less than or equal to 20 mW. The adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –15 dBm.

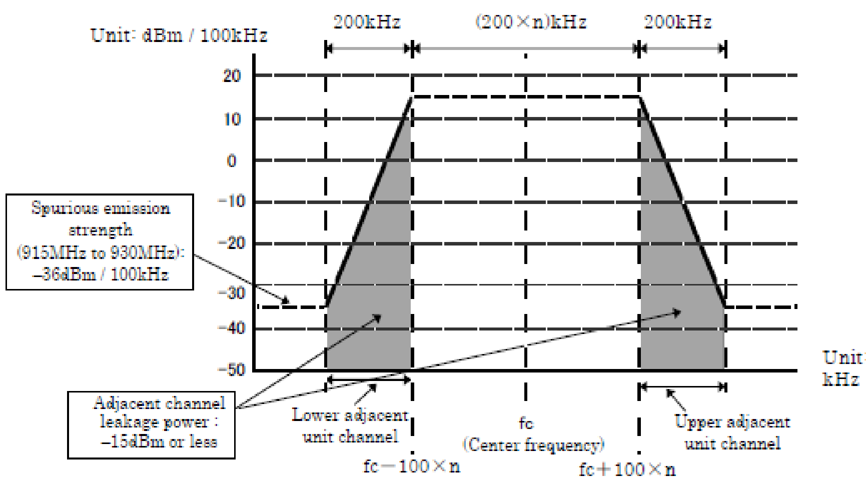

Figure 2. Channel Spectral Mask (20 mW, 922.4 to 928.0 MHz)

2.7.3. Antenna Power=250 mW, Freq. Band=922.4 to 923.4 MHz

Within the frequency band of 922.4 to 923.4 MHz, the channel spectral mask shall be shown as in Figure 3 when operating with antenna power of more than 20 mW and less than or equal to 250 mW. The adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –5 dBm.

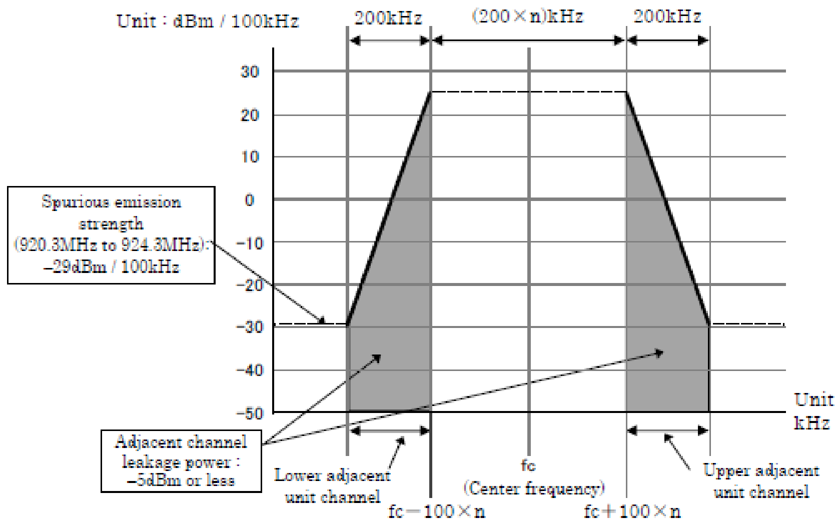

Figure 3. Channel Spectral Mask (250 mW, 922.4 to 923.4 MHz)

2.7.4. Antenna Power=20 mW, Freq. Band=920.6 to 922.2 MHz

Within the frequency band of 920.6 to 922.2 MHz, the channel spectral mask shall be as shown in Figure 4 when operating with antenna power of more than 1 mW and less than or equal to 20 mW. The adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –15 dBm.

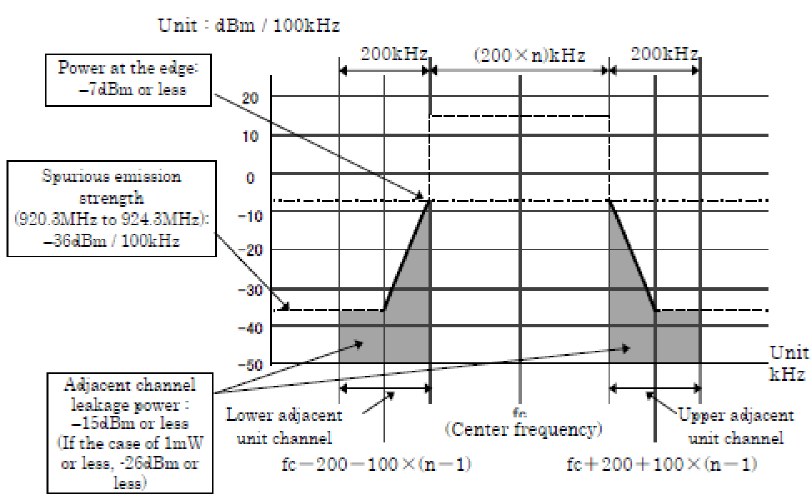

Figure 4. Channel Spectral Mask (20 mW, 920.6 to 922.2 MHz)

2.7.5. Antenna Power=250 mW, Freq. Band=920.6 to 922.2 MHz

Within the frequency band of 920.6 to 922.2 MHz, the channel spectral mask shall be as shown in Figure 5 when operating with antenna power of more than 20 mW and less than or equal to 250 mW. The adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –5 dBm.

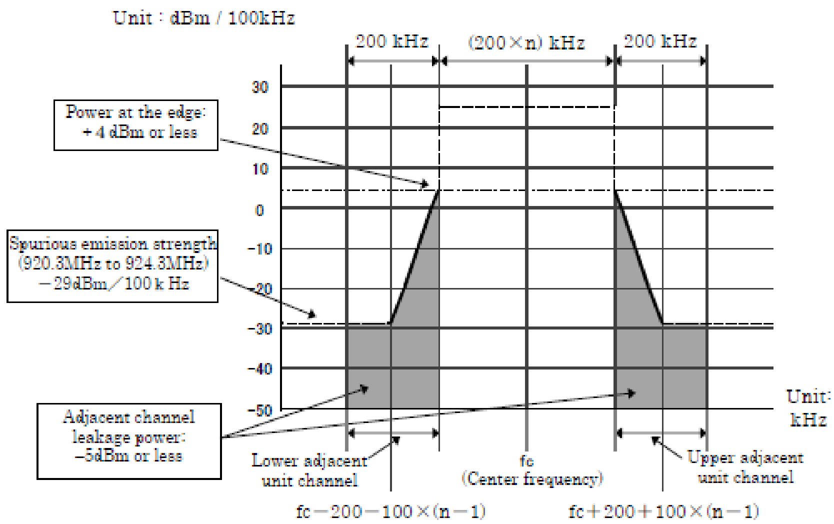

Figure 5. Channel Spectral Mask (250 mW, 920.6 to 922.2 MHz)

2.7.6. Antenna Power=1 mW, Freq. Band=928.15 to 929.65 MHz

Within the frequency band of 928.15 to 929.65 MHz, the channel spectral mask shall be as shown in Figure 6 when operating with antenna power of less than or equal to 1 mW. The adjacent channel leakage power within the 100 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –26 dBm.

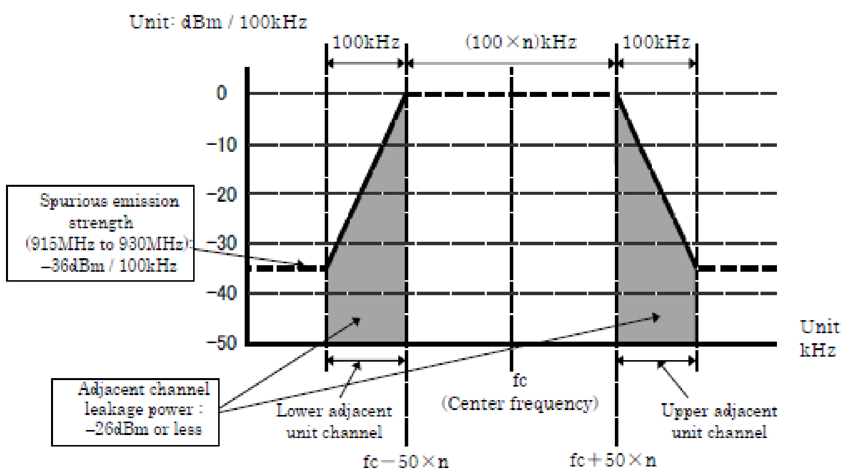

Figure 6. Channel Spectral Mask (1 mW, 928.15 to 929.65 MHz)

2.8. ARIB STD-T108 3.2(8) TX Spurious Emissions

The spurious emission strength at the antenna input in TX mode shall be less than the values shown in Table 2.

Table 2. TX Spurious Emission Specifications

Frequency Band	Spurious Emission Strength (average power)	Reference BW
F ≤ 710 MHz	–36 dBm	100 kHz
710 MHz < F ≤ 900 MHz	–55 dBm	1 MHz
900 MHz < F ≤ 915 MHz	–55 dBm	100 kHz
915 MHz < F ≤ 920.3 MHz	–36 dBm	100 kHz
920.3 MHz < F ≤ 924.3 MHz (except for |f – fc| ≤ 200 + 100 x n kHz)	–36 dBm (P_{out} ≤ 20 mW)	100 kHz
	–29 dBm (P_{out} > 20 mW)	100 kHz
924.3 MHz < f ≤ 930.0 MHz (except for |f – fc| ≤ 200 + 100 x n kHz when unit channel bandwidth is 200 kHz)	–36 dBm	100 kHz
924.3 MHz < f ≤ 930.0 MHz (except for |f – fc| ≤ 100 + 50 x n kHz when unit channel bandwidth is 100 kHz)	–36 dBm	100 kHz
930 MHz < F ≤ 1 GHz	–55 dBm	100 kHz
1 GHz < F ≤ 1.215 GHz	–48 dBm	1 MHz
F > 1.215 GHz	–30 dBm	1 MHz

2.9. ARIB STD-T108 3.3 Receiver Conducted Spurious Emissions

The conducted spurious emission strength at the receiver input shall be less than the values shown in Table 3.

Table 3. RX Conducted Spurious Emission Specifications

Frequency Band	Spurious Emission Strength	Reference BW
F ≤ 710 MHz	–54 dBm	100 kHz
710 MHz < F ≤ 900 MHz	–55 dBm	1 MHz
900 MHz < F ≤ 915 MHz	–55 dBm	100 kHz
915 MHz < F ≤ 930 MHz	–54 dBm	100 kHz
930 MHz < F ≤ 1 GHz	–55 dBm	100 kHz
F > 1 GHz	–47 dBm	1 MHz

3. TX Measurement Results

3.1. ARIB STD-T108 3.2(1) Antenna Power

The allowed transmitter antenna power is specified as less than 20 mW (+13 dBm) within the frequency range of 920.6 MHz to 928.0 MHz (however up to +24 dBm antenna power is also allowed in the band of 920.6 to 923.4 MHz). The measured transmitter antenna power within this frequency range is shown in Figure 7. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(1) for Transmit Antenna Power.

- Limit: 20 mW=+13 dBm (max)
- Measured: +13.00 dBm
- Margin: 0.00 dB (PASS)

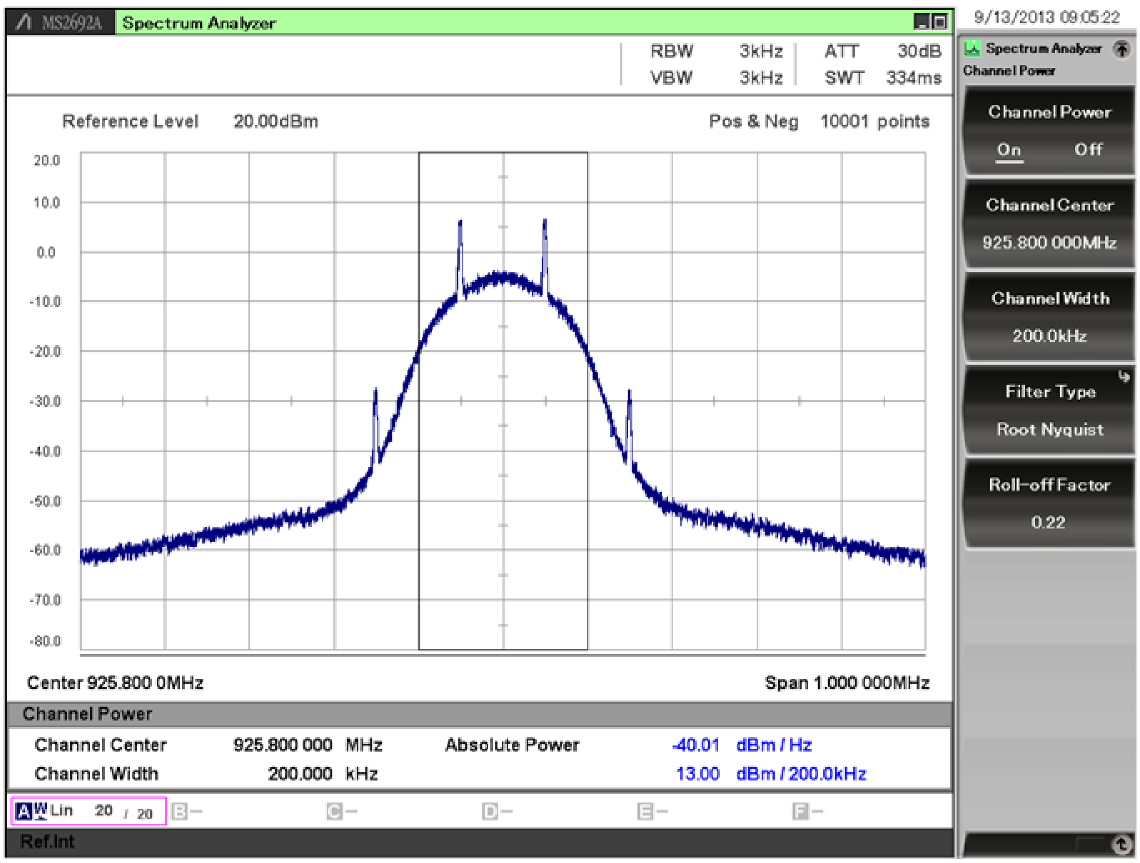

Figure 7. Transmitter Antenna Power (20 mW, 920.6 to 928.0 MHz)

The allowed transmitter antenna power is specified as less than 20 mW (+13 dBm) within the frequency range of 920.6 MHz to 928.0 MHz (however up to +24 dBm antenna power is allowed in the band of 920.6 to 923.4 MHz). The measured transmitter antenna power within this frequency range with adjusting to the output power to 10 mW (since the output power of the targeted applications with Si4455 is typically +10 dBm) is shown in Figure 8. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(1) for Transmit Antenna Power.

- Limit: 20 mW=+13 dBm (max)
- Measured: +10.31 dBm
- Margin: 2.69 dB (PASS)

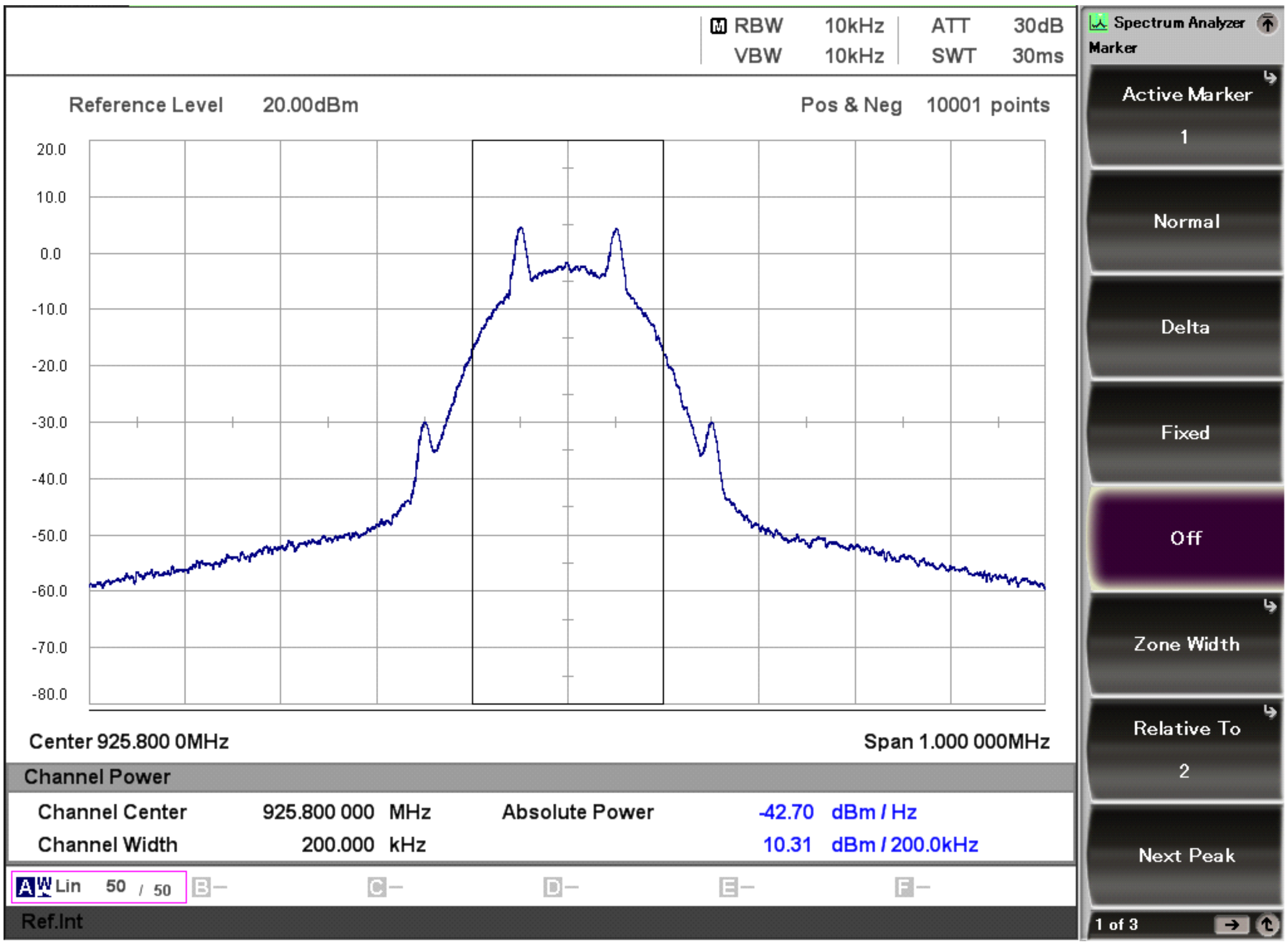

Figure 8. Transmitter Antenna Power (10 mW, 920.6 to 928.0 MHz)

The allowed transmitter antenna power is specified as less than 1 mW (0 dBm) within the frequency range of 916.0 MHz to 916.8 MHz and from 928.15 MHz to 929.65 MHz. The measured transmitter antenna power within this frequency range is shown in Figure 9. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(1) for Transmit Antenna Power.

- Limit: 1 mW=0 dBm (max)
- Measured: –0.02 dBm
- Margin: 0.02 dB (PASS)

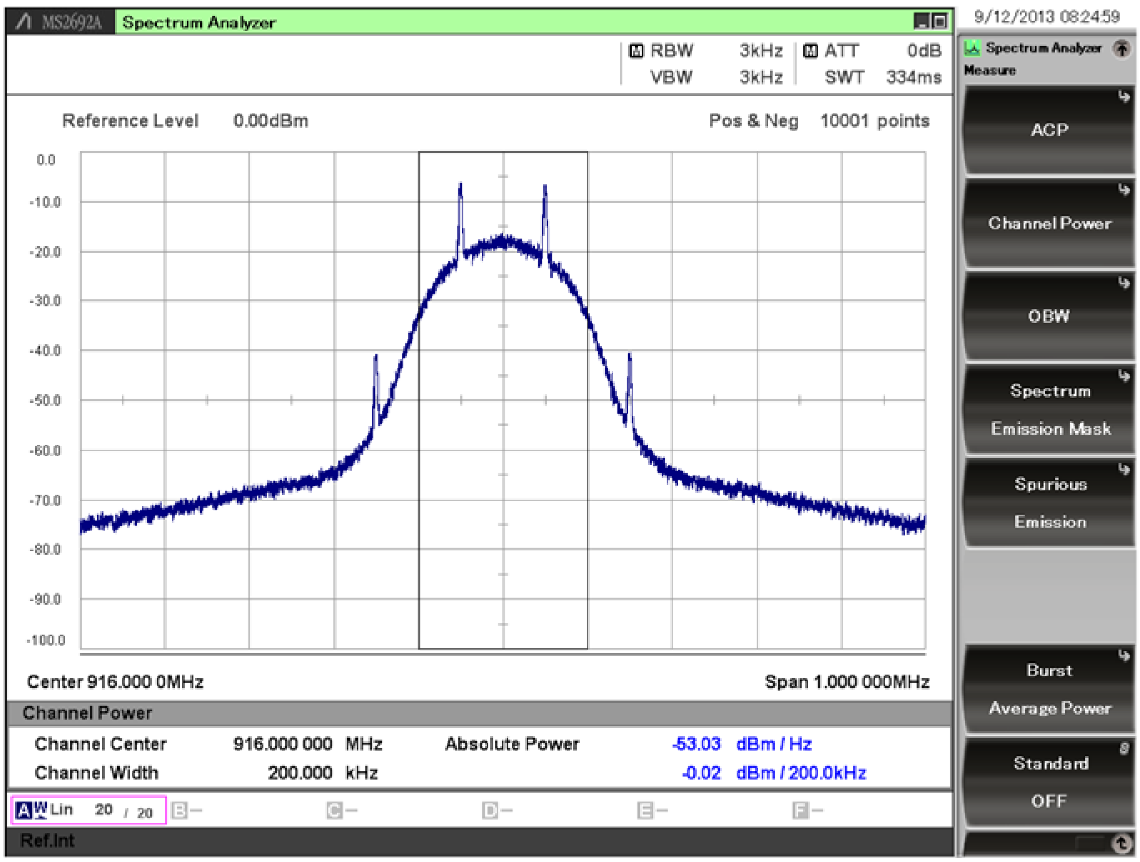

Figure 9. Transmitter Antenna Power (1 mW, 916.0 to 916.8 MHz and from 928.15 to 929.65 MHz)

3.2. ARIB STD-T108 3.2(2) Tolerance of Antenna Power

The part-to-part variation of TX output power of the Si4455 chips is typically +0.5/–1.5 dB at maximum output power, at a given frequency and VDD supply voltage. The Si4455 chips therefore comply with the requirements of ARIB STD-T108 3.2(2) Tolerance of Antenna Power.

When using Class-E type matching the TX output power of the Si4455 RFIC exhibits a dependence upon VDD supply voltage (due to use of a switching-type power amplifier), it is necessary to operate a fixed VDD supply voltage. In order to avoid this VDD dependence it is recommended to use Switched-Current matching where the output power has a flat characteristic over the VDD supply voltage variation, but in this case the current consumption is higher.

3.3. ARIB STD-T108 3.2(3) Radio Channel

The Si4455 RFICs are capable of complying with all requirements of ARIB STD-T108 when operating with one unit radio channel (N=1), and is thus inherently capable of complying with wider radio channels (i.e., N=2 to 5). However, compliance is dependent upon selection of an appropriate modulation protocol (i.e, data rate and deviation).

3.4. ARIB STD-T108 3.2(4) Frequency Tolerance

The frequency accuracy of the Si4455 RFICs is solely dependent upon the frequency accuracy of the crystal reference signal. Compliance with this requirement is thus largely determined by the frequency tolerance of the selected crystal blank or external reference oscillator. All measurements within this document were taken with the crystal oscillator adjusted for zero frequency error.

3.5. ARIB STD-T108 3.2(5) Modulation Method

The modulation method is not specified in ARIB STD-T108. All measurements within this document were taken with 2GFSK, data rate = 100 kbps, and deviation = 50 kHz (unless noted otherwise). Compliance with certain requirements of the standard are heavily influenced by the selection of the modulation protocol; a greater margin of compliance may be obtained with a different selection of modulation protocol (e.g., lowering the data rate and/or deviation).

Furthermore, it is not possible (even on a theoretical basis) to ***simultaneously*** comply with all requirements of ARIB STD-T108 with this selection of modulation protocol. For example, the Frequency Tolerance specification of STD-T108 3.2(4) requires operation with up to ±20 ppm frequency error (i.e., ±18.4 kHz at 920 MHz). It is not possible to comply with the Adjacent Channel Leakage Power requirements of ARIB STD-T108 3.2(7) while operating with ±18.4 kHz frequency offset from channel center frequency with selection of data rate = 100 kbps and deviation = 50 kHz. The modulation bandwidth of such a signal is sufficiently wide that any error in frequency will cause in an increase in integrated power in the adjacent channel bandwidth, resulting in failure to comply with the Adjacent Channel Leakage Power spec.

3.6. ARIB STD-T108 3.2(6) Occupied Frequency Bandwidth

The allowed occupied frequency bandwidth is specified in ARIB STD-T108 3.2(6) as less than (n x 100 kHz) within the frequency band from 928.15 MHz to 929.65 MHz, and less than (n x 200 kHz) in all other frequency bands. The integer number 'N' represents the number of unit radio channels used by the system, and may range in value from N=1 to N=5.

The measured occupied frequency bandwidth within the frequency range of 920.6 MHz to 928.0 MHz is shown Figure 10. The selected modulation protocol was 2GFSK, DR = 100 kbps, Deviation = 50 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band.

- Limit: 200 kHz (max, for N=1)
- Measured: 177.7 kHz
- Margin: 22.3 kHz (PASS)

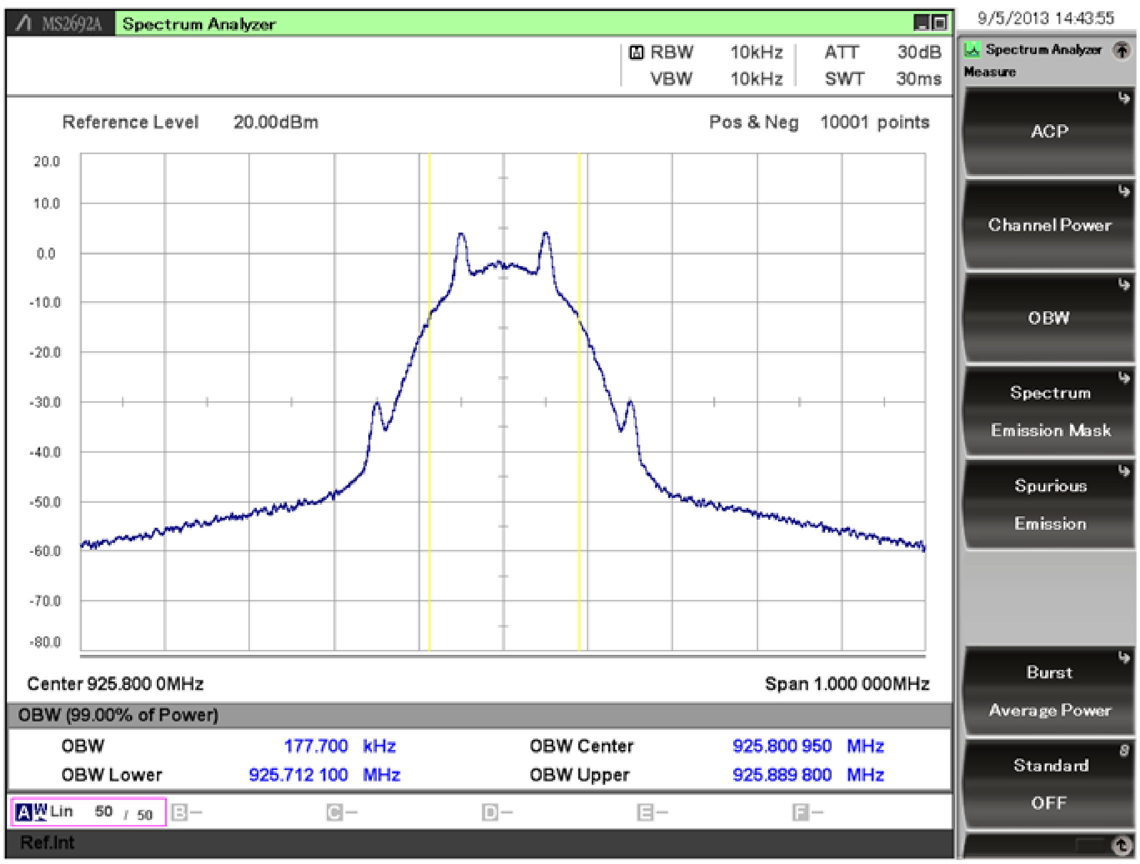

Figure 10. Occupied Bandwidth (DR=100 kbps Dev=50 kHz, 920.6 to 928.0 MHz)

The measured occupied frequency bandwidth within the frequency range of 920.6 MHz to 928.0 MHz is shown in Figure 11 with DR = 96 kbps, Deviation = 48 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band.

- Limit: 200 kHz (max, for N=1)
- Measured: 170.0 kHz
- Margin: 30.0 kHz (PASS)

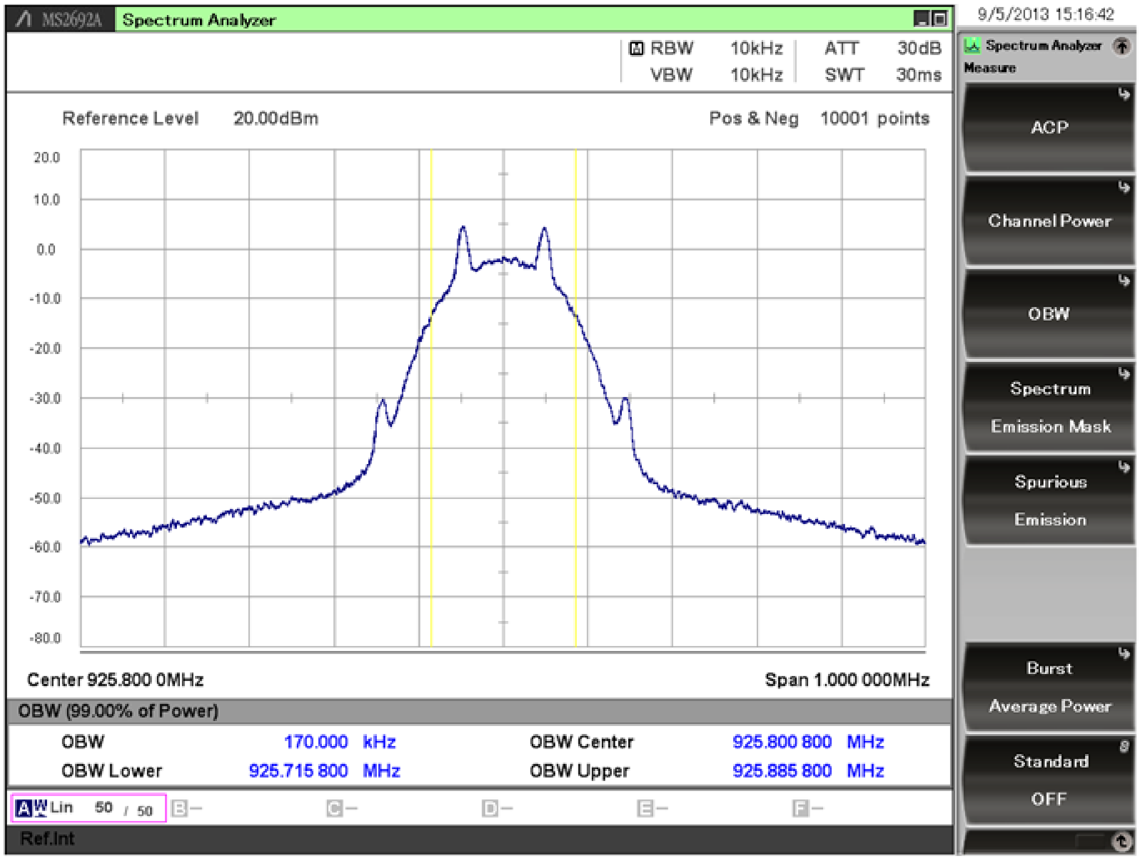

Figure 11. Occupied Bandwidth (DR=96 kbps Dev=48 kHz, 920.6 to 928.0 MHz)

The measured occupied frequency bandwidth within the frequency range of 920.6 MHz to 928.0 MHz is shown in Figure 12 with DR = 80 kbps, Deviation = 40 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band.

- Limit: 200 kHz (max, for N=1)
- Measured: 141.0 kHz
- Margin: 59.0 kHz (PASS)

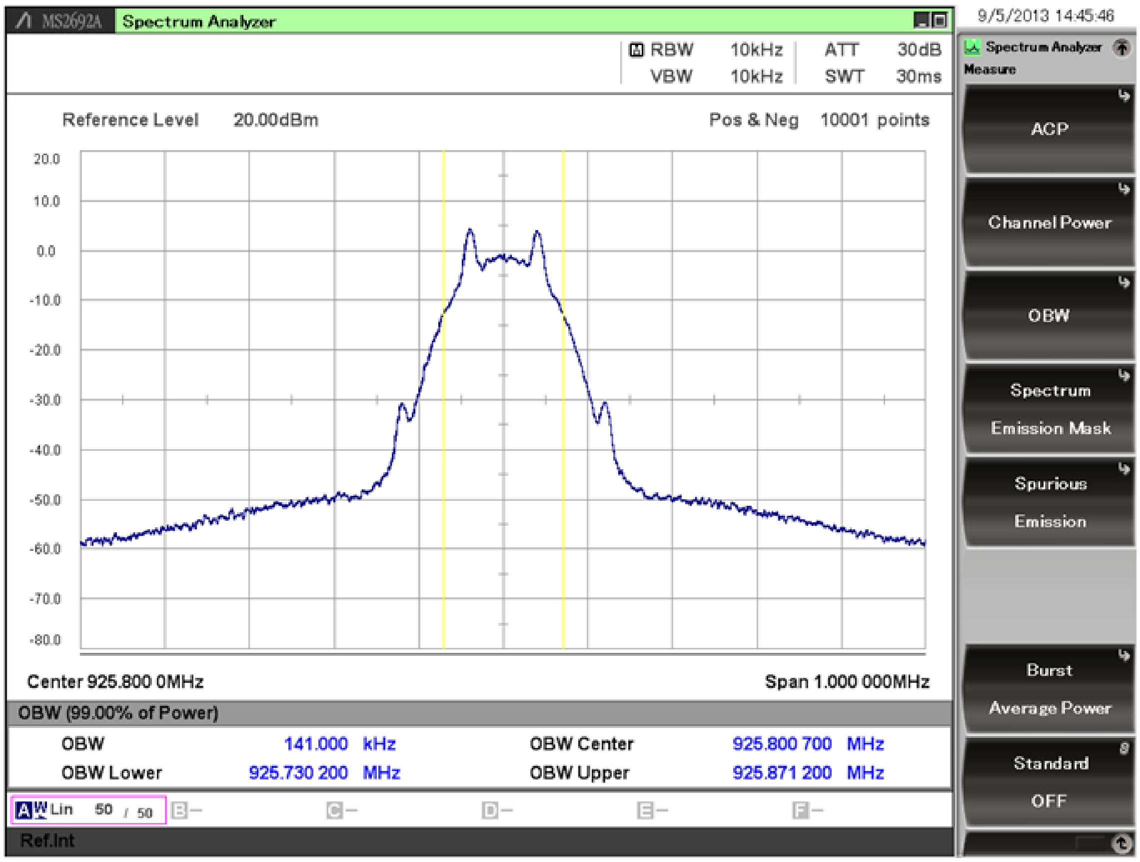

Figure 12. Occupied Bandwidth (DR=80 kbps Dev=40 kHz, 920.6 to 928.0 MHz)

The measured occupied frequency bandwidth within the frequency range of 920.6 MHz to 928.0 MHz is shown in Figure 13 with DR = 200 kbps, Deviation = 100 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band with lumping two units of radio channels (N=2).

- Limit: 400 kHz (max, for N=2)
- Measured: 341.8 kHz
- Margin: 58.2 kHz (PASS)

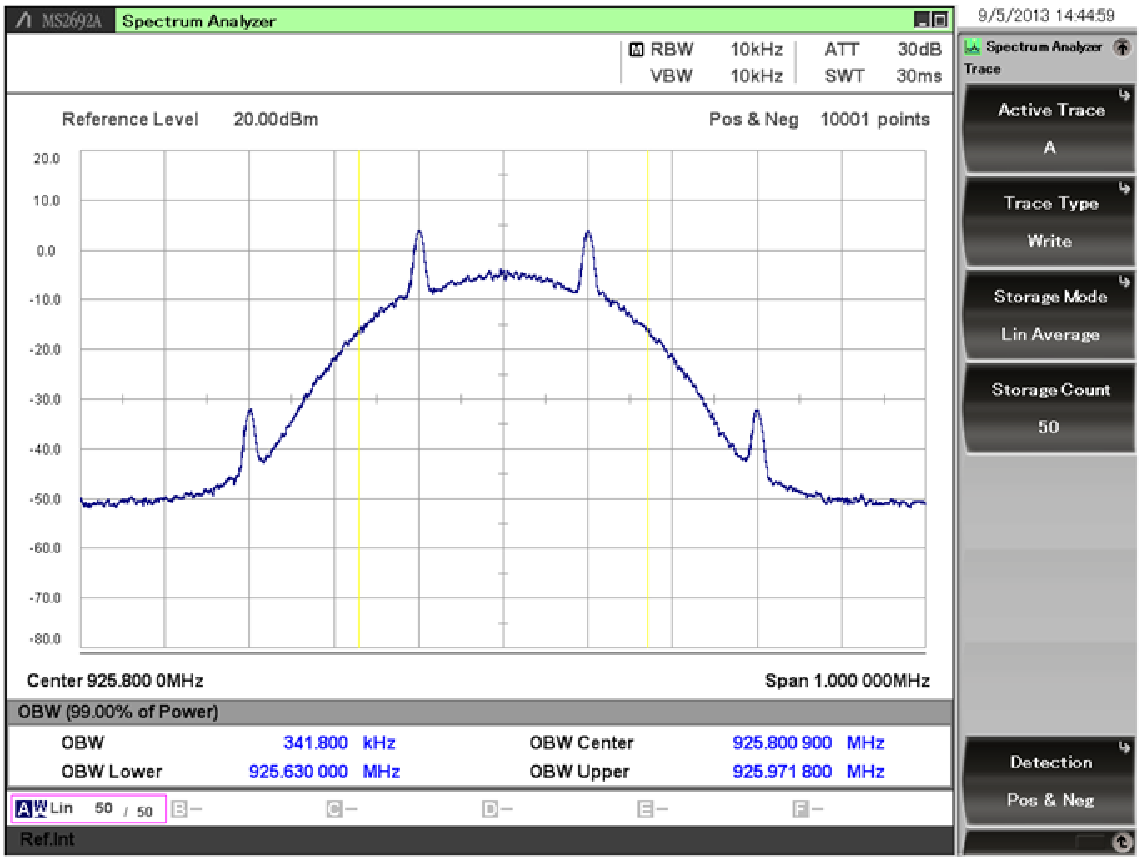

Figure 13. Occupied Bandwidth (DR=200 kbps Dev=100 kHz, 920.6 to 928.0 MHz, N=2)

The measured occupied frequency bandwidth within the frequency range of 928.15 MHz to 929.65 MHz is shown in Figure 14. The selected modulation protocol was 2GFSK, DR = 50 kbps, Deviation = 25 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band.

- Limit: 100 kHz (max, for N=1)
- Measured: 87.25 kHz
- Margin: 12.75 kHz (PASS)

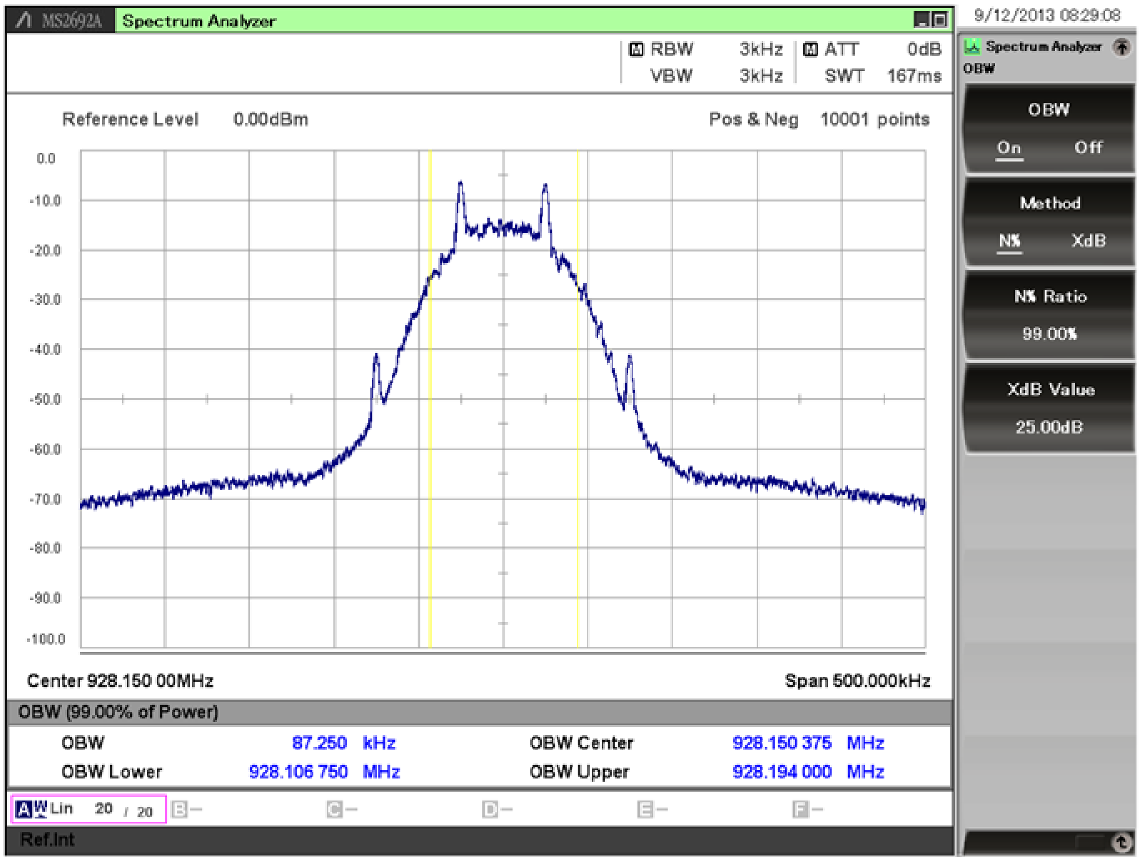

Figure 14. Occupied Bandwidth (DR=50 kbps Dev=25 kHz, 928.15 to 929.65 MHz)

The measured occupied frequency bandwidth within the frequency range of 928.15 MHz to 929.65 MHz is shown in Figure 15. The selected modulation protocol was 2GFSK, DR = 100 kbps, Deviation = 50 kHz. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(6) for Occupied Frequency Bandwidth within this frequency band with lumping two units of radio channels (N=2).

- Limit: 200 kHz (max, for N=2)
- Measured: 177.2 kHz
- Margin: 22.8 kHz (PASS)

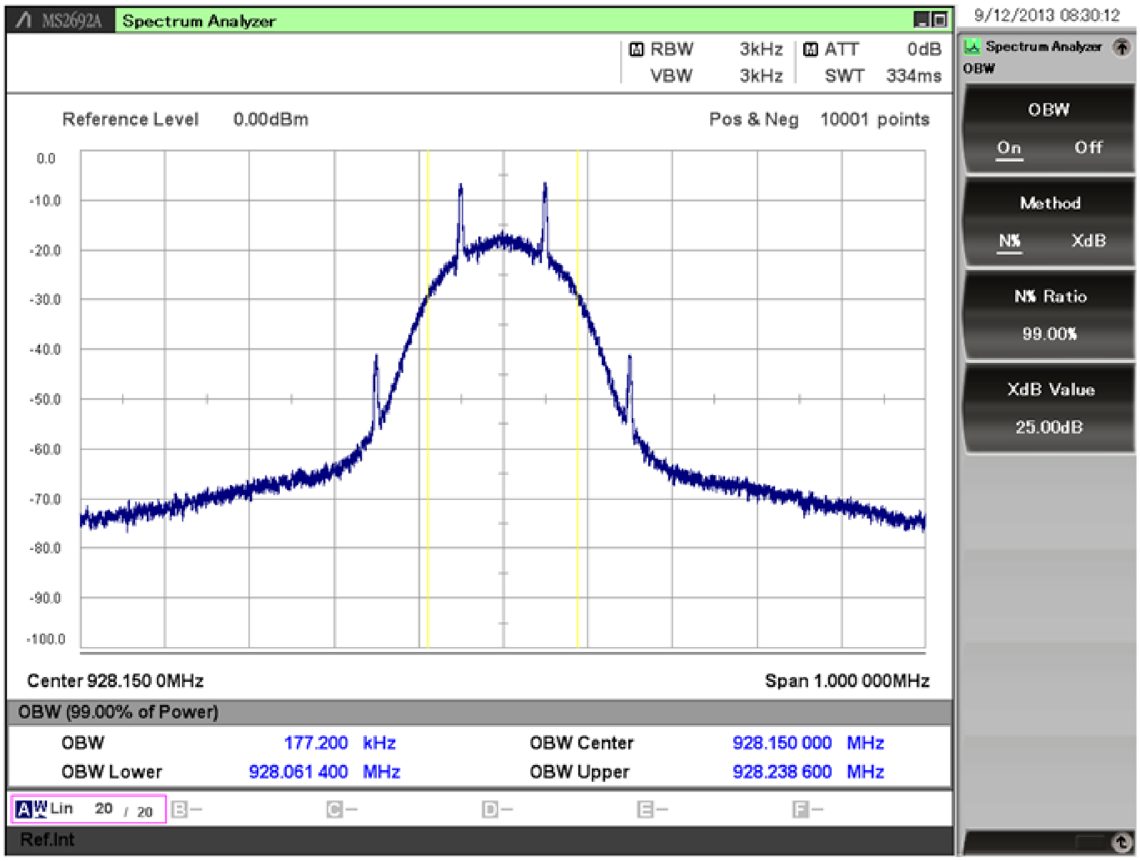

Figure 15. Occupied Bandwidth (DR=100 kbps Dev=50 kHz, 928.15 to 929.65 MHz, N=2)

3.7. ARIB STD-T108 3.2(7) Adjacent Channel Leakage Power

The allowed adjacent channel leakage power is specified in ARIB STD-T108 3.2(7), and is a function of channel center frequency and output power level.

3.7.1. ACP, Antenna power=10 mW, Freq. Band=920.6 to 928.0 MHz

Within the frequency band of 920.6 to 928.0 MHz when operating with antenna power of more than 1 mW and less than or equal to 20 mW, the integrated adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –15 dBm.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 16. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with practically no margins.

- Limit: –15 dBm (max)
- Measured: –15.33 dBm
- Margin: 0.33 dB (PASS)

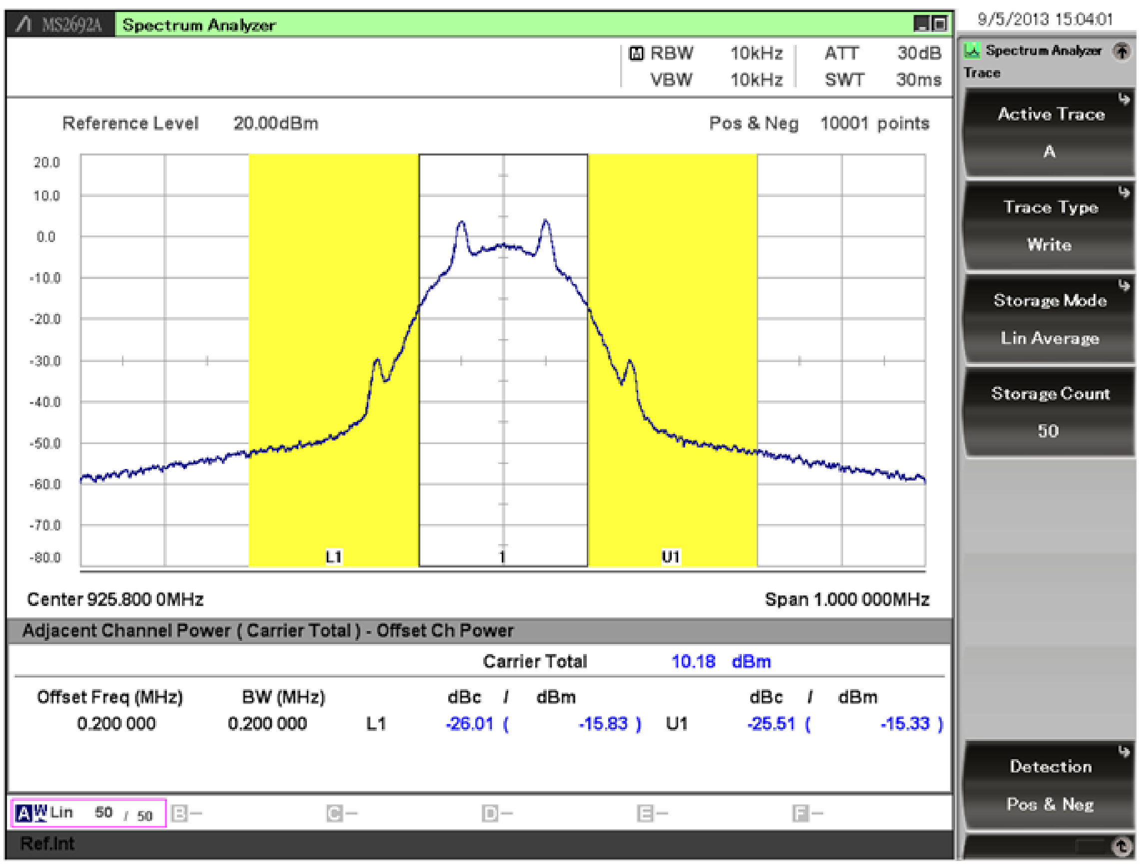

Figure 16. Adjacent Channel Leakage Power (DR=100 kbps Dev=50 kHz, 10 mW, 920.6 to 928.0 MHz, N=1)

Compliance with larger margins can be achieved by decreasing the data rate / frequency deviation of the modulation. The measured adjacent channel leakage powers with different data rates are shown in Figure 17 and Figure 18.

The selected modulation parameters were DR = 96 kbps and Deviation = 48 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 17. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –15 dBm (max)
- Measured: –17.01 dBm
- Margin: 2.01 dB (PASS)

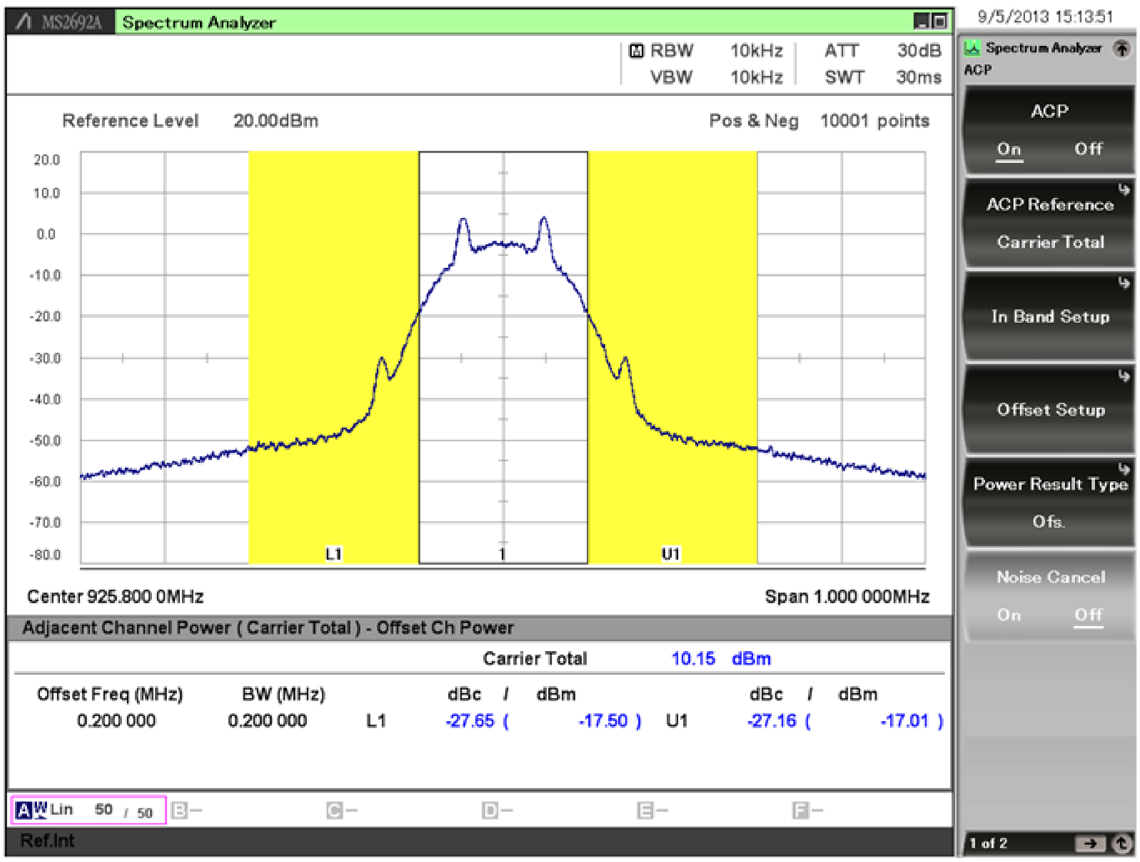

Figure 17. Adjacent Channel Leakage Power (DR=96 kbps Dev=48 kHz, 10 mW, 920.6 to 928.0 MHz, N=1)

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 18. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with large margins.

- Limit: –15 dBm (max)
- Measured: –24.26 dBm
- Margin: 9.26 dB (PASS)

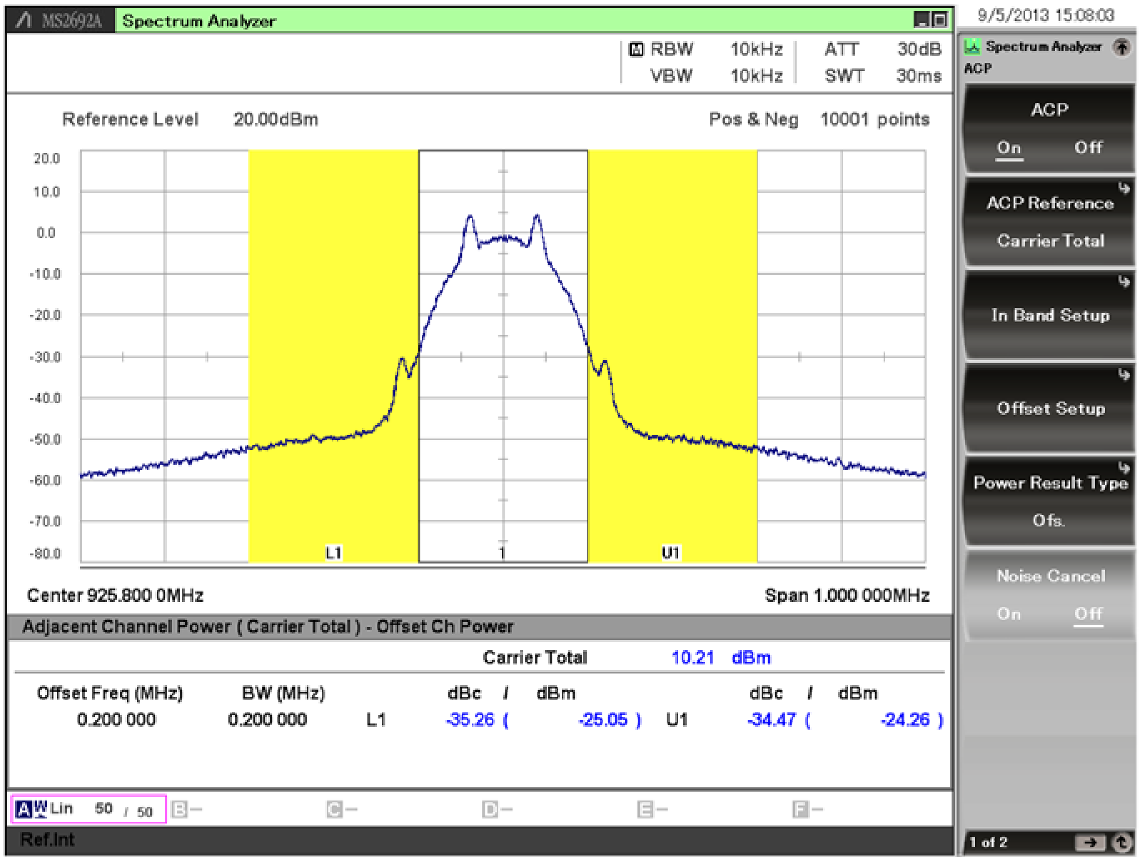

Figure 18. Adjacent Channel Leakage Power (DR=80 kbps Dev=40 kHz, 10 mW, 920.6 to 928.0 MHz, N=1)

The Si4455 chip easily complies with the adjacent channel leakage specification when using two unit radio channels (N=2). The measured adjacent channel leakage for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 19, and is observed to comply with the spec with over 20 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –15 dBm (max)
- Measured: –38.86 dBm
- Margin: 23.86 dB (PASS)

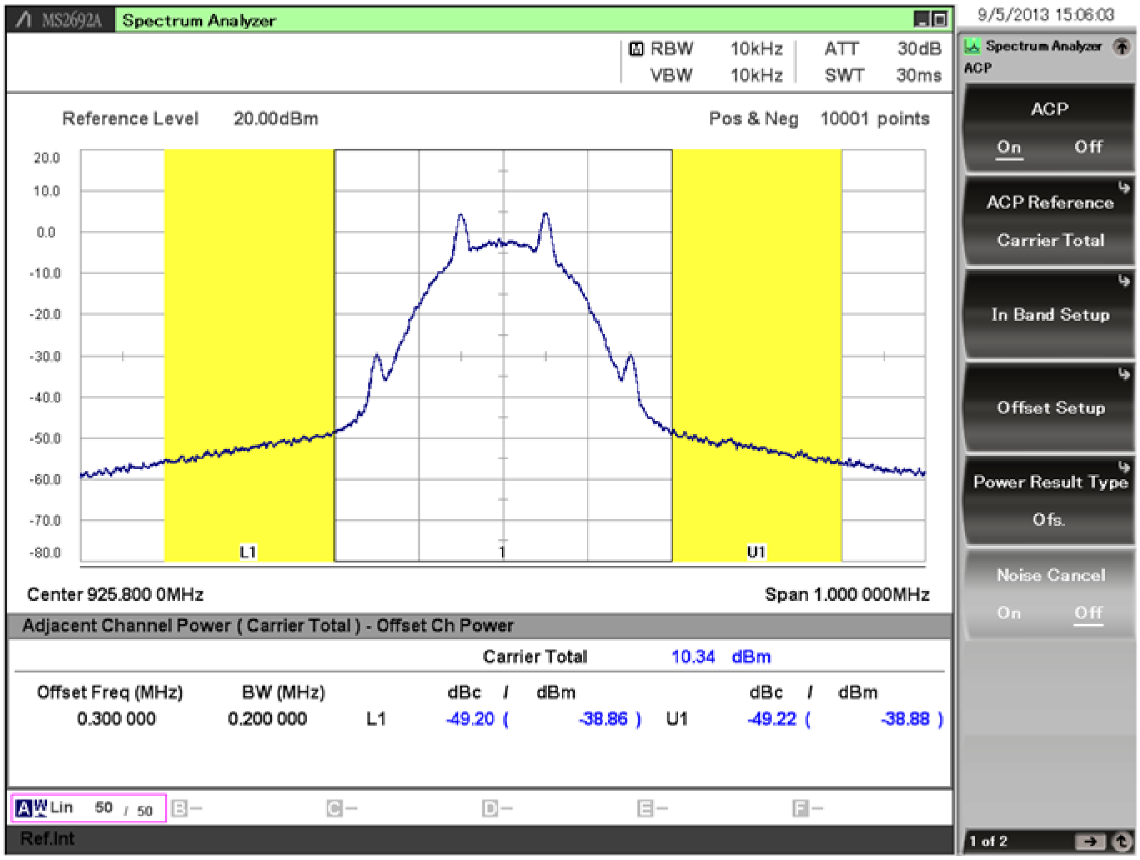

Figure 19. Adjacent Channel Leakage Power
(DR=100 kbps Dev=50 kHz, 10 mW, 920.6 to 928.0 MHz, N=2)

using N=2 unit radio channels the data rate can be increased up to 200 kbps.

The selected modulation parameters were DR = 200 kbps and Deviation = 100 kHz. The measurement was taken assuming operation with one unit radio channel (N=2). The measured adjacent channel leakage power is shown in Figure 20. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with lumping two units of radio channels.

- Limit: –15 dBm (max)
- Measured: –18.01 dBm
- Margin: 3.01 dB (PASS)

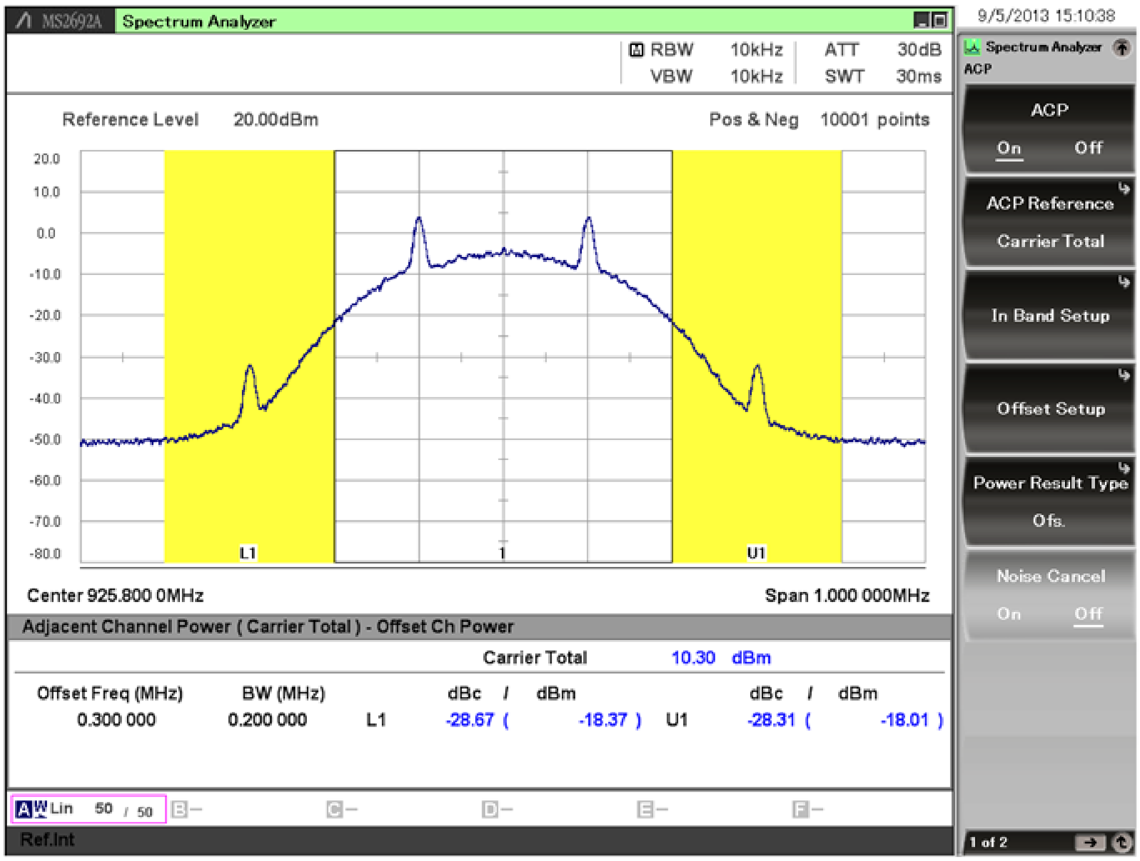

Figure 20. Adjacent Channel Leakage Power (DR=200 kbps Dev=100 kHz, 10 mW, 920.6 to 928.0 MHz, N=2)

3.7.2. Spectral Mask, Antenna power=10 mW, Freq. Band=922.4 to 928.0 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 200 kHz + n x 100 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100 kHz/3 kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/3 kHz bandwidth.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 21. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol. Of course with selecting lower data rates / frequency deviations compliance with larger margins can be obtained.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –57.01 dBm /3 kHz= –41.81 dBm/100 kHz
- Margin: 5.81 dB (PASS)

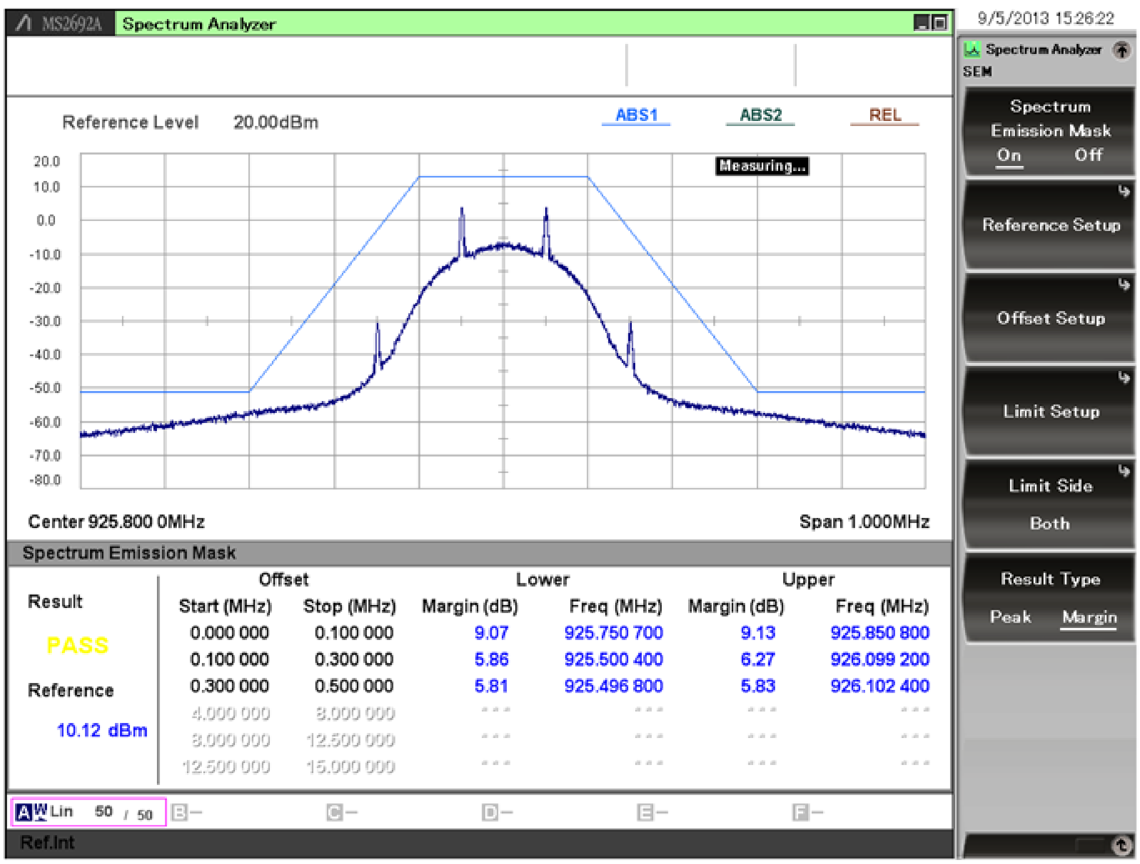

Figure 21. Spectral Mask (DR=100 kbps Dev=50 kHz, 10mW, 922.4 to 928.0 MHz, N=1)

A greater margin of compliance may be obtained when using two unit radio channels (N=2). The measured spectral mask for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 22, and is observed to comply with the spec with over 8 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –59.95 dBm /3 kHz= –44.75 dBm/100 kHz
- Margin: 8.75 dB (PASS)

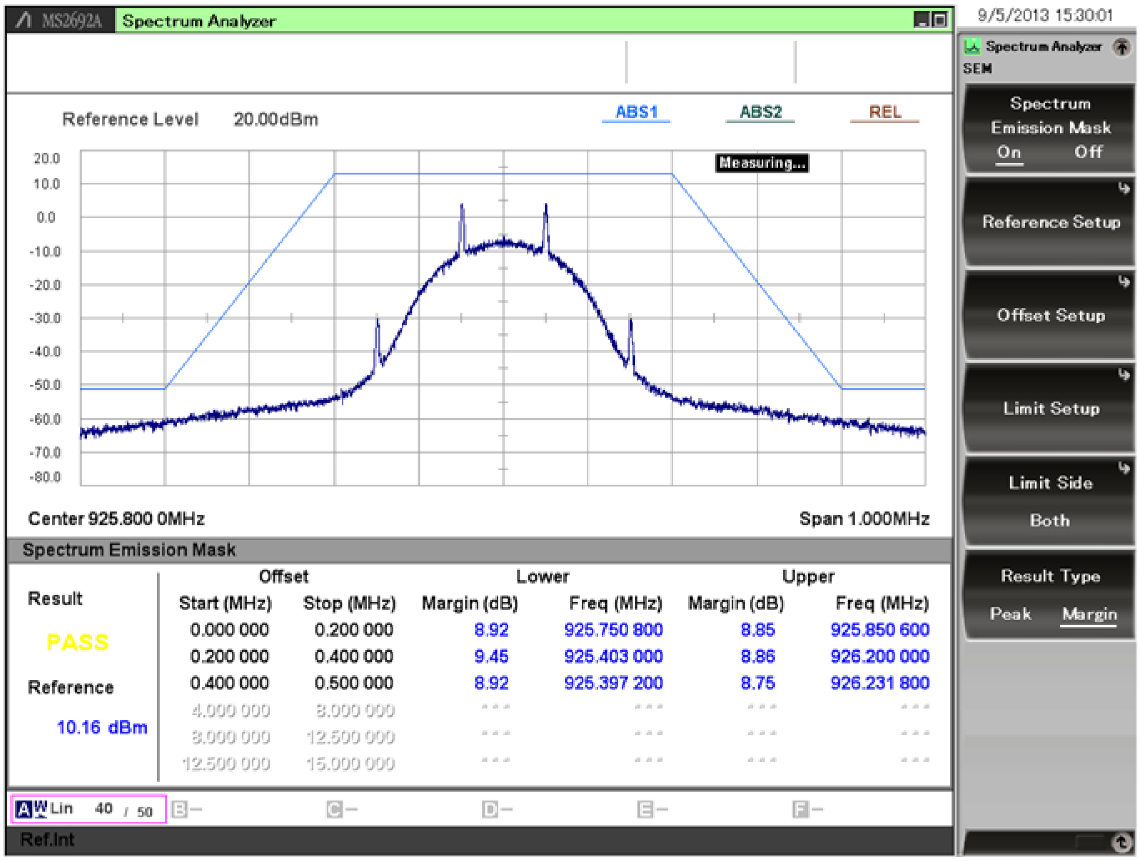

Figure 22. Spectral Mask (DR=100 kbps Dev=50 kHz, 10 mW, 922.4 to 928.0 MHz, N=2)

When using N=2 unit radio channels the data rate can be increased up to 200 kbps.

The measured spectral mask for the scenario of N=2 with DR=200 kbps Dev=100 kHz is shown in Figure 23. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with lumping two units of radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –54.47 dBm /3 kHz= –39.27 dBm/100 kHz
- Margin: 3.27 dB (PASS)

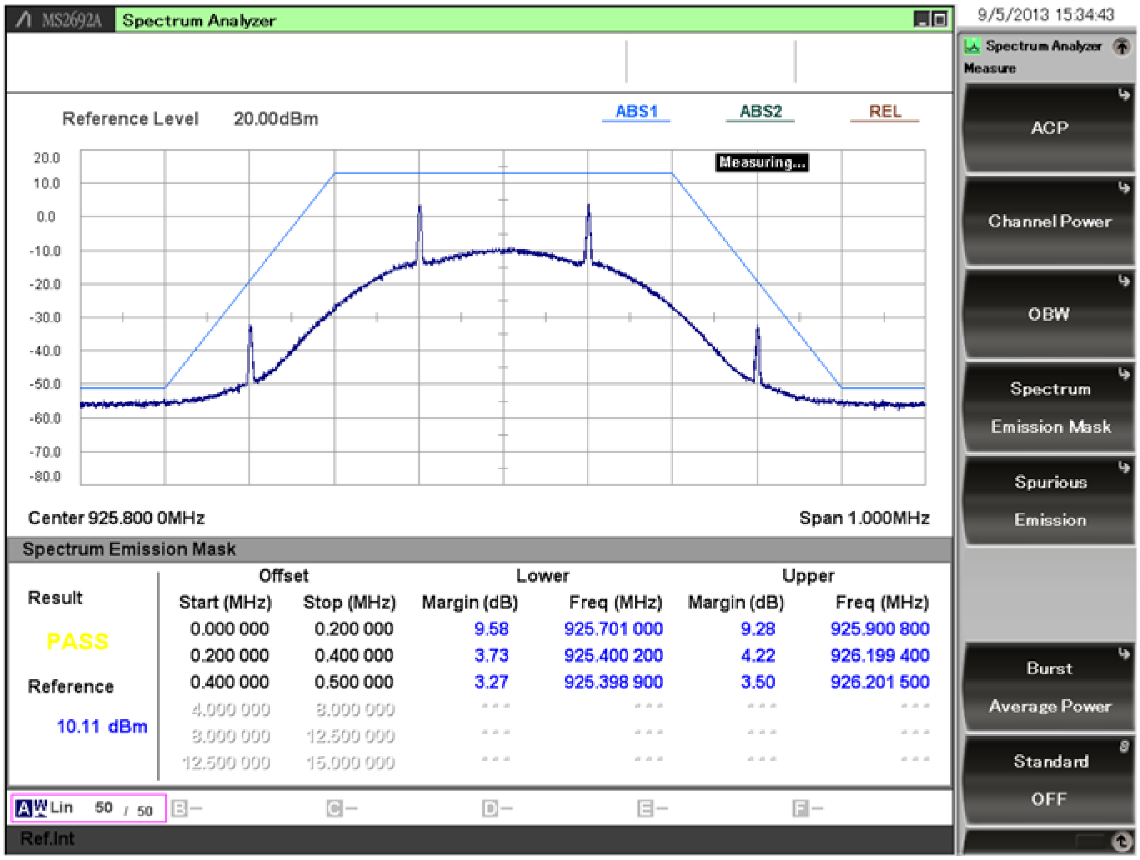

Figure 23. Spectral Mask (DR=200 kbps Dev=100 kHz, 10 mW, 922.4 to 928.0 MHz, N=2)

3.7.3. Spectral Mask, Antenna Power=10 mW, Freq. Band=920.6 to 922.2 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 200 kHz + (n–1) x 100 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100 kHz/3 kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/3 kHz bandwidth.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 24. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with practically no margins. The limiting factor in performance is the selected modulation protocol which contains discrete tones that exceed the limits of the spectral mask.

- Margin: 0.87 dB (PASS)

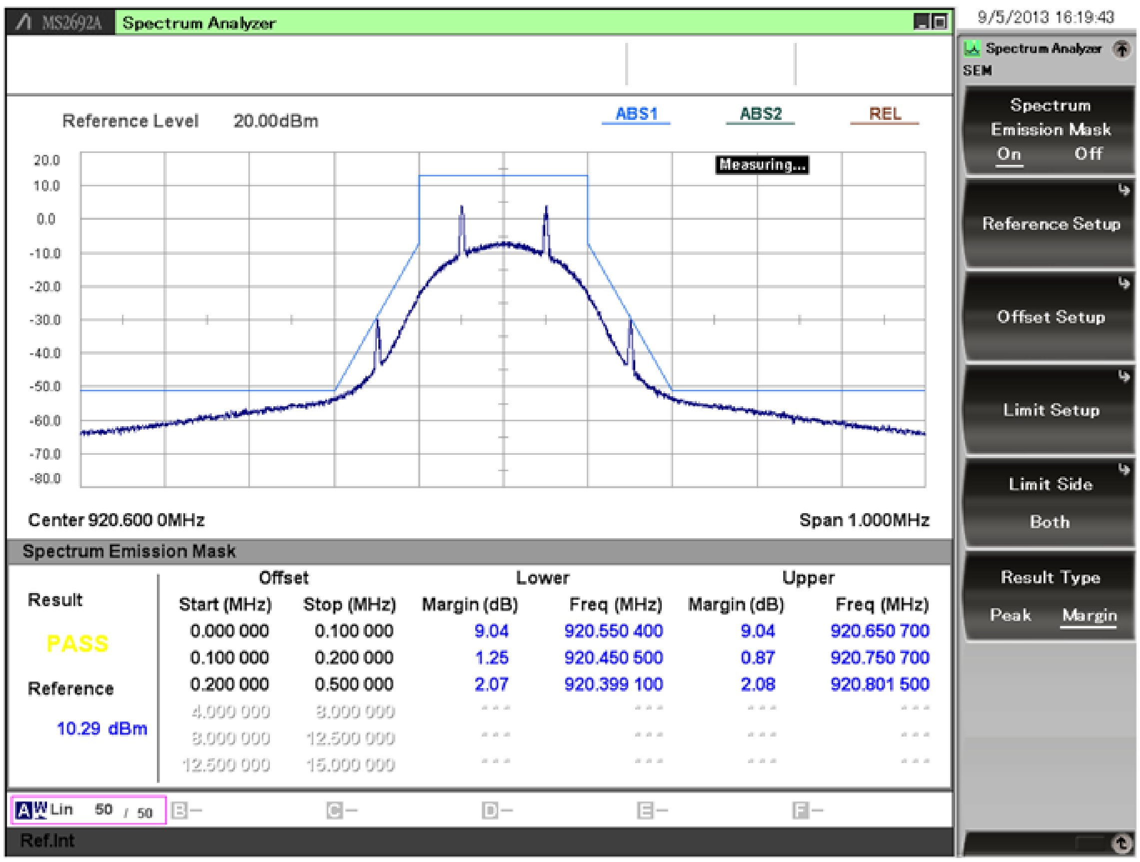

Figure 24. Spectral Mask (DR=100 kbps Dev=50 kHz, 10 mW, 920.6 to 922.2 MHz, N=1)

Compliance with larger margins can be achieved by decreasing the data rate / frequency deviation of the modulation.

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 25. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –54.13 dBm /3 kHz= –38.93 dBm/100 kHz
- Margin: 2.93 dB (PASS)

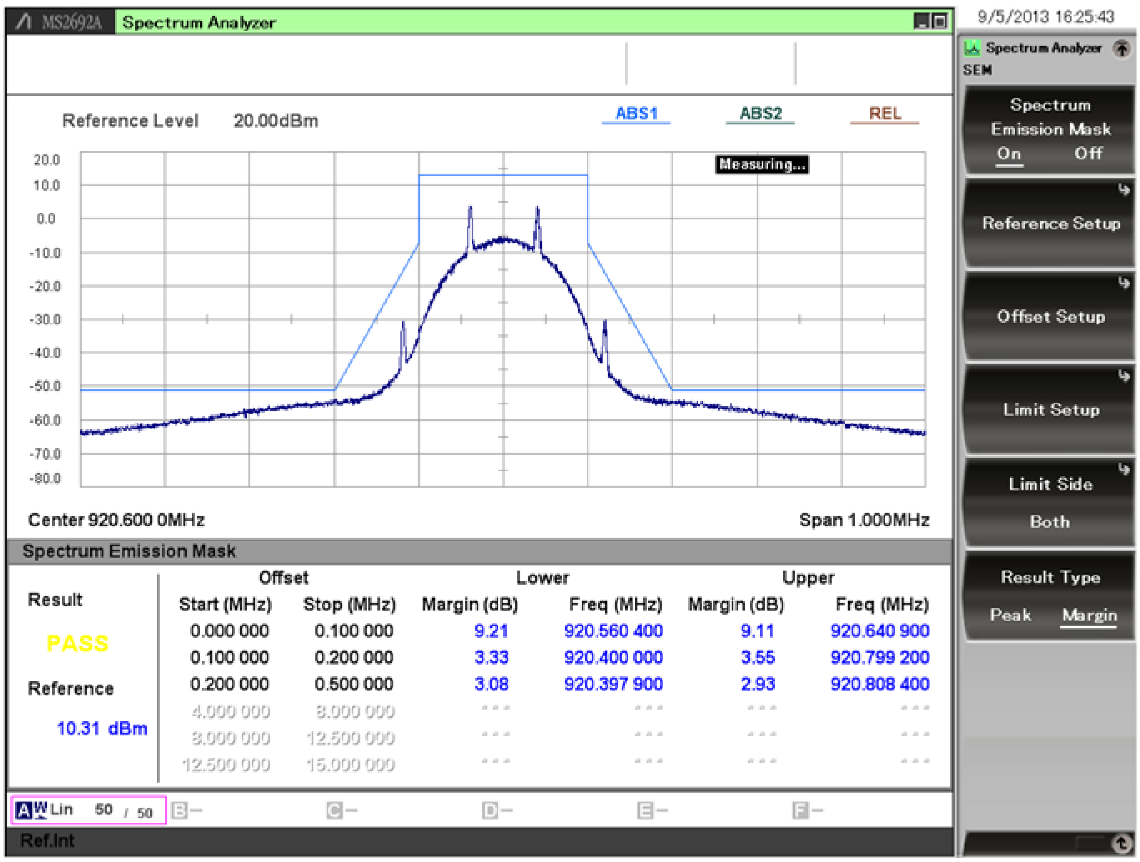

Figure 25. Spectral Mask (DR=80 kbps Dev=40 kHz, 10 mW, 920.6 to 922.2 MHz, N=1)

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Compliance with greater margins may also be obtained when using two unit radio channels (N=2). The measured spectral mask for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 26, and is observed to comply with the spec with over 13 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using n=3, 4, or 5 unit radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –56.73 dBm /3 kHz= –41.53 dBm/100 kHz
- Margin: 5.53 dB (PASS)

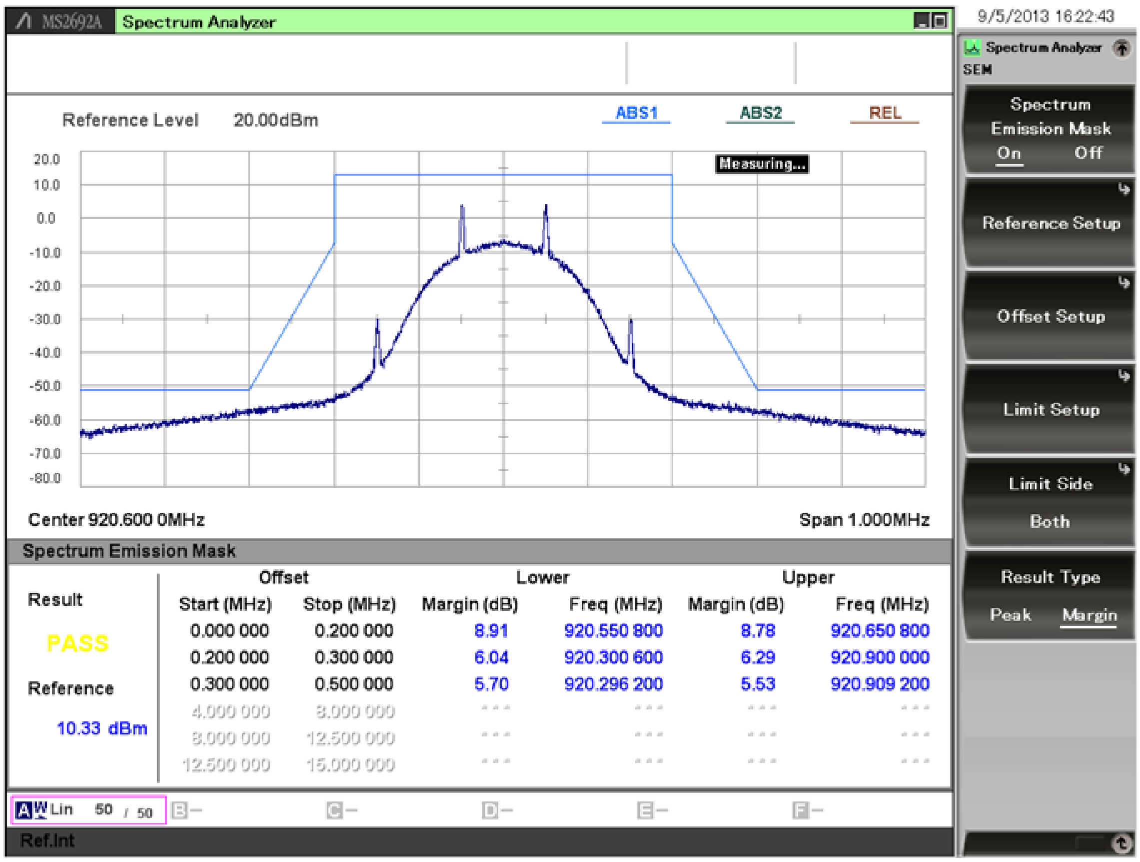


Figure 26. Spectral Mask (DR=100 kbps Dev= 50kHz, 10 mW, 920.6 to 922.2 MHz, N=2)

When using N=2 unit radio channels the data rate can be increased up to 150 kbps. The measured spectral mask for the scenario of N=2 with DR=150 kbps Dev=75 kHz is shown in Figure 27, and is observed to comply with the spec.

- Limit: –36 dBm /100 kHz=–51.2 dBm /3 kHz (max)
- Measured: –54.29 dBm /3 kHz= –39.09 dBm/100 kHz
- Margin: 3.09 dB (PASS)

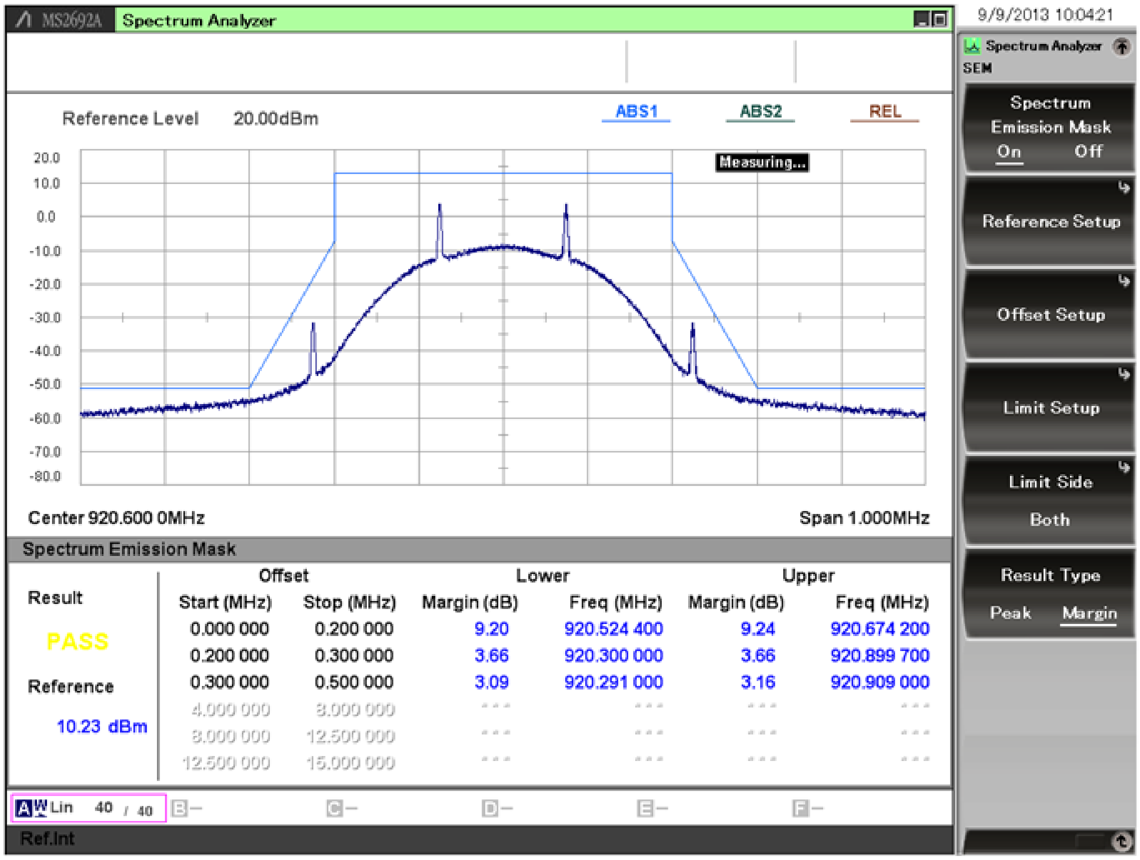


Figure 27. Spectral Mask (DR=150 kbps Dev=75 kHz, 10 mW, 920.6 to 922.2 MHz, N=2)

In order to keep the compliance in this band the data rate cannot be increased up to 200 kbps. The measured spectral mask for the scenario of N=2 with DR=200 kbps Dev=100 kHz is shown in Figure 28, and is observed to fail against the spec.

- Margin: –18.88 dB (FAIL)

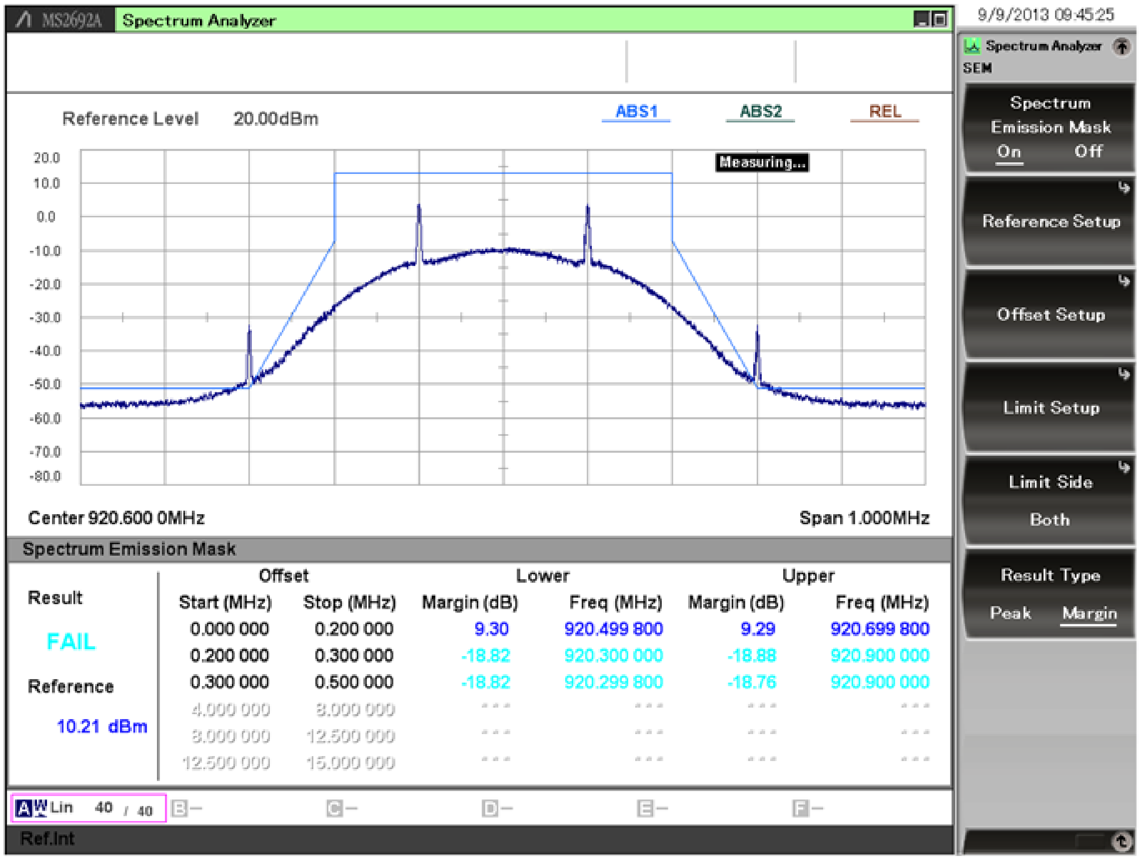


Figure 28. Spectral Mask (DR=200 kbps Dev=100 kHz, 10 mW, 920.6 to 922.2 MHz, N=2)

3.7.4. ACP, Antenna power=20 mW, Freq. Band=920.6 to 928.0 MHz

Within the frequency band of 920.6 to 928.0 MHz when operating with antenna power of more than 1 mW and less than or equal to 20 mW, the integrated adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –15 dBm.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 29. The Si4455 chip does not comply with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –15 dBm (max)
- Measured: –12.90 dBm
- Margin: –2.10 dB (FAIL)

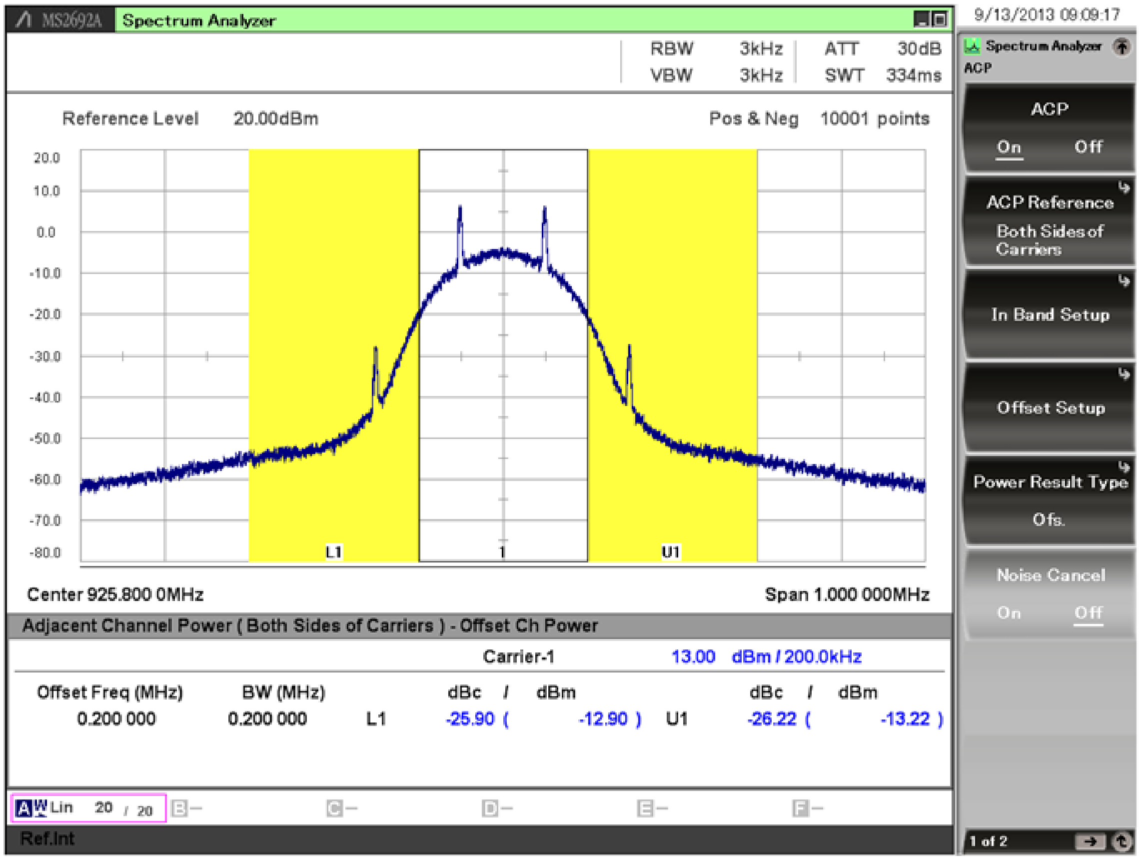


Figure 29. Adjacent Channel Leakage Power (DR=100 kbps Dev=50 kHz, 20 mW, 920.6 to 928.0 MHz, N=1)

Compliance can be achieved by decreasing the data rate / frequency deviation of the modulation. The measured adjacent channel leakage power with different data rate is shown in Figure 30.

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 30. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –15 dBm (max)
- Measured: –22.03 dBm
- Margin: 7.03 dB (PASS)

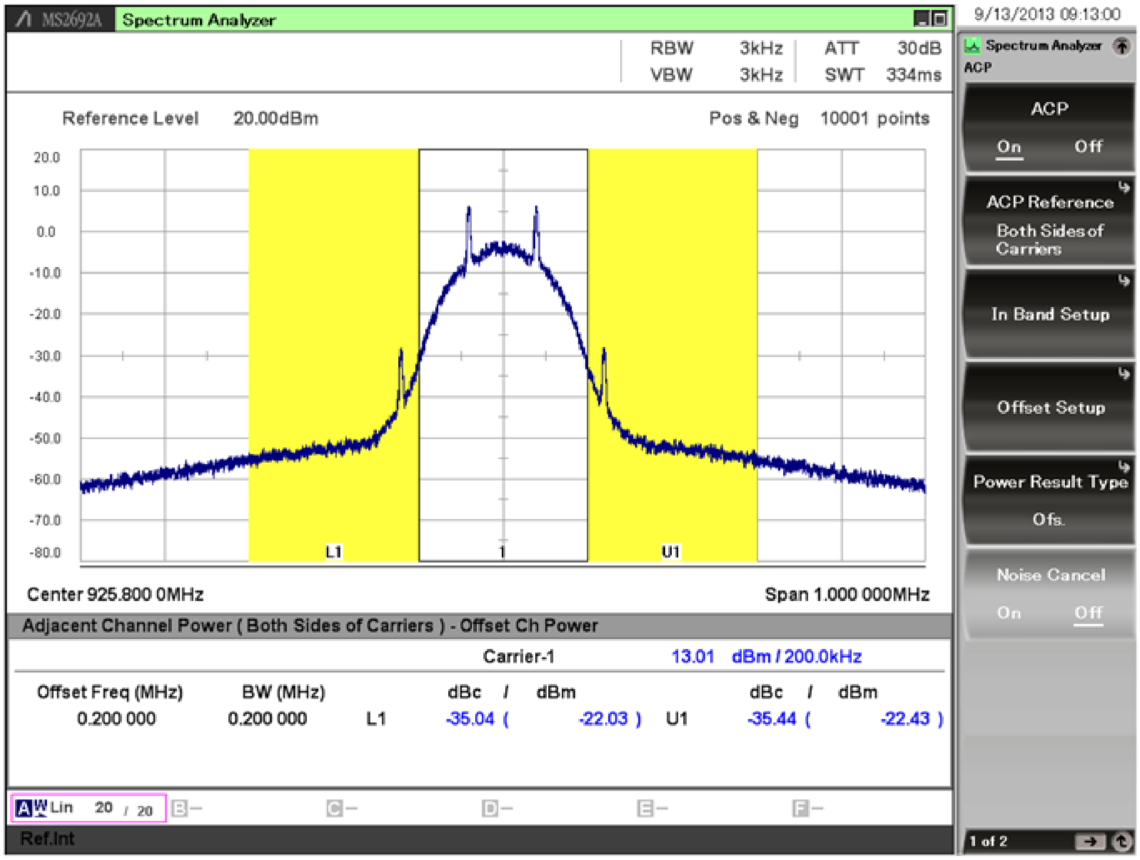


Figure 30. Adjacent Channel Leakage Power
(DR=80 kbps Dev=40 kHz, 20 mW, 920.6 to 928.0 MHz, N=1)

The Si4455 chip easily complies with the adjacent channel leakage specification when using two unit radio channels (N=2). The measured adjacent channel leakage for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 31, and is observed to comply with the spec with over 20 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –15 dBm (max)
- Measured: –36.04 dBm
- Margin: 21.04 dB (PASS)

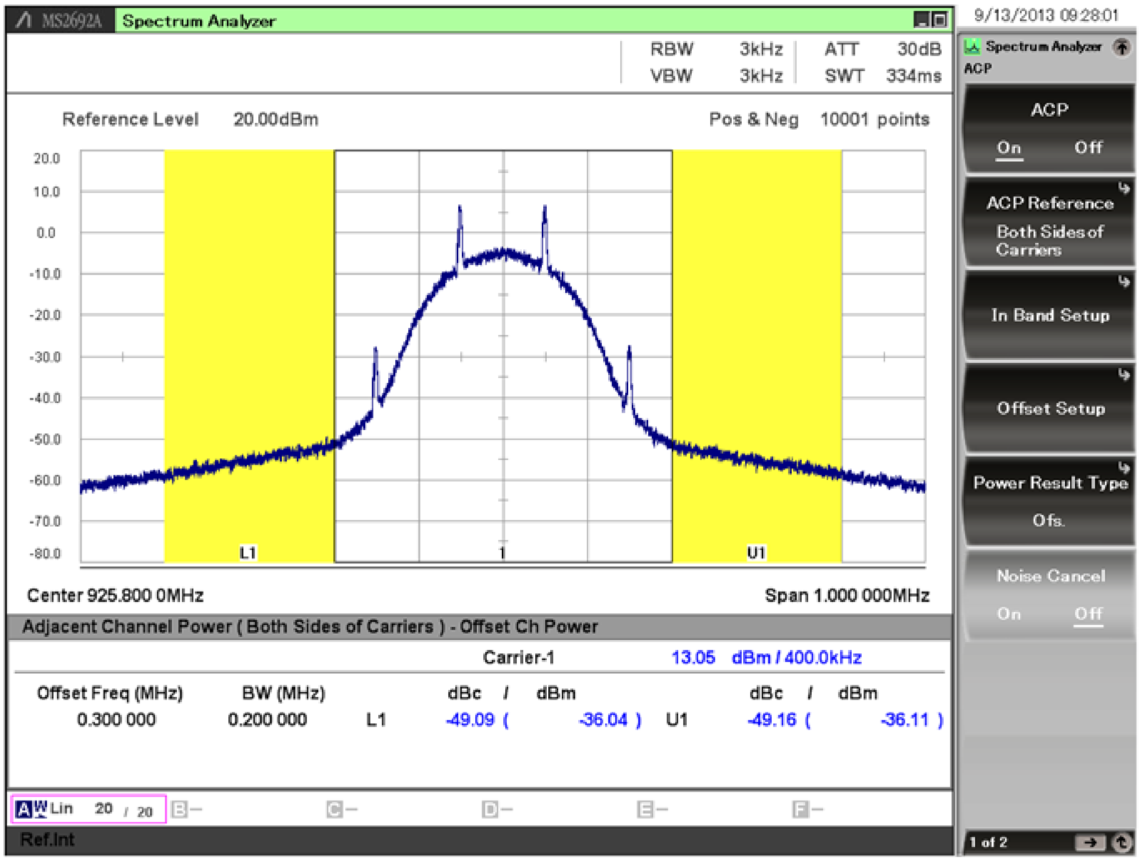


Figure 31. Adjacent Channel Leakage Power (DR=100 kbps Dev=50 kHz, 20 mW, 920.6 to 928.0 MHz, N=2)

When using N=2 unit radio channels the data rate can be increased up to 180 kbps.

The selected modulation parameters were DR = 180 kbps and Deviation = 90 kHz. The measurement was taken assuming operation with one unit radio channel (N=2). The measured adjacent channel leakage power is shown in Figure 32. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with lumping two units of radio channels.

- Limit: –15 dBm (max)
- Measured: –19.43 dBm
- Margin: 4.43 dB (PASS)

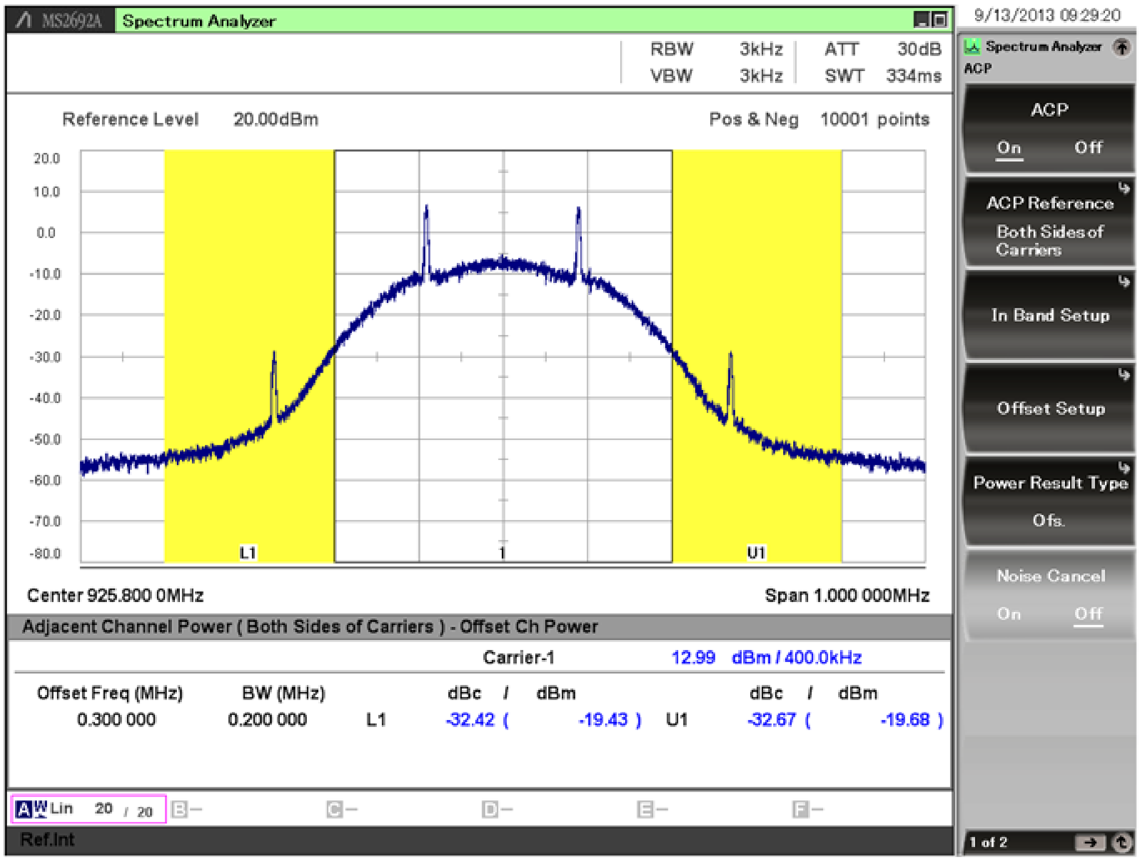


Figure 32. Adjacent Channel Leakage Power (DR=180 kbps Dev=90 kHz, 20 mW, 920.6 to 928.0 MHz, N=2)

The selected modulation parameters were DR = 200 kbps and Deviation = 100 kHz. The measurement was taken assuming operation with one unit radio channel (N=2). The measured adjacent channel leakage power is shown in Figure 33. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power with no margins for the selected modulation protocol when using two units of radio channels.

- Limit: –15 dBm (max)
- Measured: –15.48 dBm
- Margin: 0.48 dB (PASS)

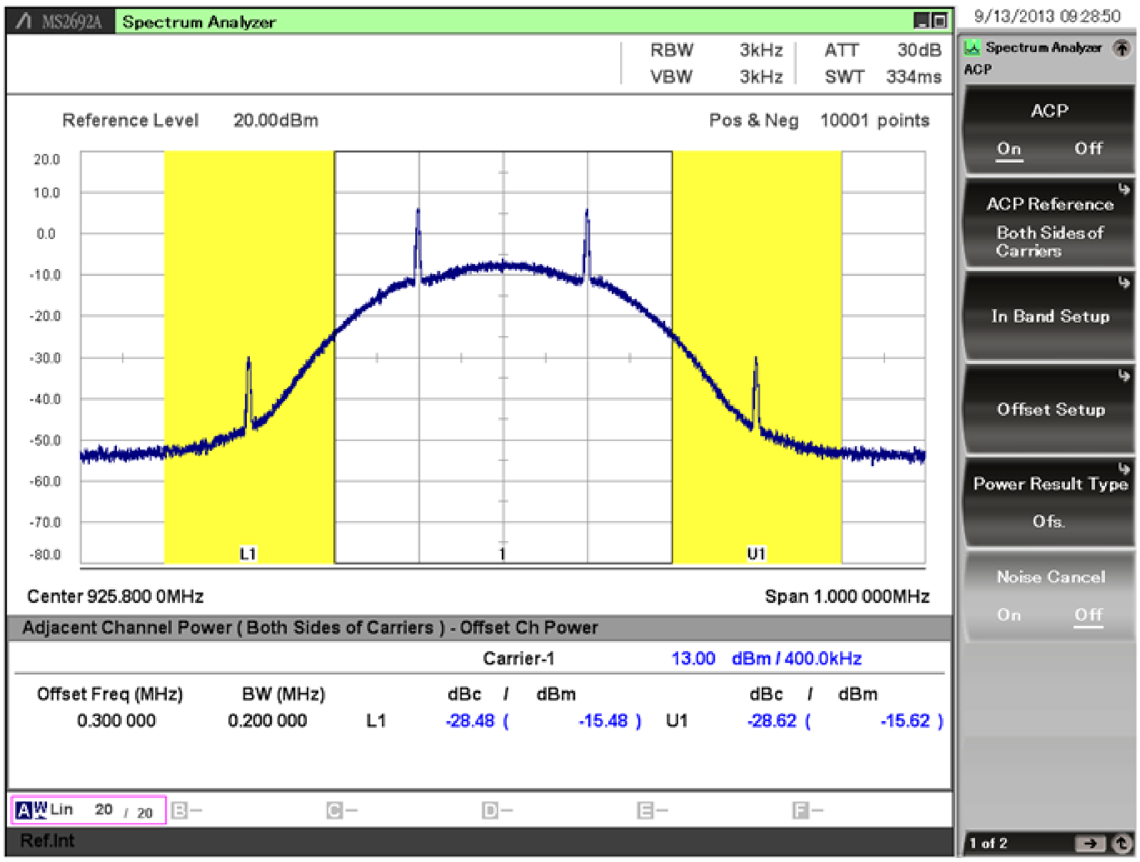


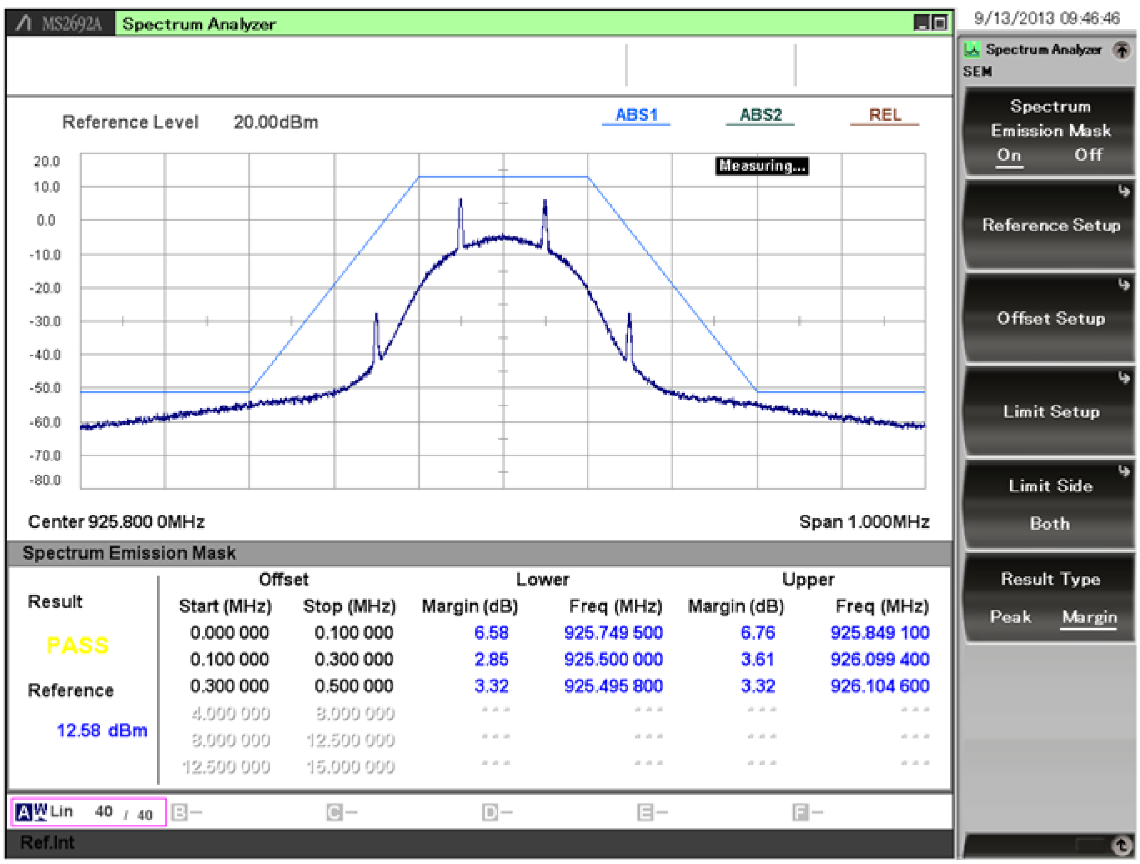
Figure 33. Adjacent Channel Leakage Power
(DR=200 kbps Dev=100 kHz, 20 mW, 920.6 to 928.0 MHz, N=2)

3.7.5. Spectral Mask, Antenna power=20 mW, Freq. Band=922.4 to 928.0 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 200 kHz + n x 100 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/ 100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100 kHz/3 kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/ 3 kHz bandwidth.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 34. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol. Of course with selecting lower data rates / frequency deviations a compliance with larger margins can be achieved.

- Margin: 2.85 dB (PASS)



Offset Start (MHz)	Offset Stop (MHz)	Lower Margin (dB)	Lower Freq (MHz)	Upper Margin (dB)	Upper Freq (MHz)
0.000 000	0.100 000	6.58	925.749 500	6.76	925.849 100
0.100 000	0.300 000	2.85	925.500 000	3.61	926.099 400
0.300 000	0.500 000	3.32	925.495 800	3.32	926.104 600
4.000 000	8.000 000	---	---	---	---
8.000 000	12.500 000	---	---	---	---
12.500 000	15.000 000	---	---	---	---

Figure 34. Spectral Mask (DR=100 kbps Dev=50 kHz, 20 mW, 922.4 to 928.0 MHz

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 35. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol.

- Limit: –36 dBm /100 kHz=–51.2 dBm /3 kHz (max)
- Measured: –54.50 Bm /3 kHz= –39.30 dBm/100 kHz
- Margin: 3.30 dB (PASS)

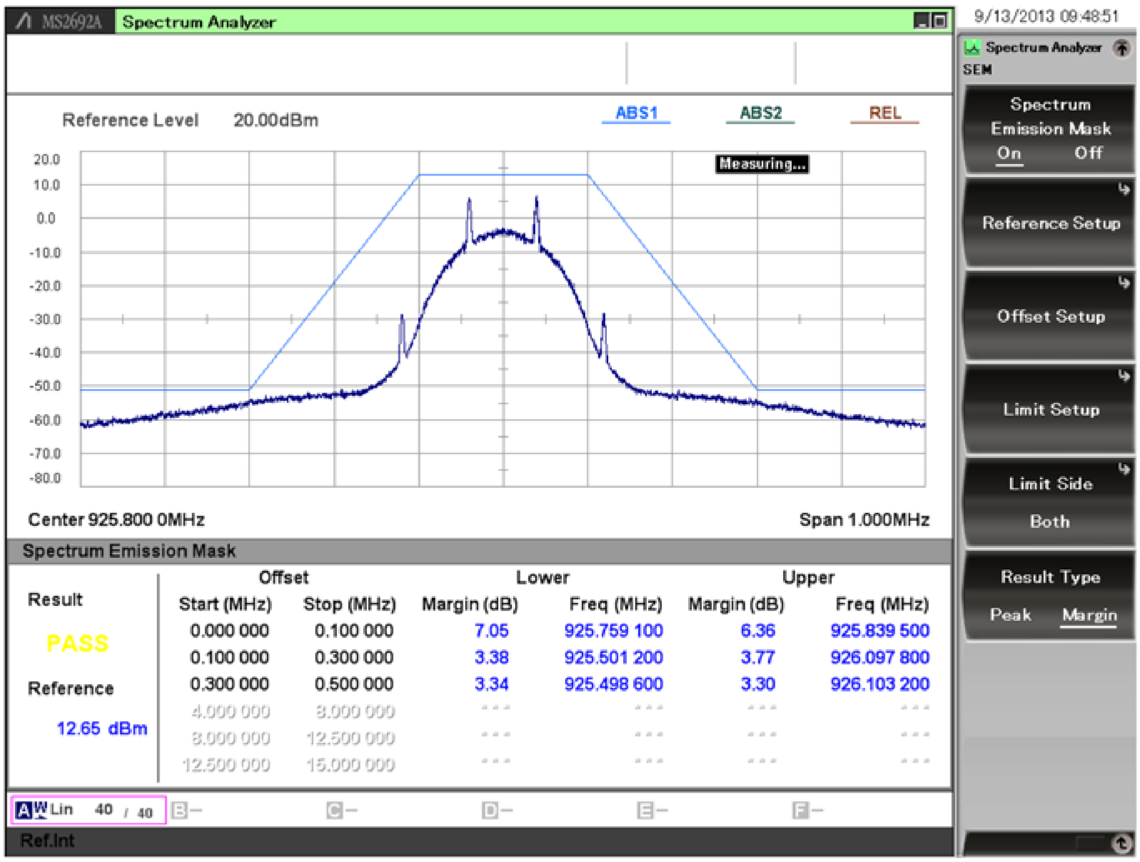


Figure 35. Spectral Mask (DR=80 kbps Dev=40 kHz, 20 mW, 922.4 to 928.0 MHz, N=1)

A greater margin of compliance may be obtained when using two unit radio channels (N=2). The measured spectral mask for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 36, and is observed to comply with the spec with larger margins. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –57.90 dBm /3 kHz= –42.70 dBm/100 kHz
- Margin: 6.70 dB (PASS)

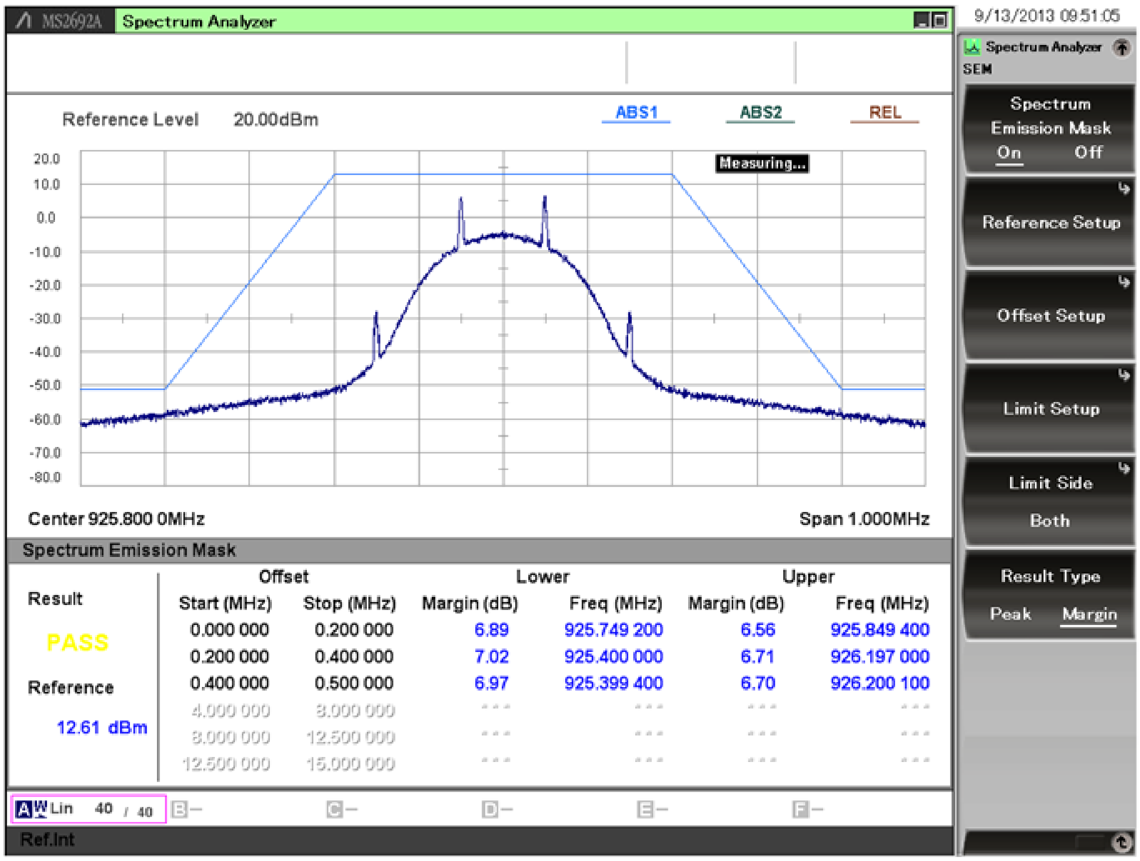
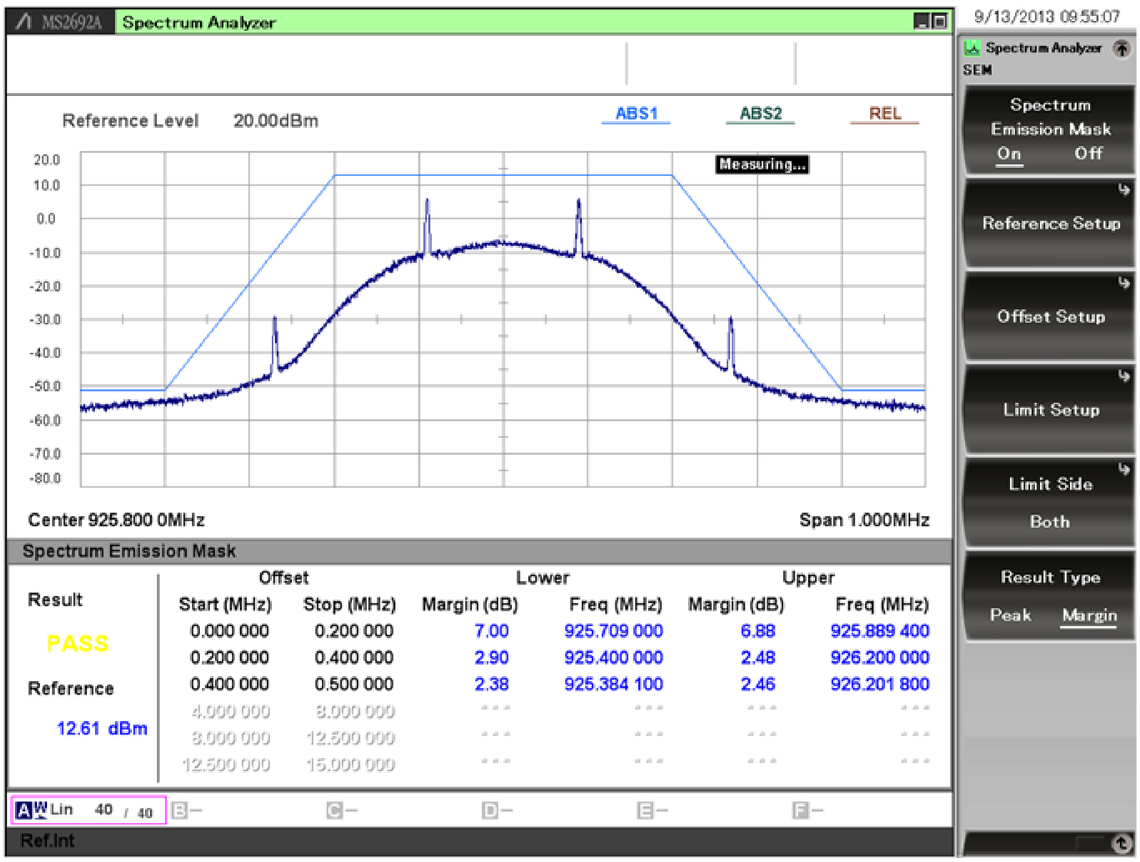


Figure 36. Spectral Mask (DR=100 kbps Dev=50 kHz, 20 mW, 922.4 to 928.0 MHz, N=2)

When using N=2 unit radio channels the data rate can be increased up to 180 kbps.

The measured spectral mask for the scenario of N=2 with DR=180 kbps Dev=90 kHz is shown in Figure 37. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with lumping two units of radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –53.58 dBm /3 kHz= –38.38 dBm/100 kHz
- Margin: 2.38 dB (PASS)



Offset Start (MHz)	Offset Stop (MHz)	Lower Margin (dB)	Lower Freq (MHz)	Upper Margin (dB)	Upper Freq (MHz)
0.000 000	0.200 000	7.00	925.709 000	6.88	925.889 400
0.200 000	0.400 000	2.90	925.400 000	2.48	926.200 000
0.400 000	0.500 000	2.38	925.384 100	2.46	926.201 800
4.000 000	8.000 000	---	---	---	---
8.000 000	12.500 000	---	---	---	---
12.500 000	15.000 000	---	---	---	---

Figure 37. Spectral Mask (DR=180 kbps Dev=90 kHz, 20 mW, 922.4 to 928.0 MHz, N=2)

The measured spectral mask for the scenario of N=2 with DR=200 kbps Dev=100 kHz is shown in Figure 38. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with no margins.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –51.92 dBm /3 kHz= –36.72 dBm/100 kHz
- Margin: 0.72 dB (PASS)

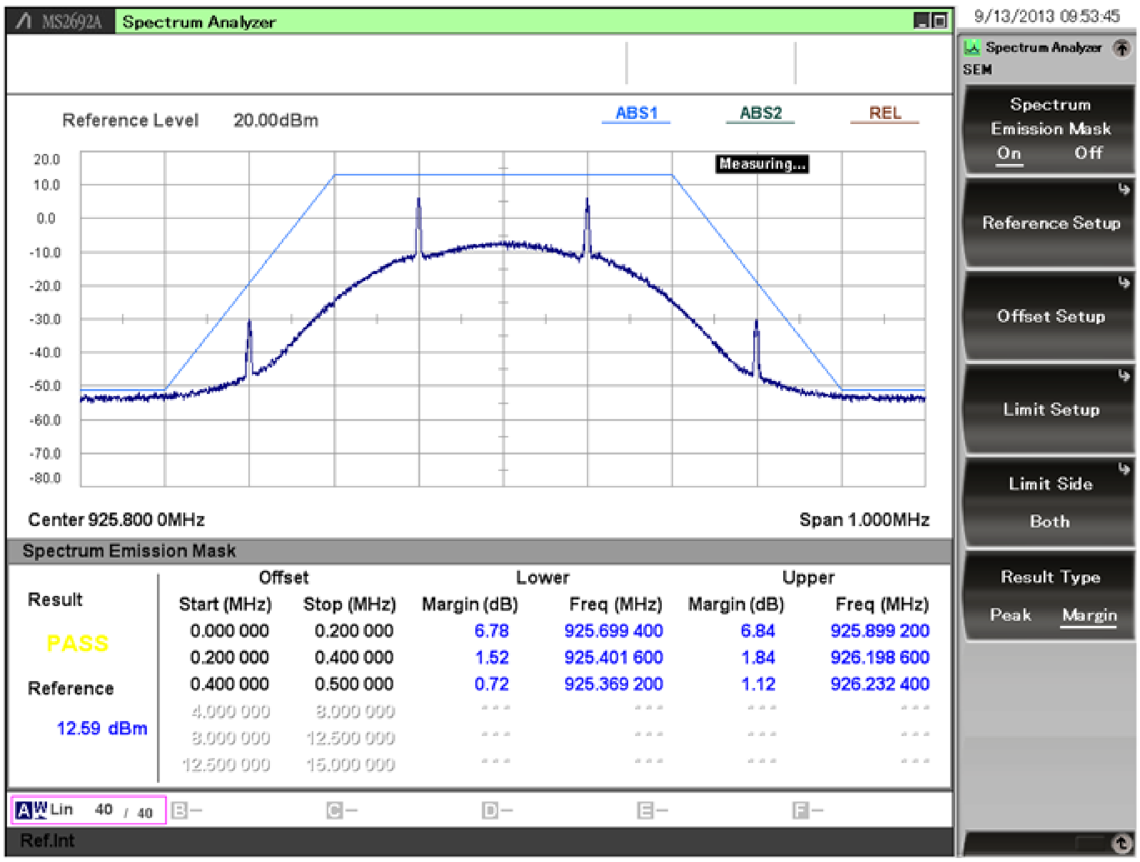


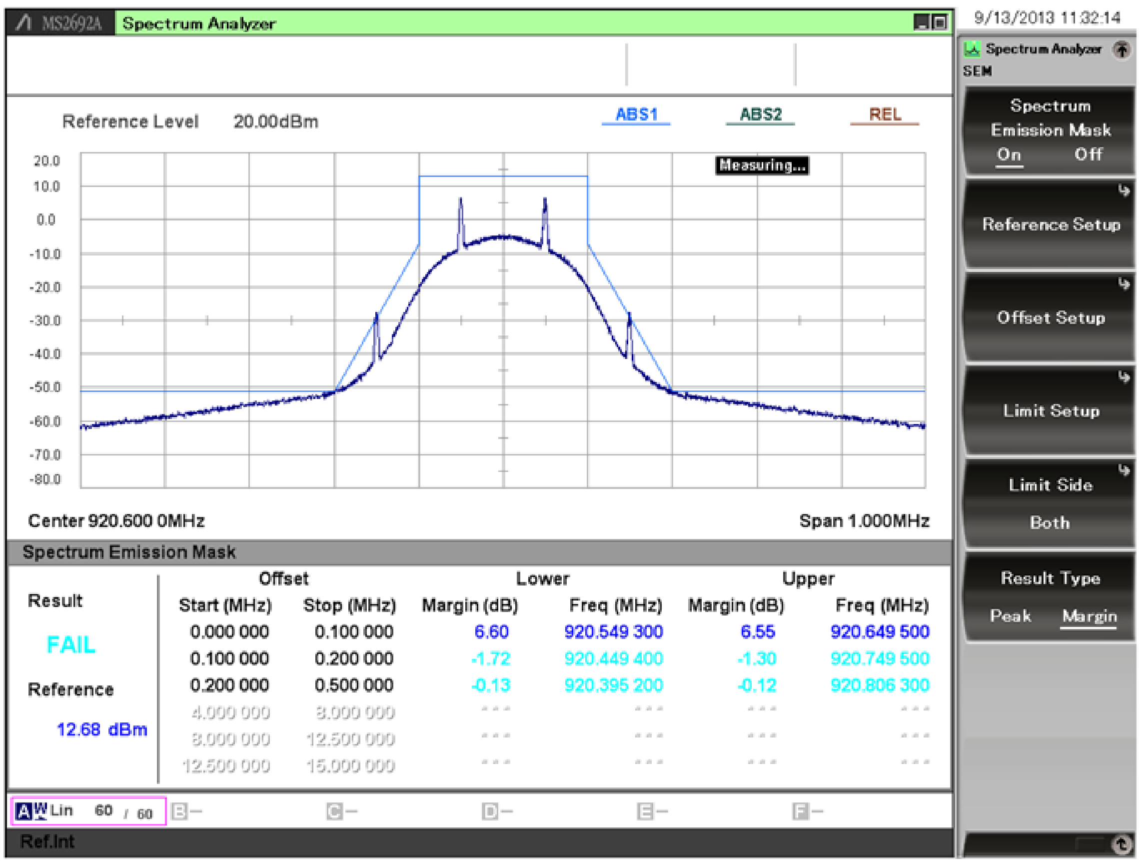
Figure 38. Spectral Mask (DR=200 kbps Dev=100 kHz, 20 mW, 922.4 to 928.0 MHz, N=2)

3.7.6. Spectral Mask, Antenna Power= 20 mW, Freq. Band=920.6 to 922.2 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 200 kHz + (n–1) x 100 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/ 100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100kHz/3kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/3 kHz bandwidth.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 39. The Si4455 chip does not comply with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol.

- Margin: –1.72 dB (FAIL)



Offset		Lower		Upper	
Start (MHz)	Stop (MHz)	Margin (dB)	Freq (MHz)	Margin (dB)	Freq (MHz)
0.000 000	0.100 000	6.60	920.549 300	6.55	920.649 500
0.100 000	0.200 000	-1.72	920.449 400	-1.30	920.749 500
0.200 000	0.500 000	-0.13	920.395 200	-0.12	920.806 300
4.000 000	8.000 000	- - -	- - -	- - -	- - -
8.000 000	12.500 000	- - -	- - -	- - -	- - -
12.500 000	15.000 000	- - -	- - -	- - -	- - -

Figure 39. Spectral Mask (DR=100 kbps Dev=50 kHz, 20 mW, 920.6 to 922.2 MHz, N=1)

Compliance can be achieved by decreasing the data rate / frequency deviation of the modulation. The measured results with different data rates are shown in Figure 40 and Figure 41.

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 40. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with no margins.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –51.80 dBm /3 kHz= –36.60 dBm/100 kHz
- Margin: 0.60 dB (PASS)

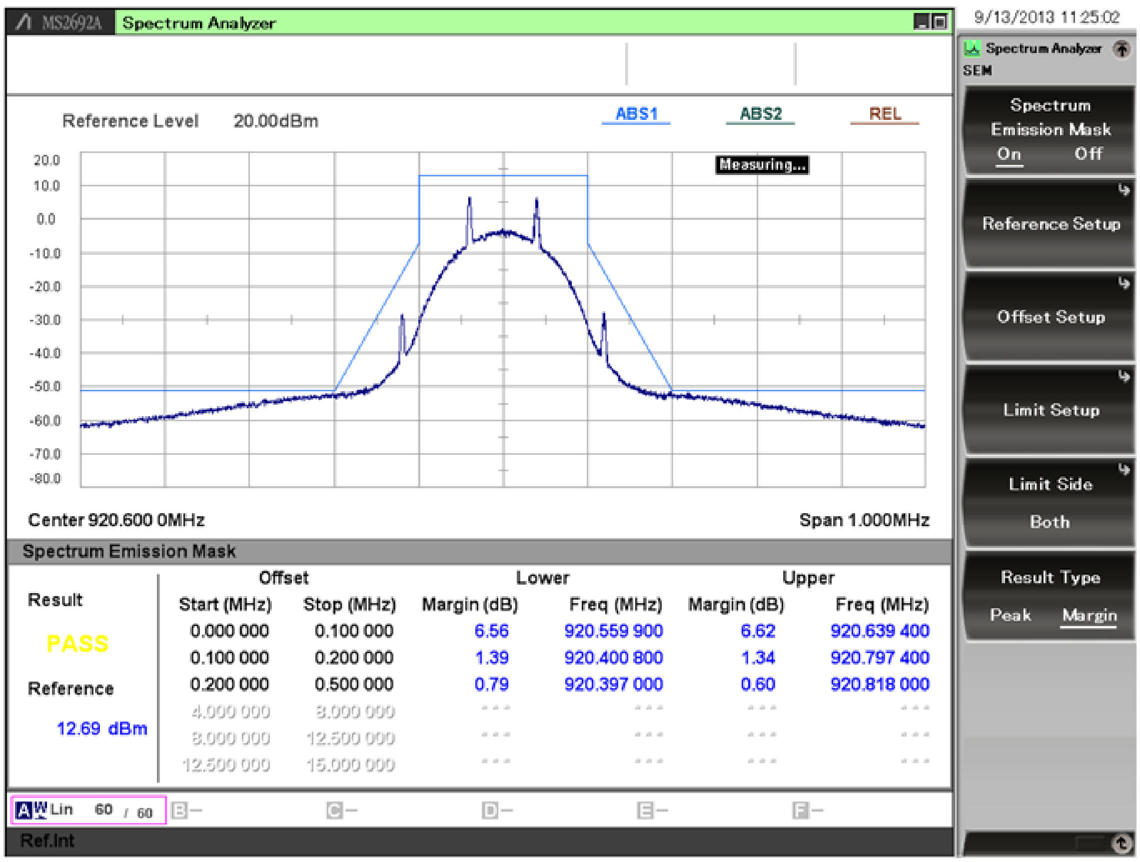


Figure 40. Spectral Mask (DR=80 kbps Dev=40 kHz, 20 mW, 920.6 to 922.2 MHz, N=1)

The selected modulation parameters were DR = 70 kbps and Deviation = 35 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 41. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with acceptable margins.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –54.41 dBm /3 kHz= –39.21 dBm/100 kHz
- Margin: 3.21 dB (PASS)

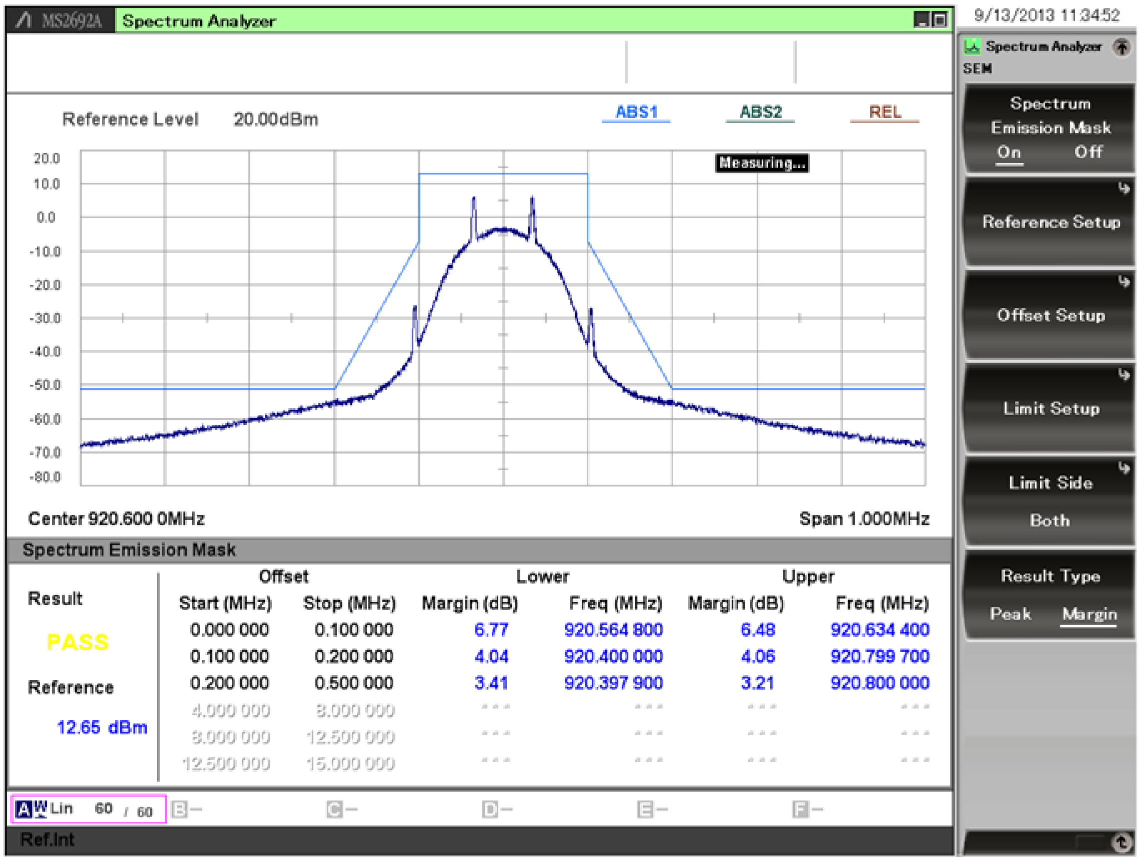
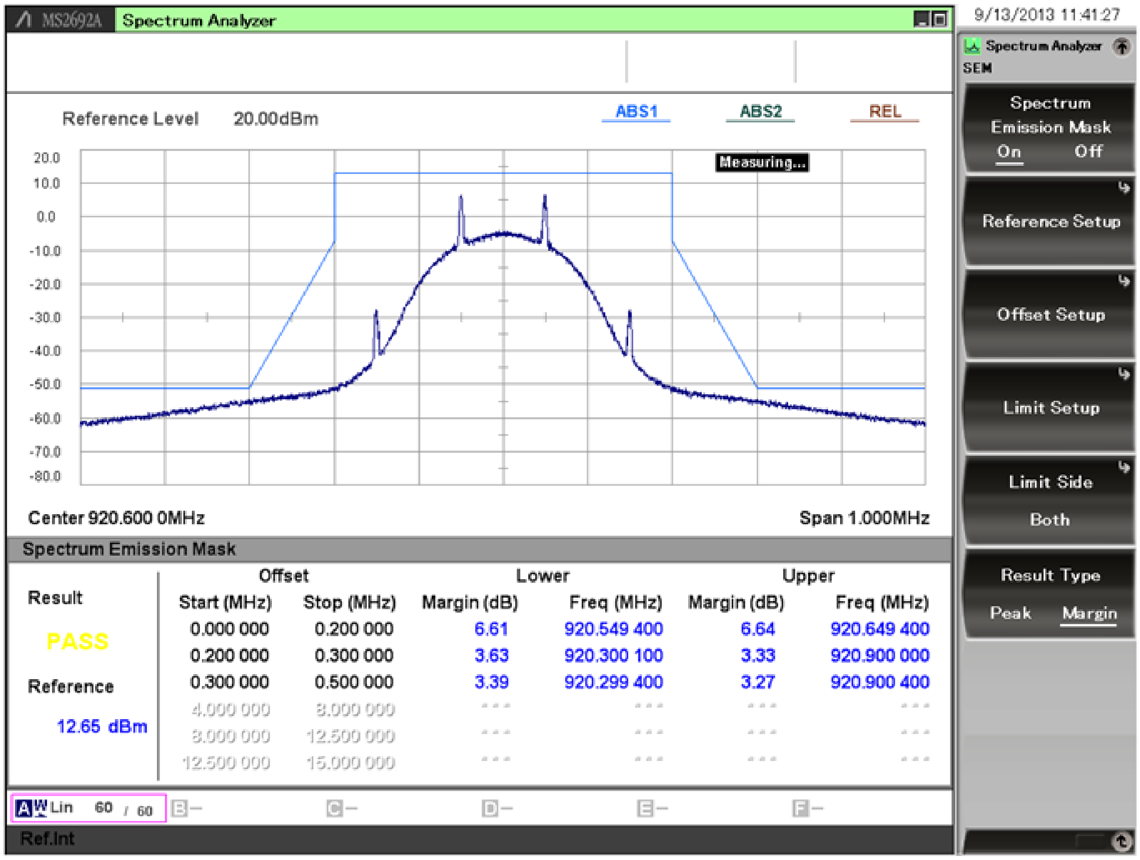


Figure 41. Spectral Mask (DR=70 kbps Dev=35 kHz, 20 mW, 920.6 to 922.2 MHz, N=1)

Compliance may be obtained when using two unit radio channels (N=2). The measured spectral mask for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 42, and is observed to comply with the spec with larger margins. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –54.47 dBm /3 kHz= –39.27 dBm/100 kHz
- Margin: 3.27 dB (PASS)



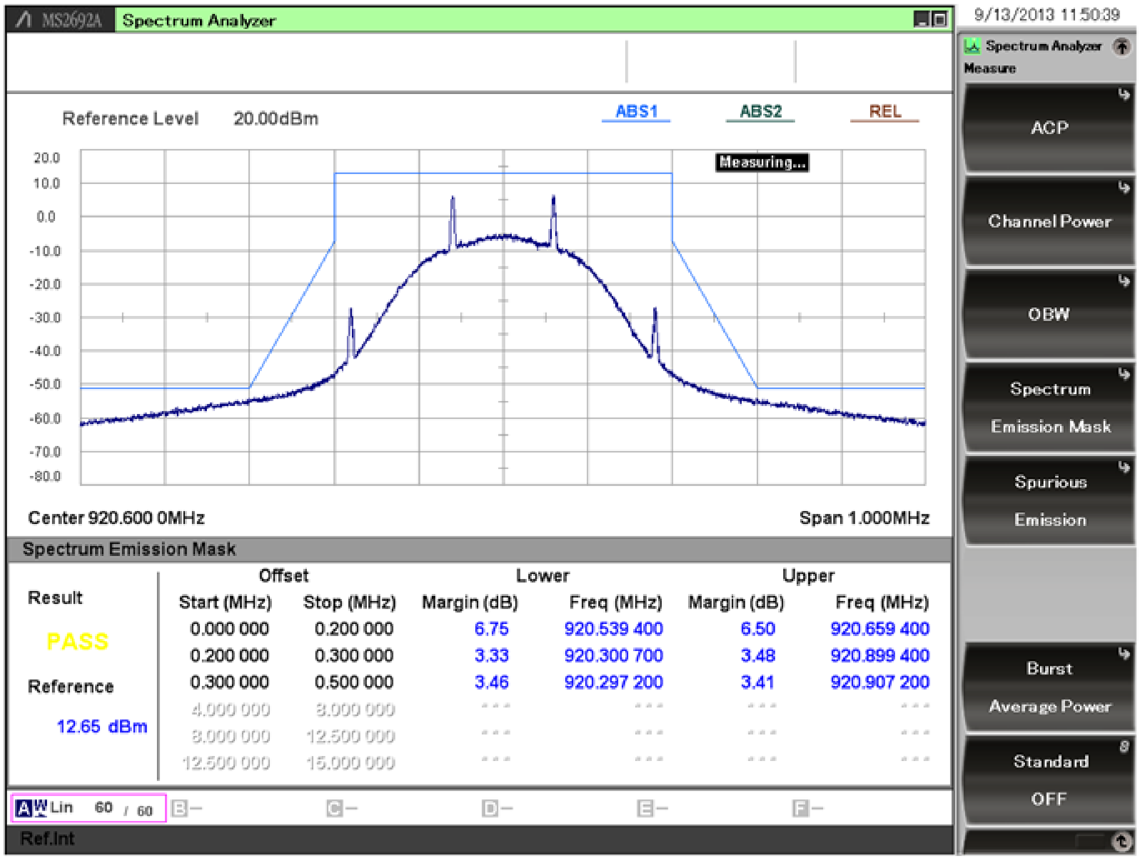
Offset		Lower		Upper	
Start (MHz)	Stop (MHz)	Margin (dB)	Freq (MHz)	Margin (dB)	Freq (MHz)
0.000 000	0.200 000	6.61	920.549 400	6.64	920.649 400
0.200 000	0.300 000	3.63	920.300 100	3.33	920.900 000
0.300 000	0.500 000	3.39	920.299 400	3.27	920.900 400
4.000 000	8.000 000	- - -	- - -	- - -	- - -
8.000 000	12.500 000	- - -	- - -	- - -	- - -
12.500 000	15.000 000	- - -	- - -	- - -	- - -

Figure 42. Spectral Mask (DR=100 kbps Dev=50 kHz, 20 mW, 920.6 to 922.2 MHz, N=2)

When using N=2 unit radio channels the data rate can be slightly further increased.

The measured spectral mask for the scenario of N=2 with DR=120 kbps Dev=60 kHz is shown in Figure 43. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with lumping two units of radio channels.

- Margin: 3.33 dB (PASS)



Spectrum Emission Mask

Result	Offset Start (MHz)	Offset Stop (MHz)	Lower Margin (dB)	Lower Freq (MHz)	Upper Margin (dB)	Upper Freq (MHz)
PASS	0.000 000	0.200 000	6.75	920.539 400	6.50	920.659 400
	0.200 000	0.300 000	3.33	920.300 700	3.48	920.899 400
Reference	0.300 000	0.500 000	3.46	920.297 200	3.41	920.907 200
12.65 dBm	4.000 000	8.000 000	- - -	- - -	- - -	- - -
	8.000 000	12.500 000	- - -	- - -	- - -	- - -
	12.500 000	15.000 000	- - -	- - -	- - -	- - -

Figure 43. Spectral Mask (DR=120 kbps Dev=60 kHz, 20 mW, 920.6 to 922.2 MHz, N=2)

The measured spectral mask for the scenario of N=2 with DR=150 kbps Dev=75 kHz is shown in Figure 44. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with no margins.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –51.90 dBm /3 kHz= –36.70 dBm/100 kHz
- Margin: 0.70 dB (PASS)

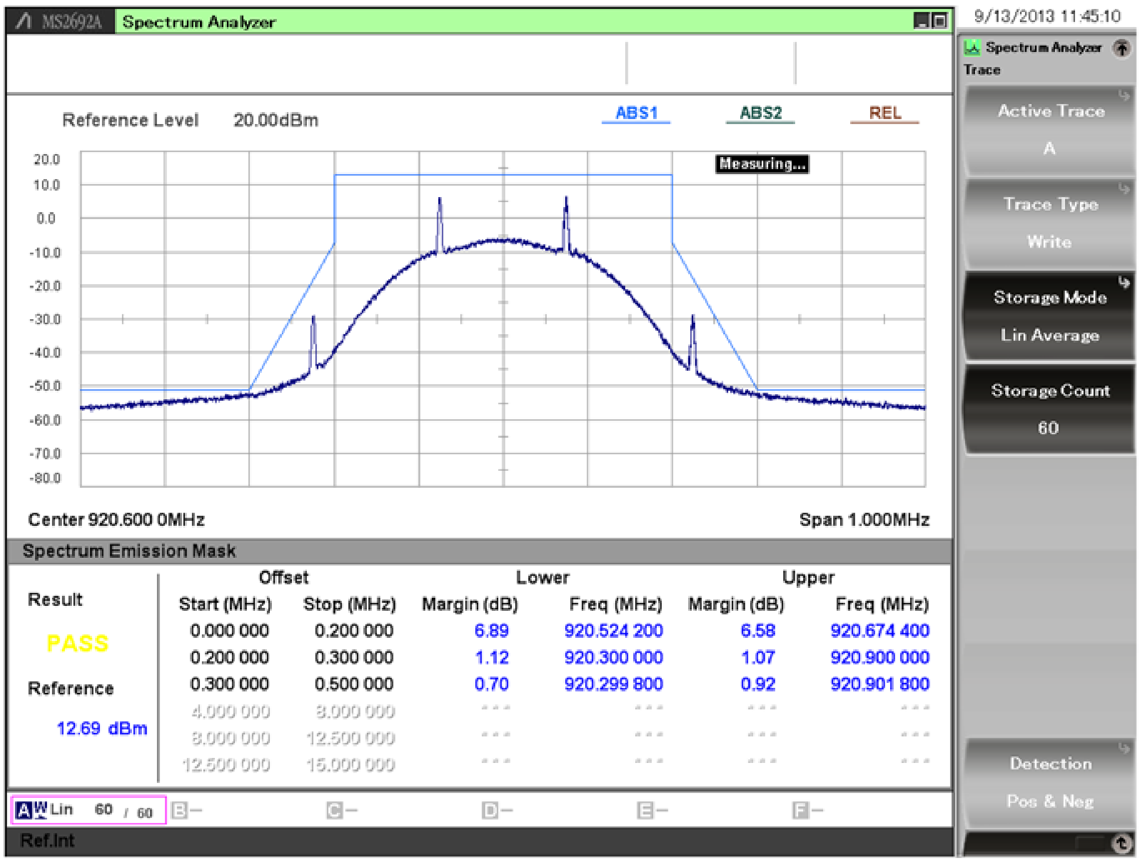


Figure 44. Spectral Mask (DR=150 kbps Dev=75 kHz, 20 mW, 920.6 to 922.2 MHz, N=2)

The measured spectral mask for the scenario of N=2 with DR=200 kbps Dev=100 kHz is shown in Figure 45. The Si4455 chip does not comply with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol.

- Limit: –36 dBm /100 kHz= –51.2 dBm /3 kHz (max)
- Measured: –29.86 dBm /3 kHz= –14.66 dBm/100 kHz
- Margin: –21.34 dB (FAIL)

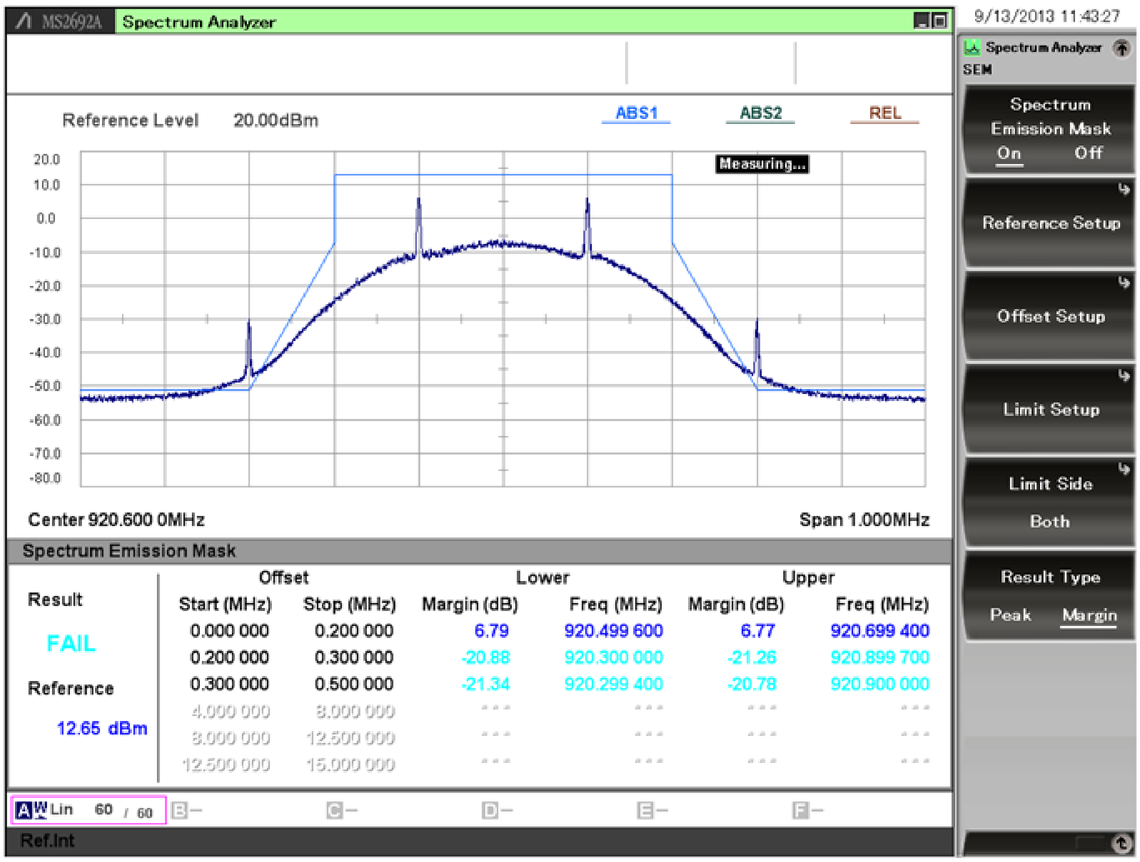


Figure 45. Spectral Mask (DR=200 kbps Dev=100 kHz, 20 mW, 920.6 to 922.2 MHz, N=2)

3.7.7. ACP, Antenna power= 1 mW, Freq. Band=916.0 to 916.8 MHz and 920.6 to 928.0 MHz

Within the frequency band of 916.0 to 916.8 MHz and 920.6 to 928.0 MHz when operating with antenna power of less than or equal to 1 mW, the integrated adjacent channel leakage power within the 200 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –26 dBm.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 46. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with no margins.

- Limit: –26 dBm (max)
- Measured: –26.01 dBm
- Margin: 0.01 dB (PASS)

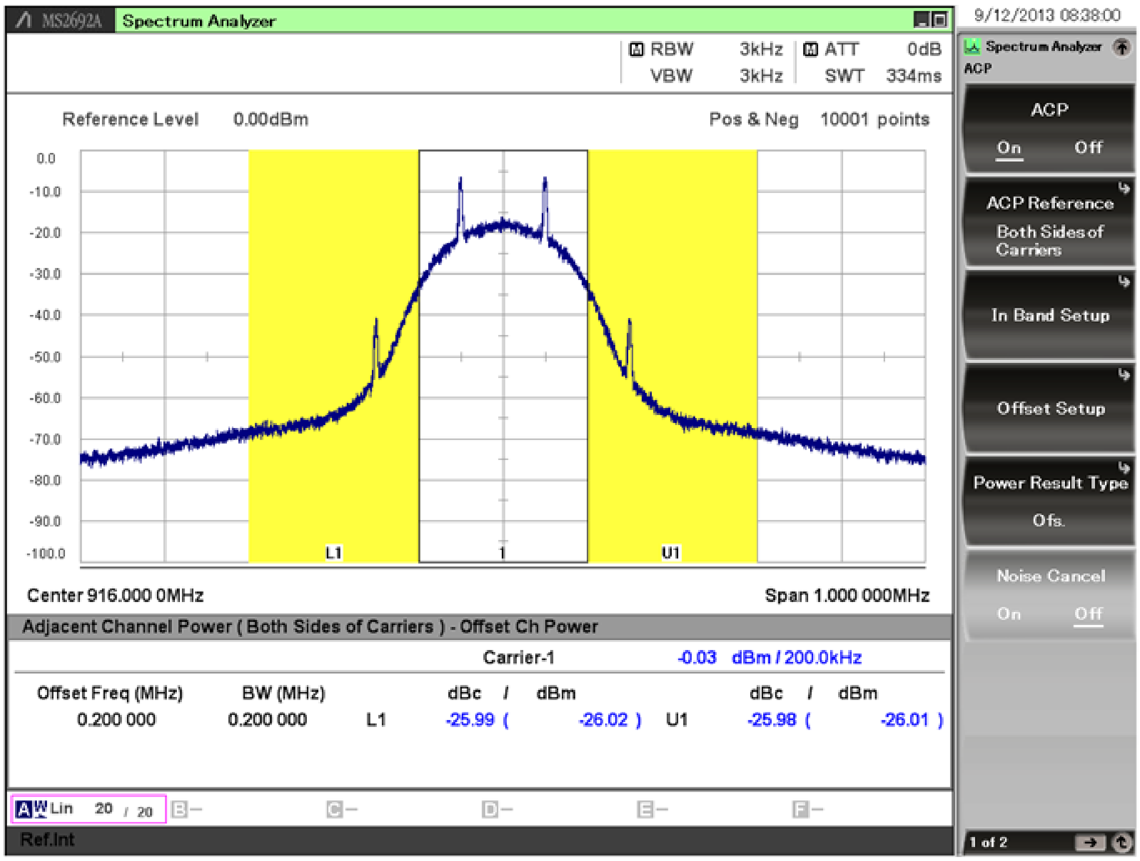


Figure 46. Adjacent Channel Leakage Power (DR=100 kbps Dev=50 kHz, 1 mW, 916.0 to 916.8 MHz, N=1)

Compliance with margins can be achieved by decreasing the data rate / frequency deviation of the modulation. The measured adjacent channel leakage powers with different data rates are shown in Figure 47 and Figure 48.

The selected modulation parameters were DR = 92 kbps and Deviation = 46 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 47. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –26 dBm (max)
- Measured: –29.31 dBm
- Margin: 3.31 dB (PASS)

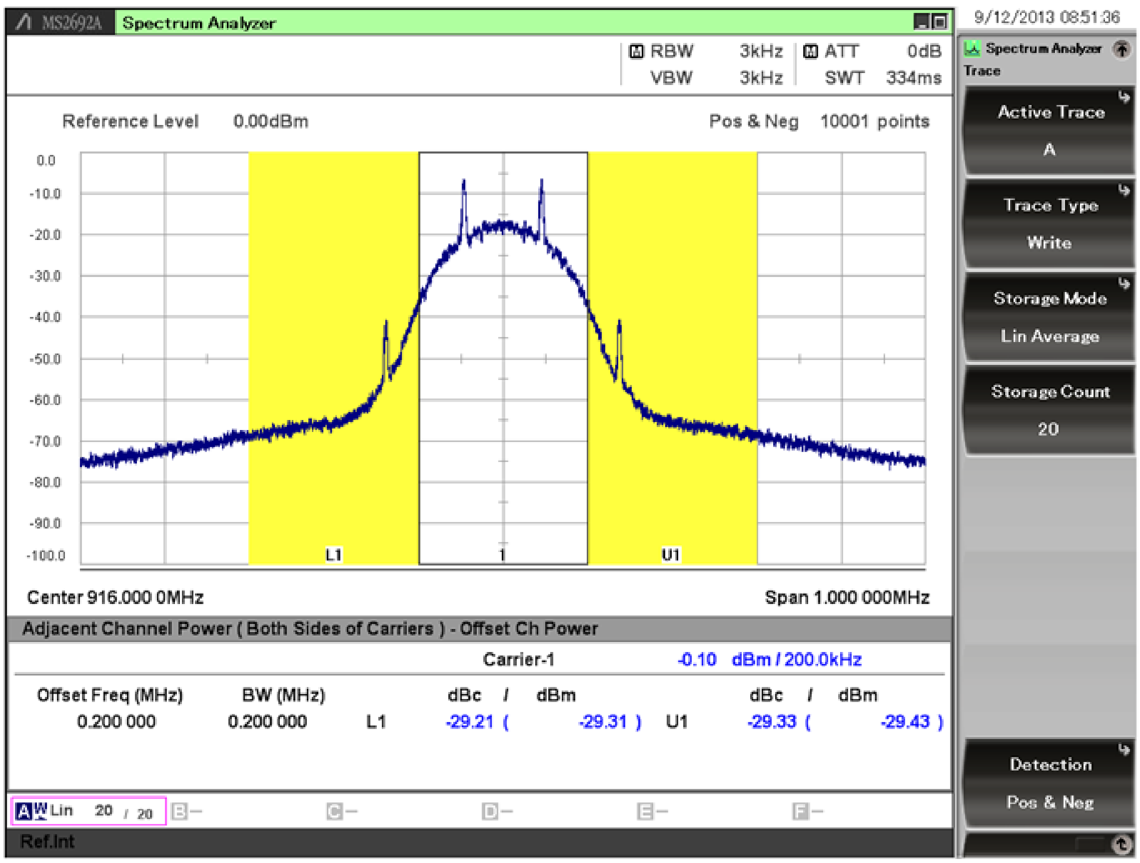


Figure 47. Adjacent Channel Leakage Power (DR=92 kbps Dev=46 kHz, 1 mW, 916.0 to 916.8 MHz, N=1)

The selected modulation parameters were DR = 80 kbps and Deviation = 40 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 48. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) with great margins for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –26 dBm (max)
- Measured: –35.17 dBm
- Margin: 9.17 dB (PASS)

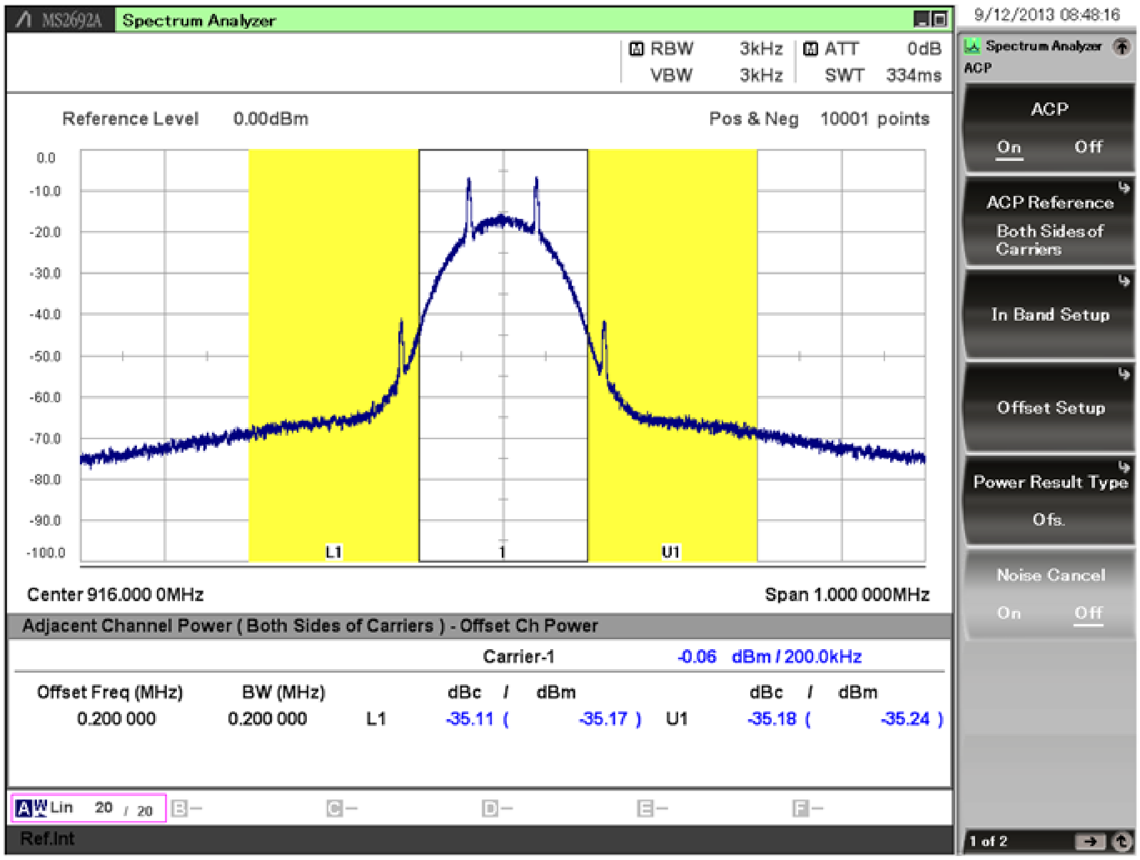


Figure 48. Adjacent Channel Leakage Power (DR=80 kbps Dev=40 kHz, 1 mW, 916.0 to 916.8 MHz, N=1)

The Si4455 chip easily complies with the adjacent channel leakage specification when using two unit radio channels (N=2). The measured adjacent channel leakage for the scenario of N=2 with DR=100 kbps Dev=50 kHz is shown in Figure 49, and is observed to comply with the spec with over 20 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –26 dBm (max)
- Measured: –49.60 dBm
- Margin: 23.60 dB (PASS)

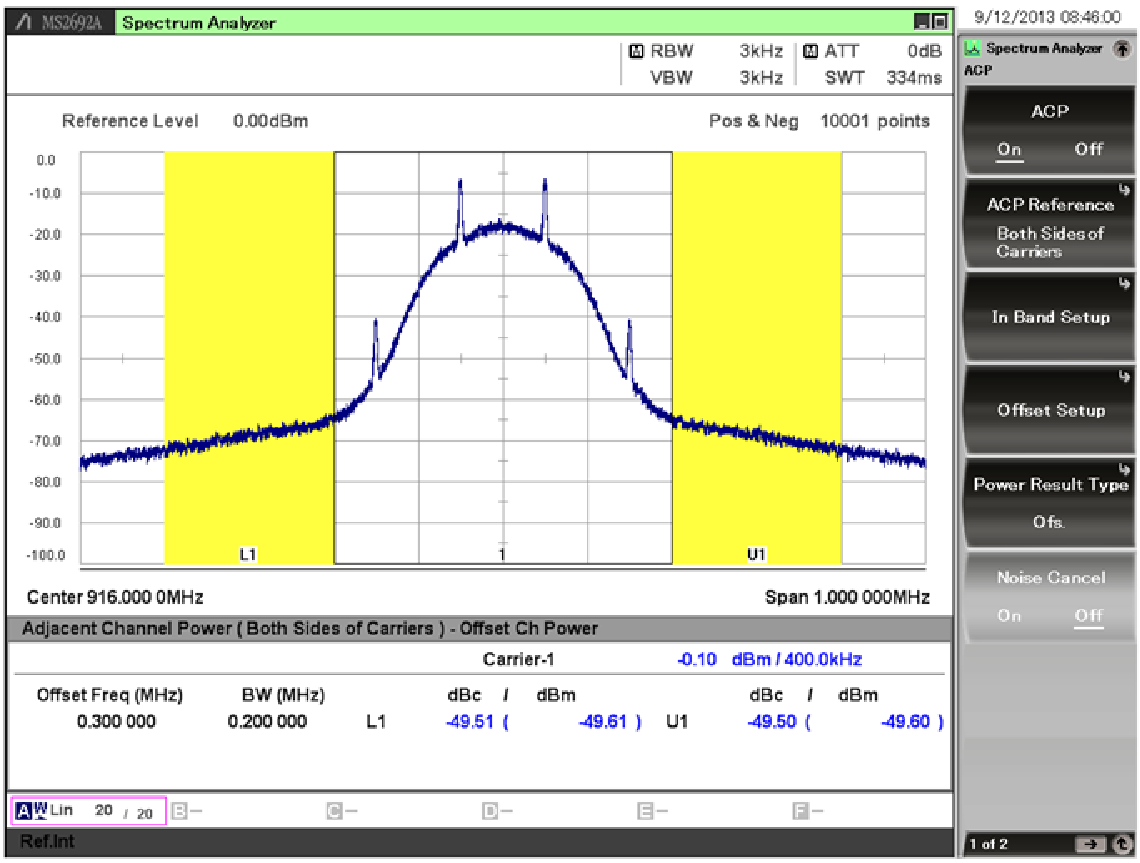


Figure 49. Adjacent Channel Leakage Power
(DR=100 kbps Dev=50 kHz, 1 mW, 916.0 to 916.8 MHz, N=2)

3.7.8. Spectral Mask, Antenna power= 1 mW, Freq. Band=916.0 to 916.8 MHz and 920.6 to 928.0 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 200 kHz + n x 100 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100 kHz/3 kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/3 kHz bandwidth.

The selected modulation parameters were DR = 100 kbps and Deviation = 50 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 50. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with large margins. Of course with selecting lower data rates / frequency deviations compliance with greater margins can be obtained.

- Margin: 16.07 dB (PASS)

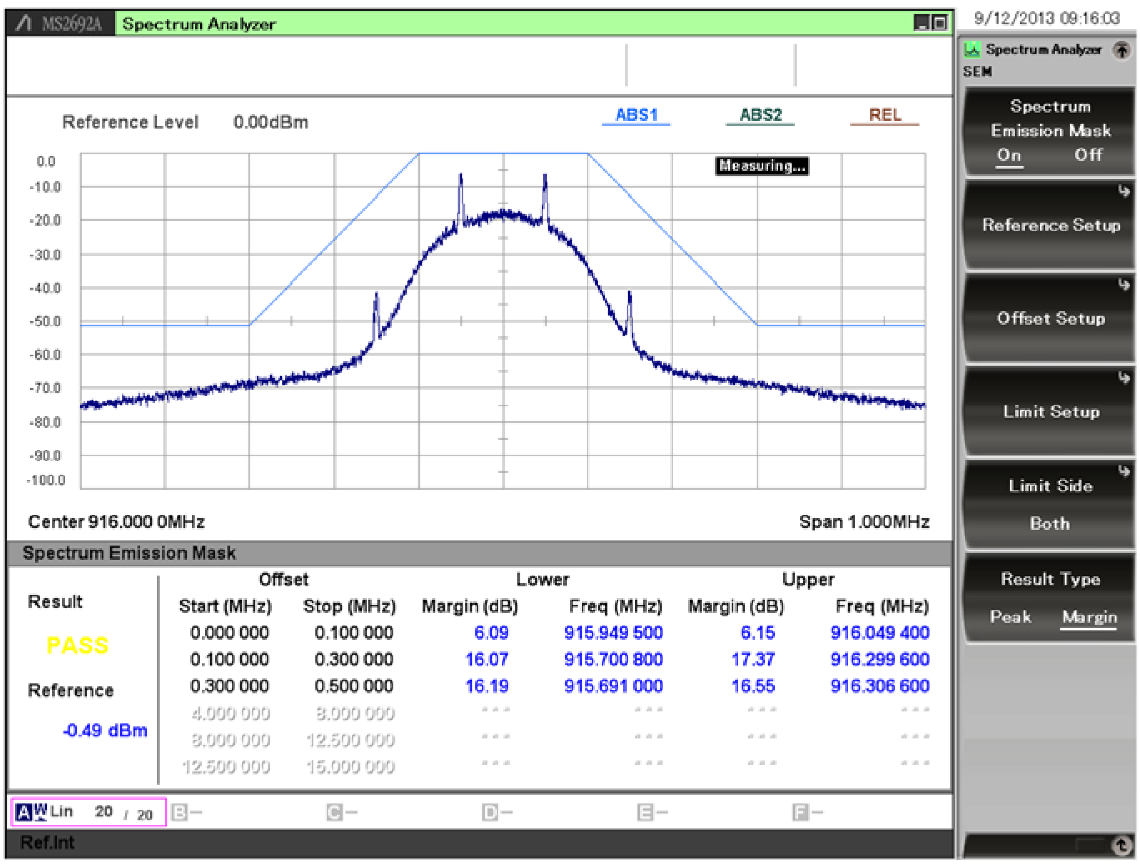


Figure 50. Spectral Mask (DR=100 kbps Dev=50 kHz, 1 mW, 916.0 to 916.8 MHz, N=1)

3.7.9. ACP, Antenna power= 1 mW, Freq. Band=928.15 to 929.65 MHz

Within the frequency band of 928.15 to 929.65 MHz when operating with an antenna power of less than or equal to 1 mW, the integrated adjacent channel leakage power within the 100 kHz bandwidth at the upper and lower edges of the radio channel shall be less than or equal to –26 dBm.

The selected modulation parameters were DR = 50 kbps and Deviation = 25 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 51. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol with no margins.

- Limit: –26 dBm (max)
- Measured: –26.34 dBm
- Margin: 0.34 dB (PASS)

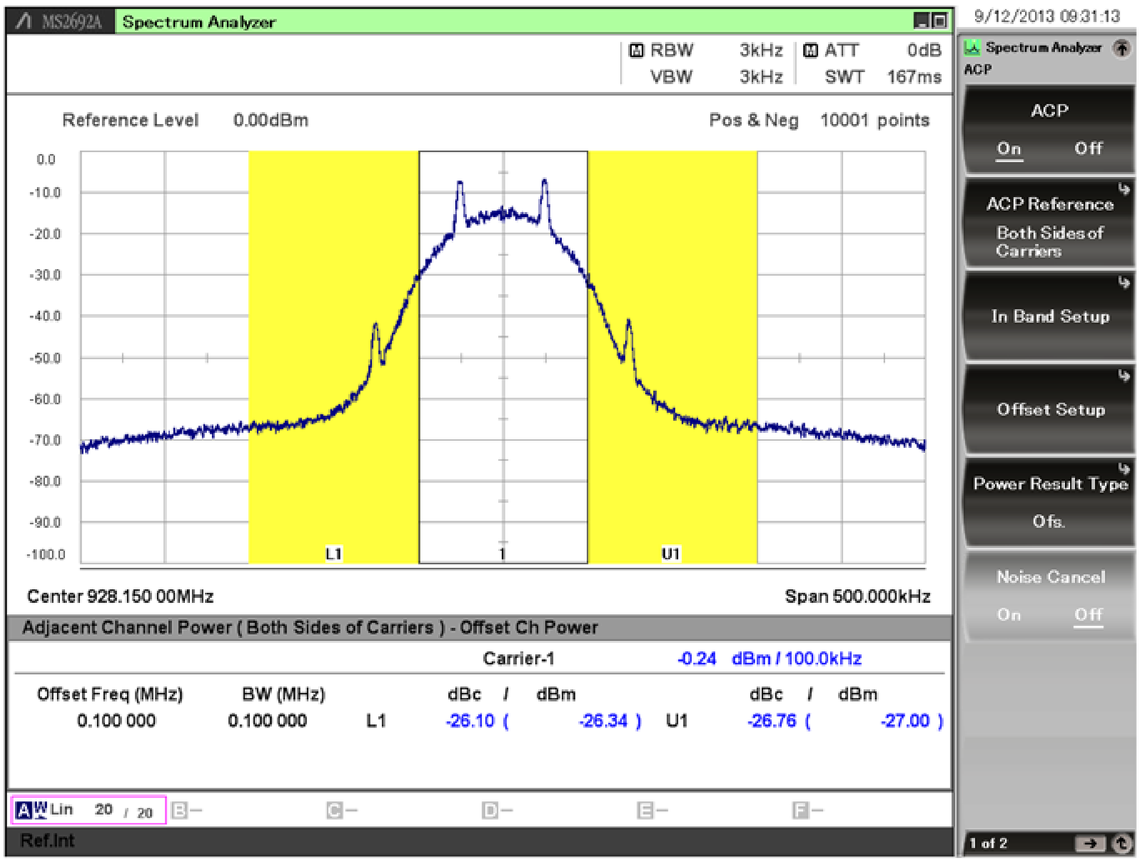


Figure 51. Adjacent Channel Leakage Power (DR=50 kbps Dev=25 kHz, 1 mW, 928.15 to 929.65 MHz, N=1)

Compliance with greater margins can be achieved by decreasing the data rate / frequency deviation of the modulation. The measured adjacent channel leakage power with lower data rate is shown in Figure 52.

The selected modulation parameters were DR = 40 kbps and Deviation = 20 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured adjacent channel leakage power is shown in Figure 52. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Adjacent Channel Leakage Power for the selected modulation protocol.

- Limit: –26 dBm (max)
- Measured: –35.53 dBm
- Margin: 9.53 dB (PASS)

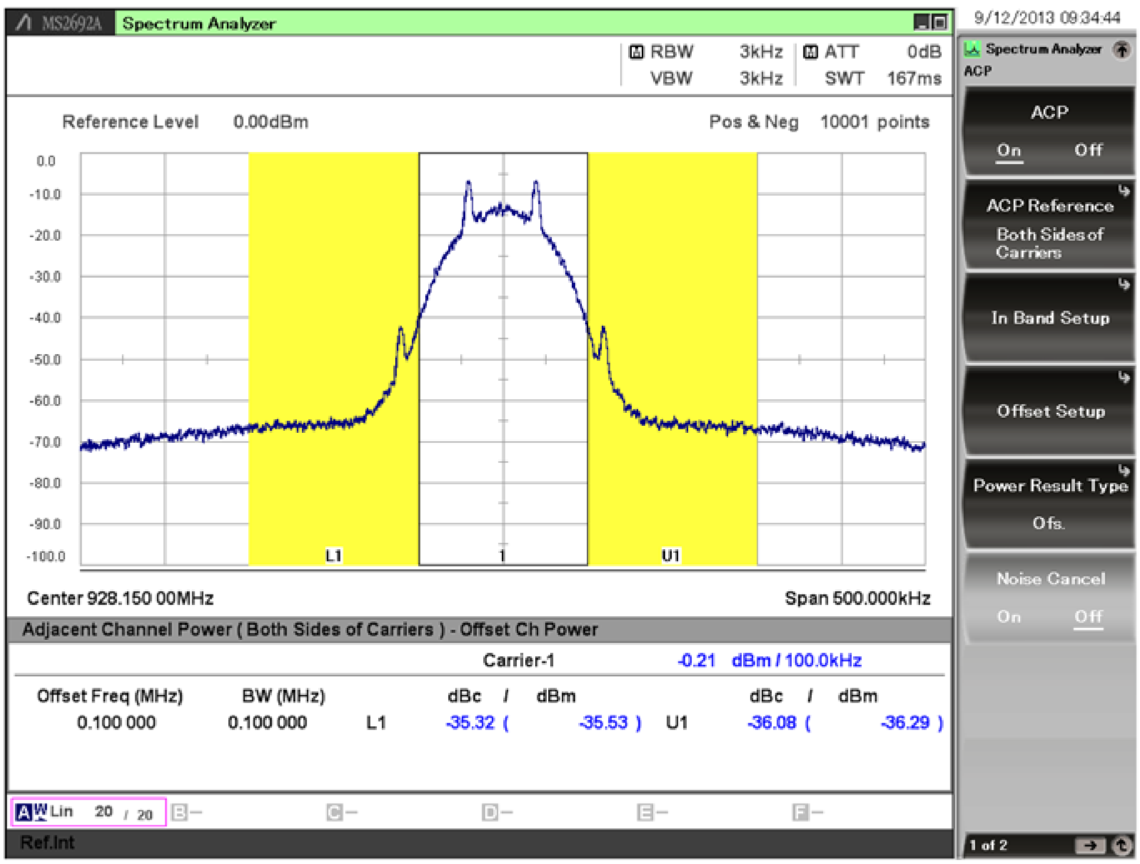


Figure 52. Adjacent Channel Leakage Power (DR=40 kbps Dev=20 kHz, 1 mW, 928.15 to 929.65 MHz, N=1)

The Si4455 chip easily complies with the adjacent channel leakage specification when using two unit radio channels (N=2). The measured adjacent channel leakage for the scenario of N=2 with DR=50 kbps Dev=25 kHz is shown in Figure 53, and is observed to comply with the spec with over 20 dB of margin. This test also inherently verifies compliance with wider radio channels, such as when using N=3, 4, or 5 unit radio channels.

- Limit: –26 dBm (max)
- Measured: –51.07 dBm
- Margin: 25.07 dB (PASS)

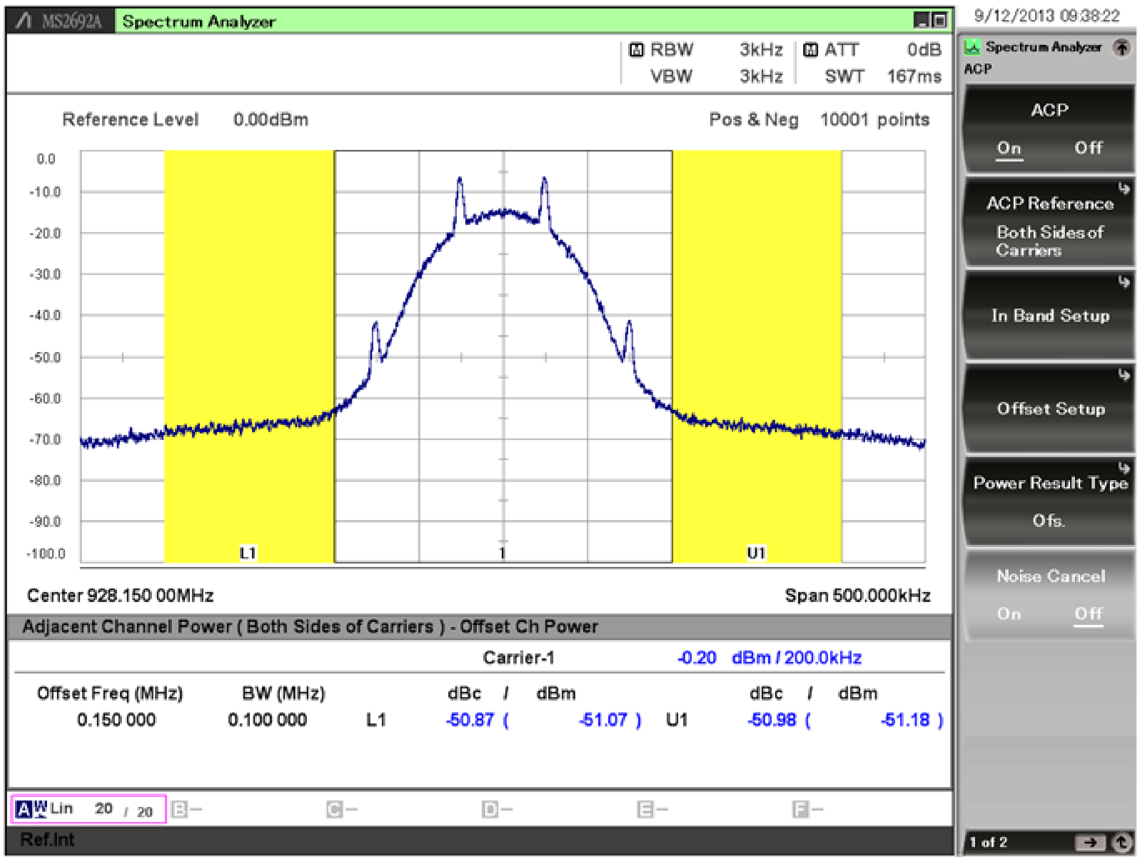


Figure 53. Adjacent Channel Leakage Power (DR=50 kbps Dev=25 kHz, 1 mW, 928.15 to 929.65 MHz, N=2)

3.7.10. Spectral Mask, Antenna power= 1 mW, Freq. Band=928.15 to 929.65 MHz

Within the frequency band of 915.0 to 930.0 MHz at frequency offsets from the channel center frequency of |f – fc| > 100 kHz + n x 50 kHz, the limit of unwanted spurious signals shall be less than or equal to –36 dBm/100 kHz. Although the allowed spurious level is specified in a 100 kHz reference bandwidth, it is not appropriate to use ResBW=100 kHz while taking the measurement due to the proximity to the modulation bandwidth of the desired signal. Accordingly, a ResBW=3 kHz configuration is used for the measurement, and the measurement limit is adjusted downwards by 10 x log(100 kHz/3 kHz) = 15.2 dB, resulting in a modified spec limit of –51.2 dBm/3 kHz bandwidth.

The selected modulation parameters were DR = 50 kbps and Deviation = 25 kHz. The measurement was taken assuming operation with one unit radio channel (N=1). The measured spectral mask is shown in Figure 54. The Si4455 chip complies with the requirements of ARIB STD-T108 3.2(7) for Spectral Mask for the selected modulation protocol with large margins. Of course with selecting lower data rates / frequency deviations compliance with greater margins can be obtained.

- Margin: 13.97 dB (PASS)

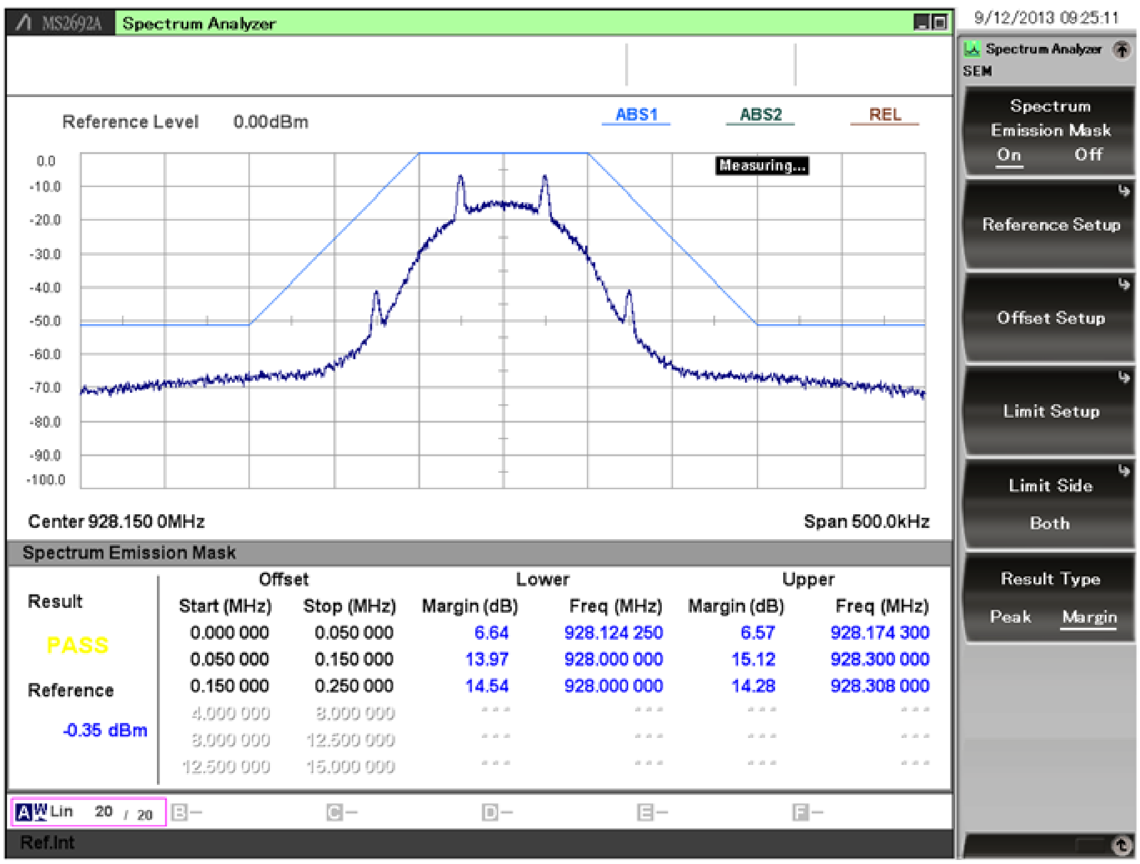


Figure 54. Spectral Mask (DR=50 kbps Dev=25 kHz, 1 mW, 928.15 to 929.65 MHz, N=1)

3.8. ARIB STD-T108 3.2(8) Spurious Emissions

The allowed level of spurious emissions is specified in ARIB STD-T108 3.2(8) and shall not exceed the limits shown in Table 2. The Si4455-B1 device was configured for an output power level of +10 dBm and +13 dBm on a channel center frequency of 925.8 MHz for all tests within this section. Since the +10 dBm and 0 dBm schematics are identical, the compliance is only demonstrated at +10 dBm (beside the +13 dBm case what uses different matching network). The selected modulation protocol was 2GFSK with DR = 100 kbps and Deviation = 50 kHz.

3.8.1. F ≤ 710 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions at frequencies below 710 MHz is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 55. The Si4455 chip easily complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –67.08 dBm
- Margin: 31.08 dB (PASS)

Figure 55. Spurious Emissions (10 mW, F≤710 MHz)

3.8.2. 710 MHz < F ≤ 900 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 710–900 MHz frequency band is specified as less than –55 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 56. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /1 MHz (max)
- Measured: –62.62 dBm
- Margin: 7.62 dB (PASS)

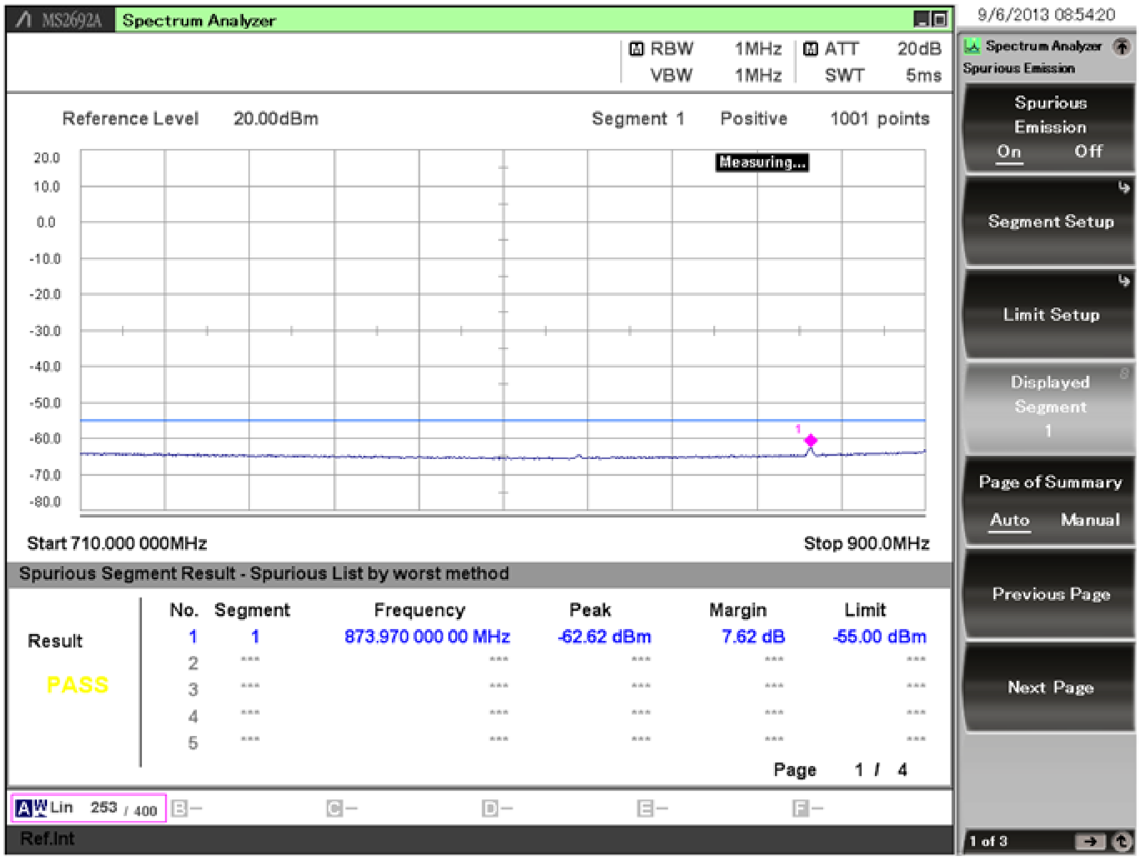


Figure 56. Spurious Emissions (10 mW, 710-900 MHz)

3.8.3. 900 MHz < F ≤ 915 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 900–915 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 57. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –74.52 dBm
- Margin: 19.52 dB (PASS)

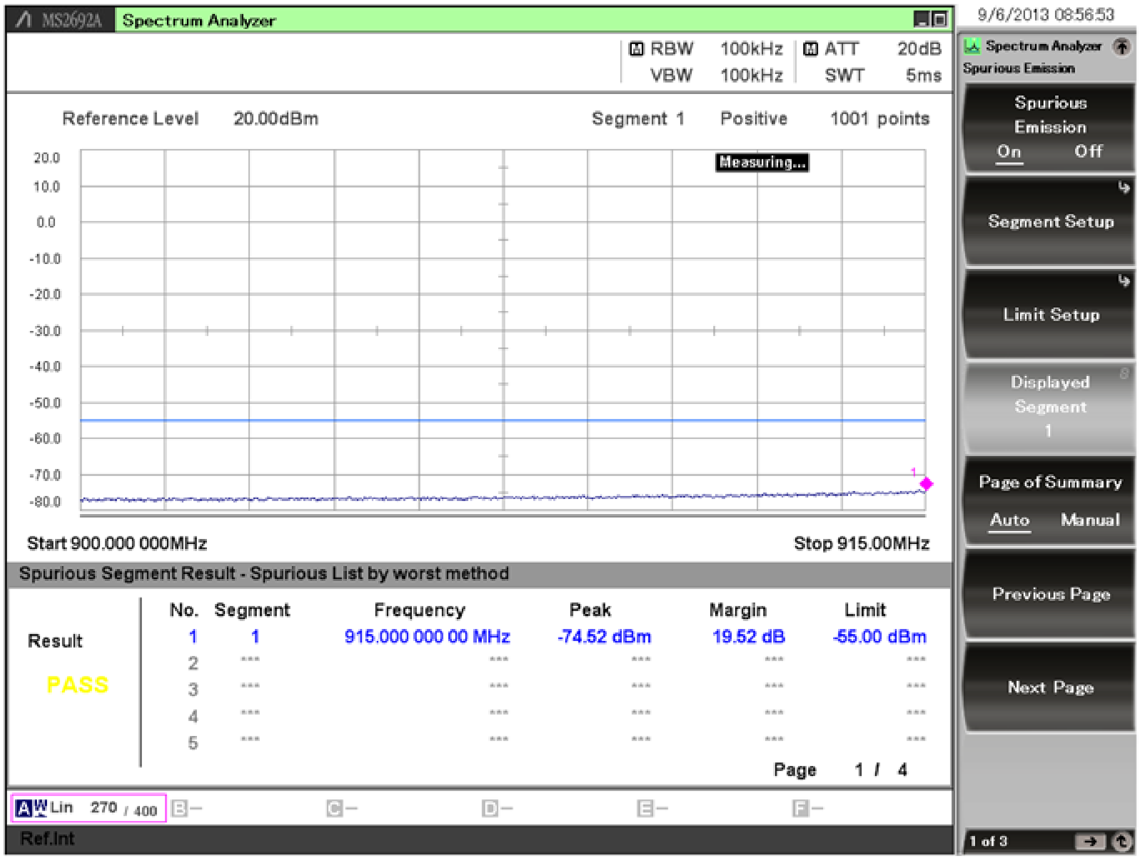


Figure 57. Spurious Emissions (10 mW, 900-915 MHz)

3.8.4. 915 MHz < F ≤ 920.3 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 915–920.3 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 58. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –68.17 dBm
- Margin: 32.17 dB (PASS)

Figure 58. Spurious Emissions (10 mW, 915-920.3 MHz)

3.8.5. 920.3 MHz < F ≤ 924.3 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 920.3–924.3 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 59. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –56.19 dBm
- Margin: 20.19 dB (PASS)

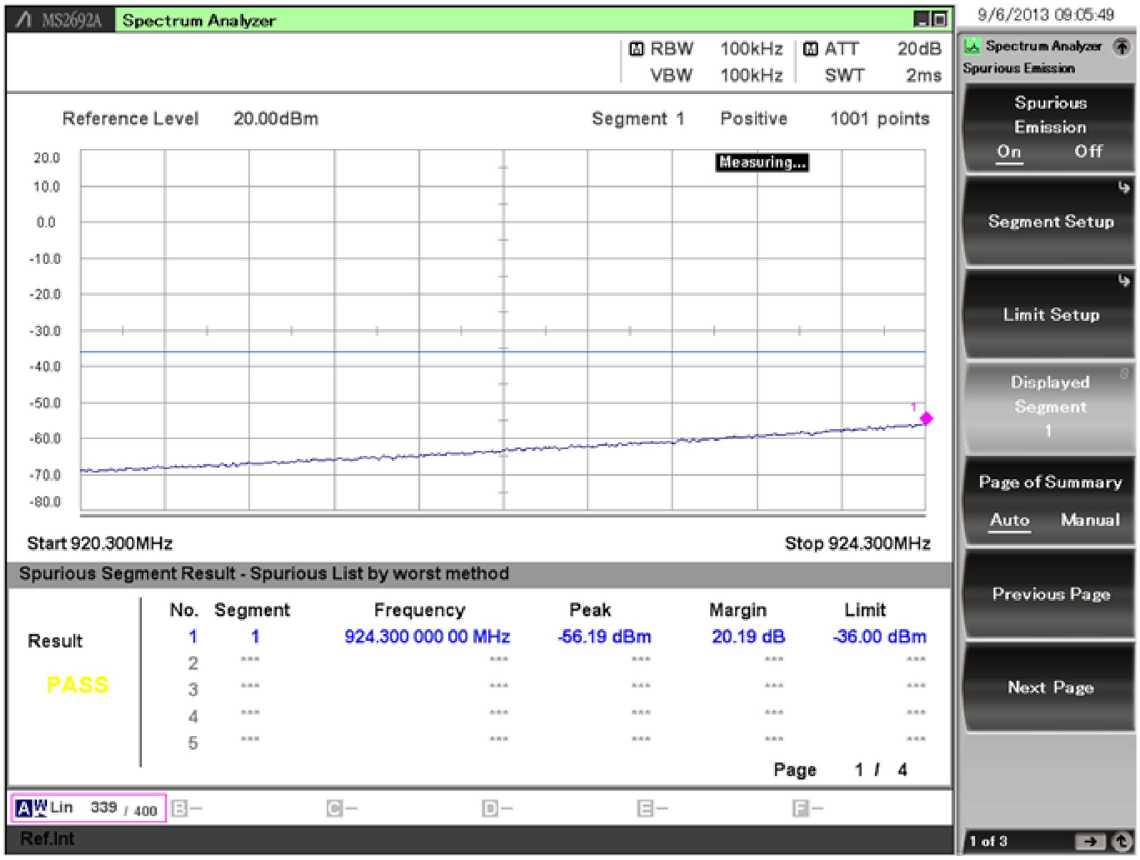


Figure 59. Spurious Emissions (10 mW, 920.3-924.3 MHz)

3.8.6. 924.3 MHz < F ≤ 930.0 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 924.3–930.0 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. This limit applies at all frequencies within this sub-band except at frequency offsets from the channel center frequency of |f – fc| ≤ 200 kHz + n x 100 kHz. The measured spurious emissions within this frequency band are shown in Figure 60 and Figure 61, lower and upper range, respectively. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –41.60 dBm
- Margin: 5.60 dB (PASS)

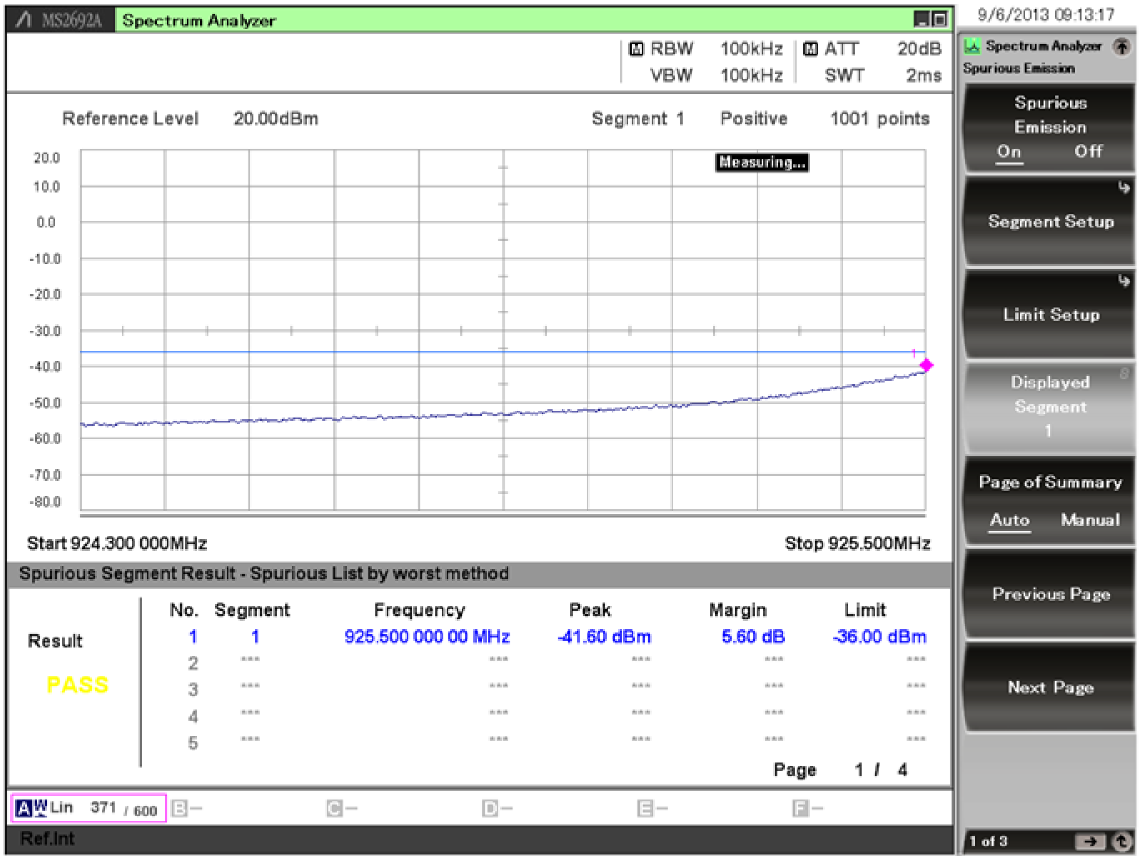


Figure 60. Spurious Emissions (10 mW, 924.3-930.0 MHz, lower range)

- Limit: –36 dBm /100 kHz (max)
- Measured: –41.90 dBm
- Margin: 5.90 dB (PASS)

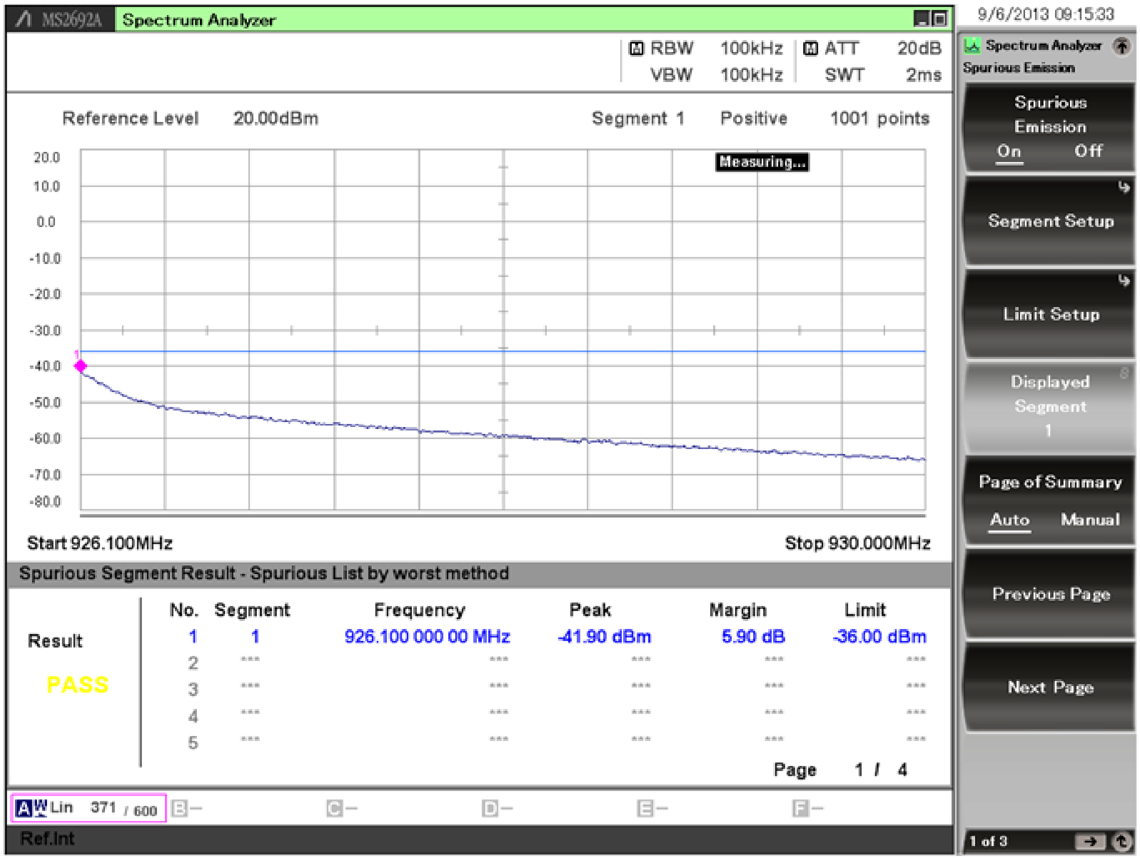


Figure 61. Spurious Emissions (10 mW, 924.3-930.0 MHz, upper range)

3.8.7. 930.0 MHz < F ≤ 1 GHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 930.0–1000 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 62. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –63.08 dBm
- Margin: 8.08 dB (PASS)

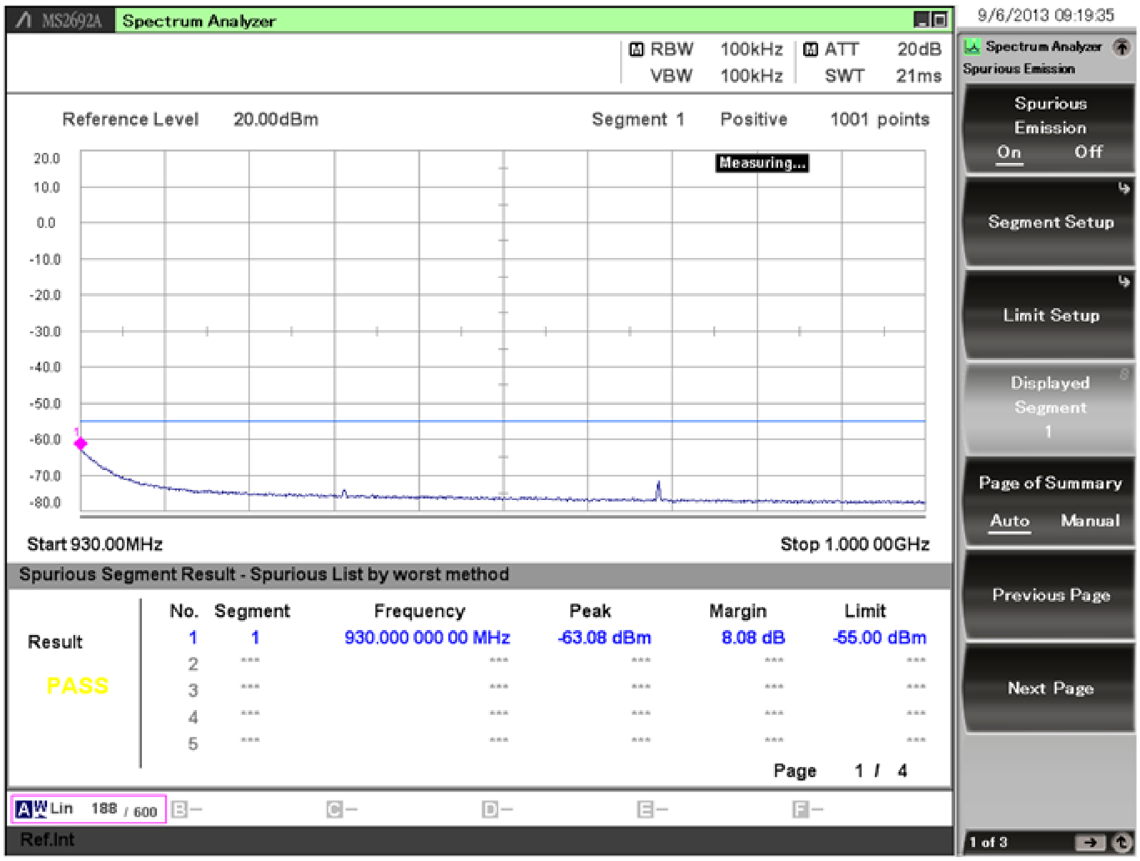


Figure 62. Spurious Emissions (10 mW, 930.0-1000 MHz)

3.8.8. 1000 MHz < F ≤ 1215 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions within the 1–1.215 GHz frequency band is specified as less than –48 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 63. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –48 dBm /1 MHz (max)
- Measured: –66.04 dBm
- Margin: 18.04 dB (PASS)

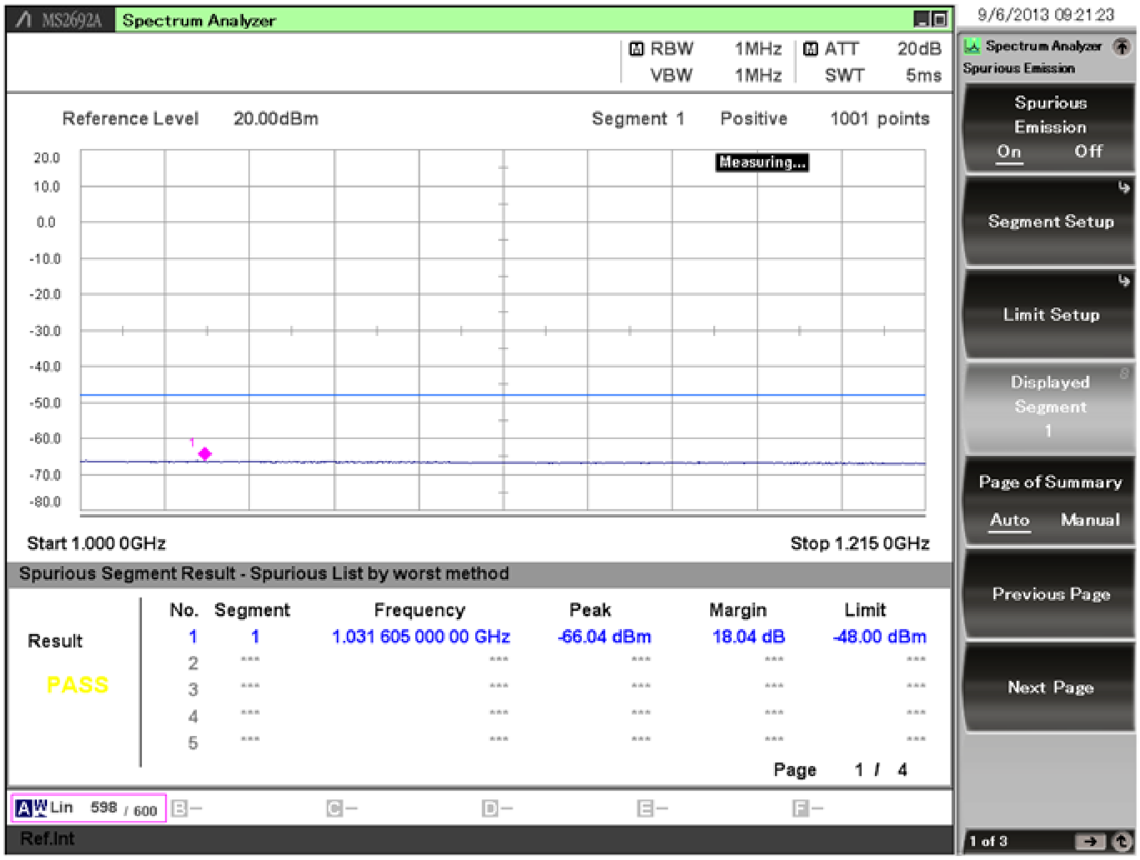


Figure 63. Spurious Emissions (10 W, 1–1.215 GHz)

3.8.9. F > 1215 MHz, Antenna Power= 10 mW

The allowed level of spurious emissions at frequencies above 1.215 GHz is specified as less than –30 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 64. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –30 dBm /1 MHz (max)
- Measured: –39.44 dBm
- Margin: 9.44 dB (PASS)

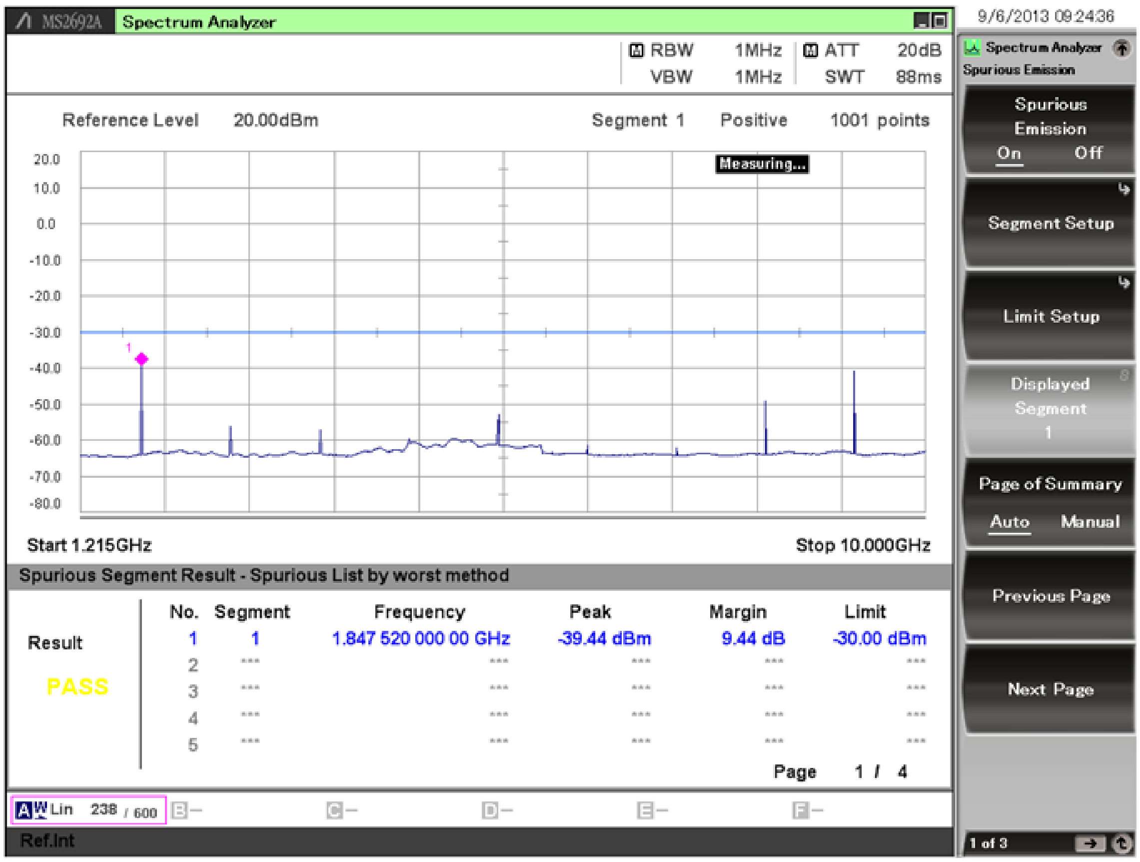


Figure 64. Spurious Emissions (10 mW, above 1.215 GHz)

3.8.10. F ≤ 710 MHz, Antenna Power=20 mW

The allowed level of spurious emissions at frequencies below 710 MHz is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 65. The Si4455 chip easily complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –73.77 dBm
- Margin: 37.77 dB (PASS)

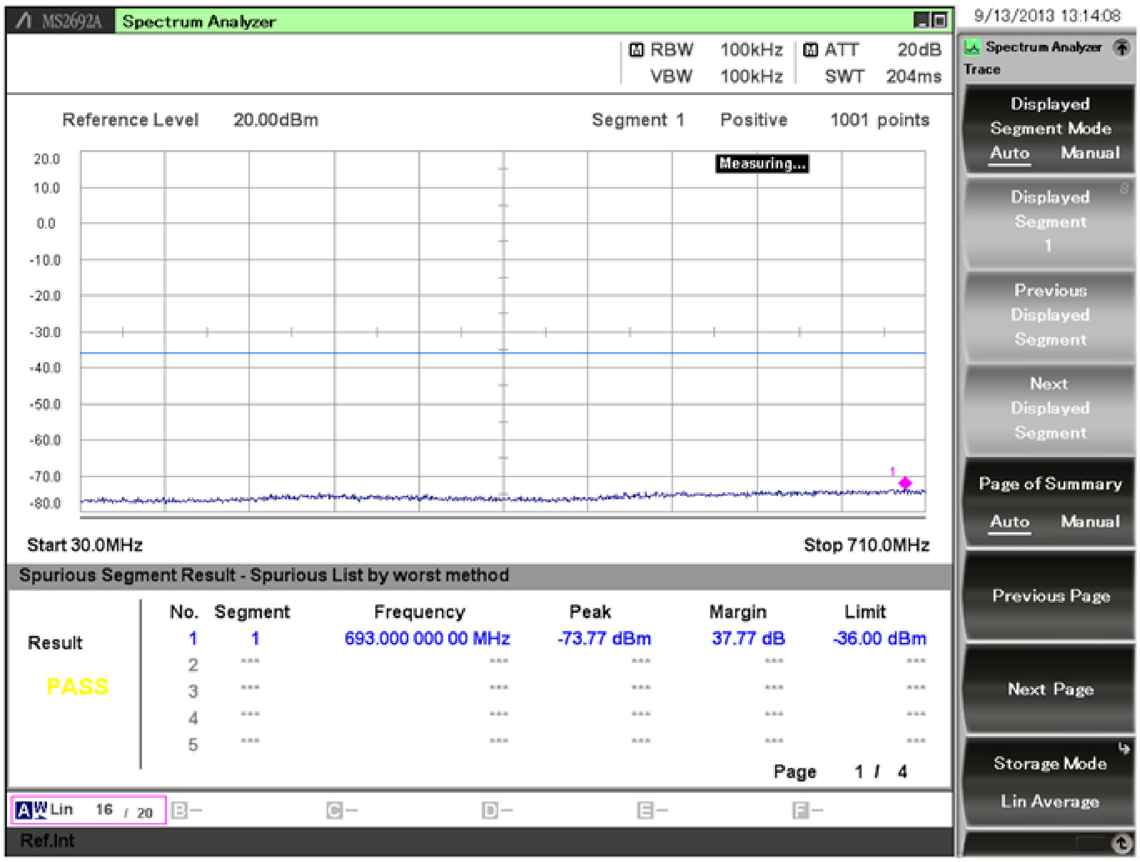


Figure 65. Spurious Emissions (20 mW, F≤710 MHz)

3.8.11. 710 MHz < F ≤ 900 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 710–900 MHz frequency band is specified as less than –55 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 66. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /1 MHz (max)
- Measured: –61.80 dBm
- Margin: 6.80 dB (PASS)

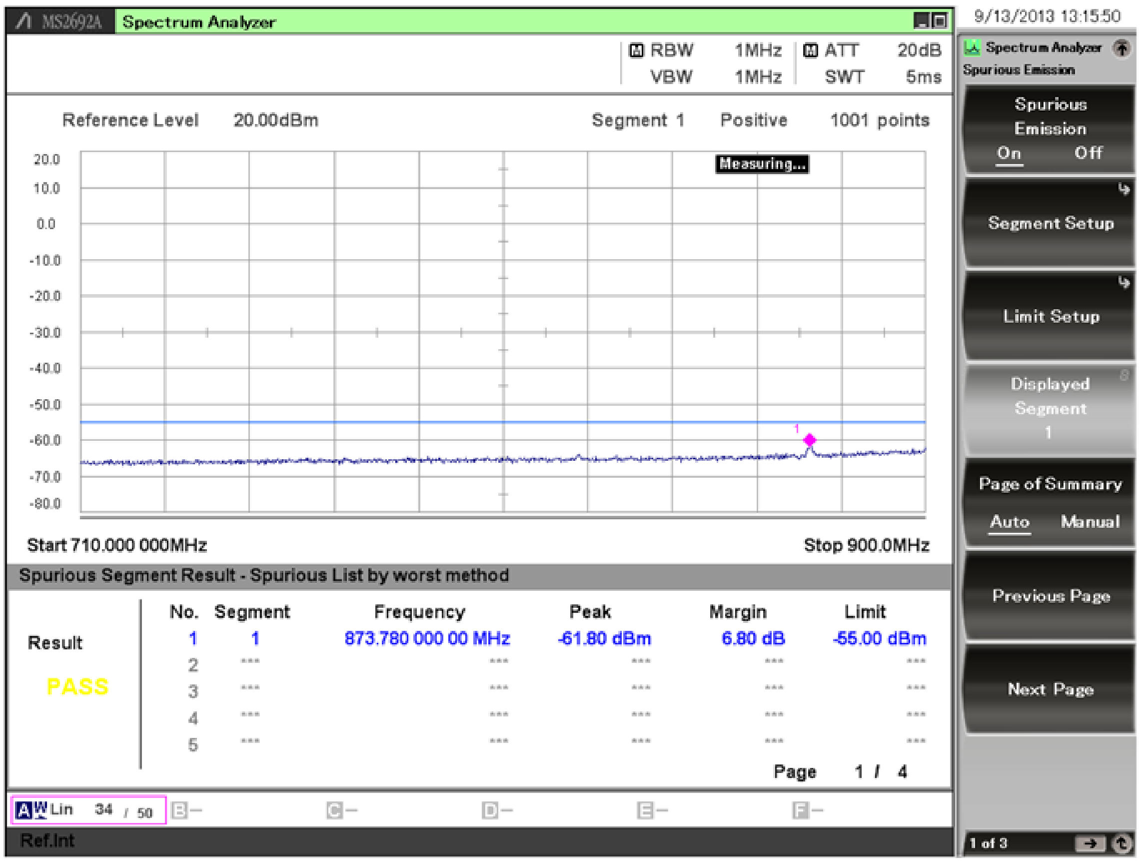


Figure 66. Spurious Emissions (20 mW, 710-900 MHz)

3.8.12. 900 MHz < F ≤ 915 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 900–915 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 67. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –72.92 dBm
- Margin: 17.92 dB (PASS)

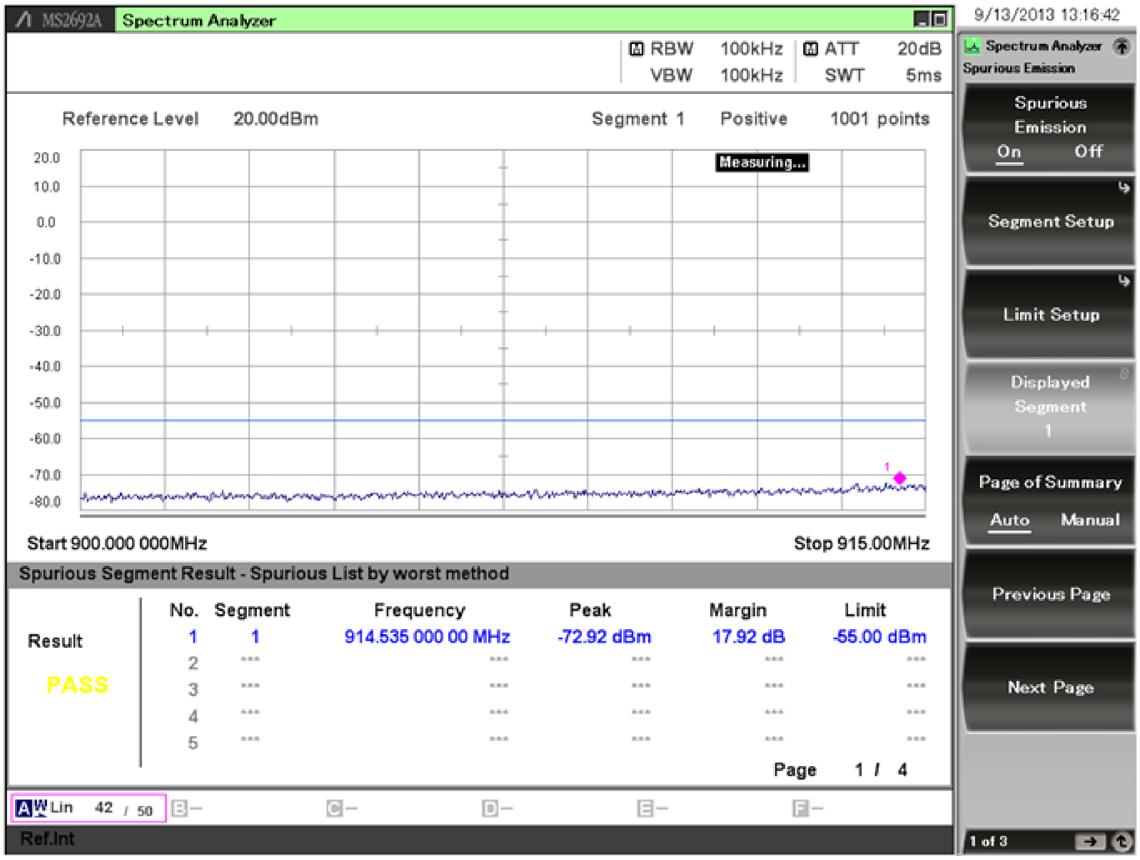


Figure 67. Spurious Emissions (20 mW, 900–915 MHz)

3.8.13. 915 MHz < F ≤ 920.3 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 915–920.3 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 68. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –66.00 dBm
- Margin: 30.00 dB (PASS)

Figure 68. Spurious Emissions (20 mW, 915–920.3 MHz)

3.8.14. 920.3 MHz < F ≤ 924.3 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 920.3–924.3 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 69. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –53.69 dBm
- Margin: 17.69 dB (PASS)

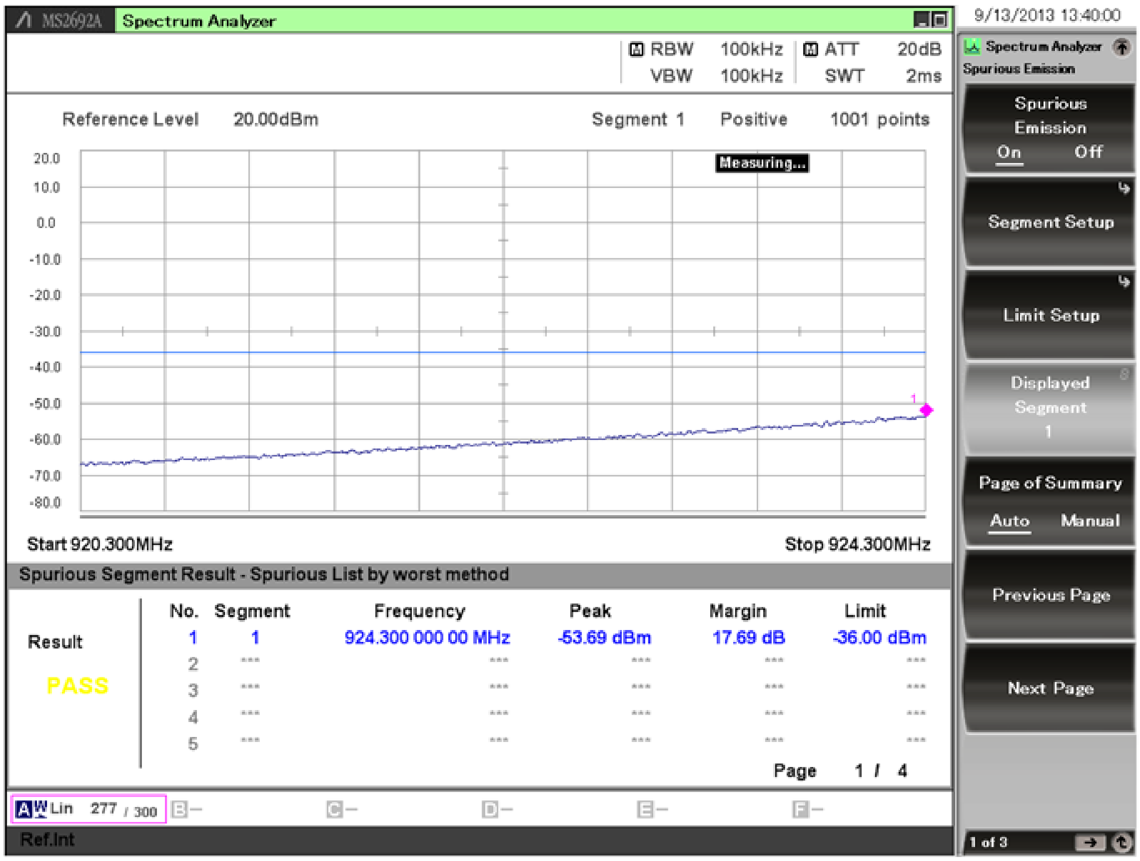


Figure 69. Spurious Emissions (20 mW, 920.3–924.3 MHz)

3.8.15. 924.3 MHz < F ≤ 930.0 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 924.3–930.0 MHz frequency band is specified as less than –36 dBm in any 100 kHz bandwidth. This limit applies at all frequencies within this sub-band except at frequency offsets from the channel center frequency of |f – fc| ≤ 200 kHz + n x 100 kHz. The measured spurious emissions within this frequency band are shown in Figure 70 and Figure 71, lower and upper range, respectively. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –36 dBm /100 kHz (max)
- Measured: –39.24 dBm
- Margin: 3.24 dB (PASS)

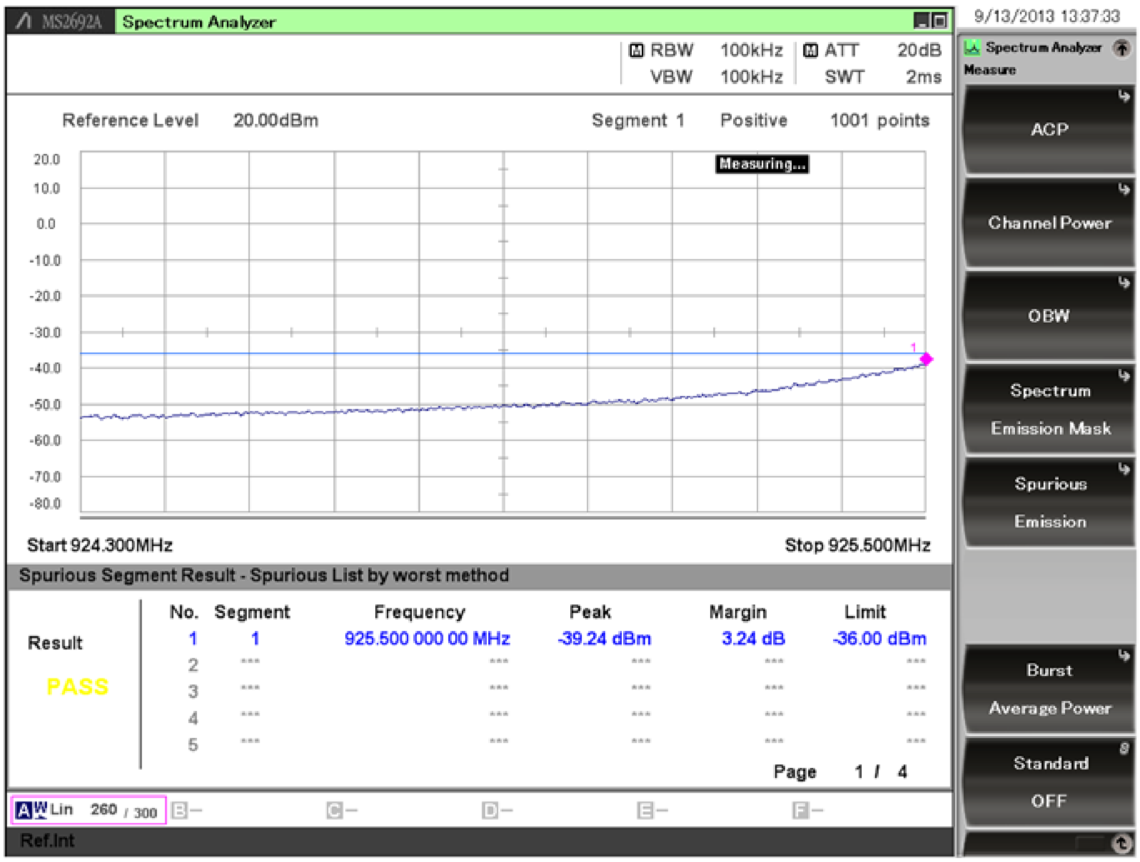


Figure 70. Spurious Emissions (20 mW, 924.3–930.0 MHz, lower range)

- Limit: –36 dBm /100 kHz (max)
- Measured: –39.37 dBm
- Margin: 3.37 dB (PASS)

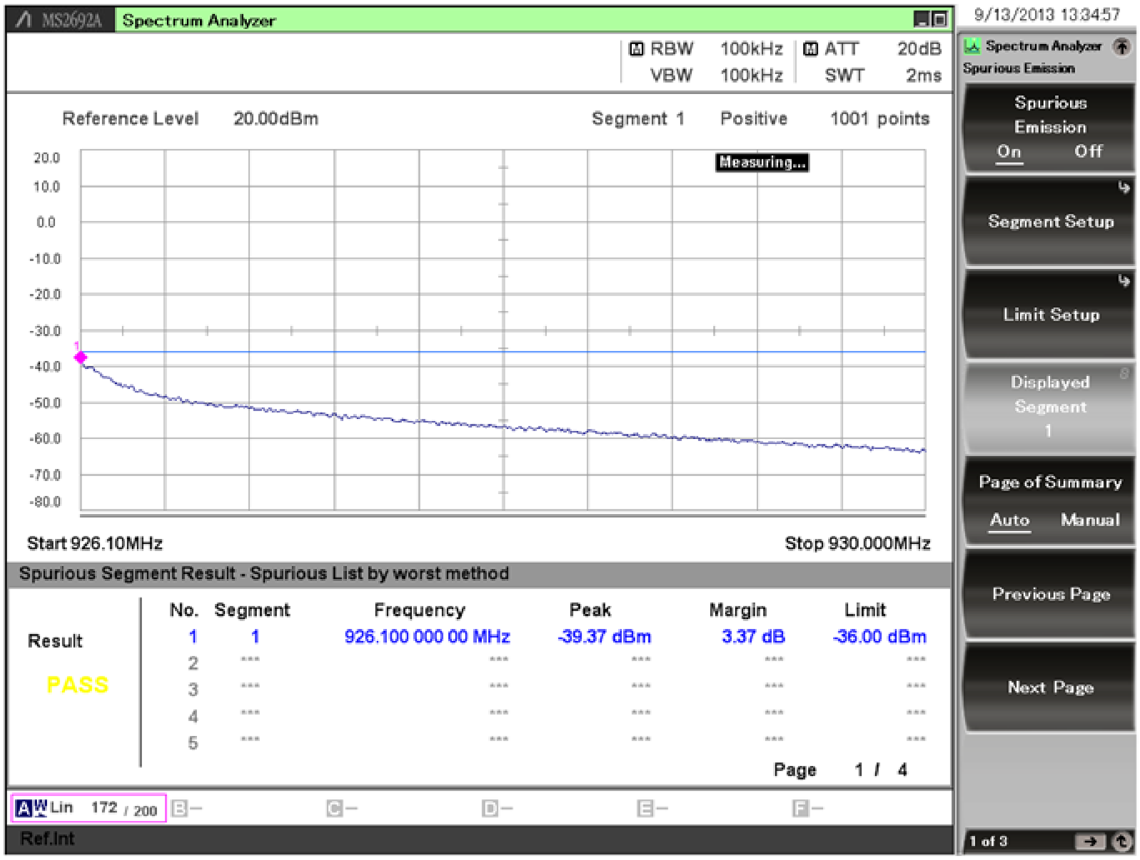


Figure 71. Spurious Emissions (20 mW, 924.3–930.0 MHz, upper range)

3.8.16. 930.0 MHz < F ≤ 1 GHz, Antenna Power= 20 mW

The allowed level of spurious emissions within the 930.0–1000 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 72. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –60.73 dBm
- Margin: 5.73 dB (PASS)

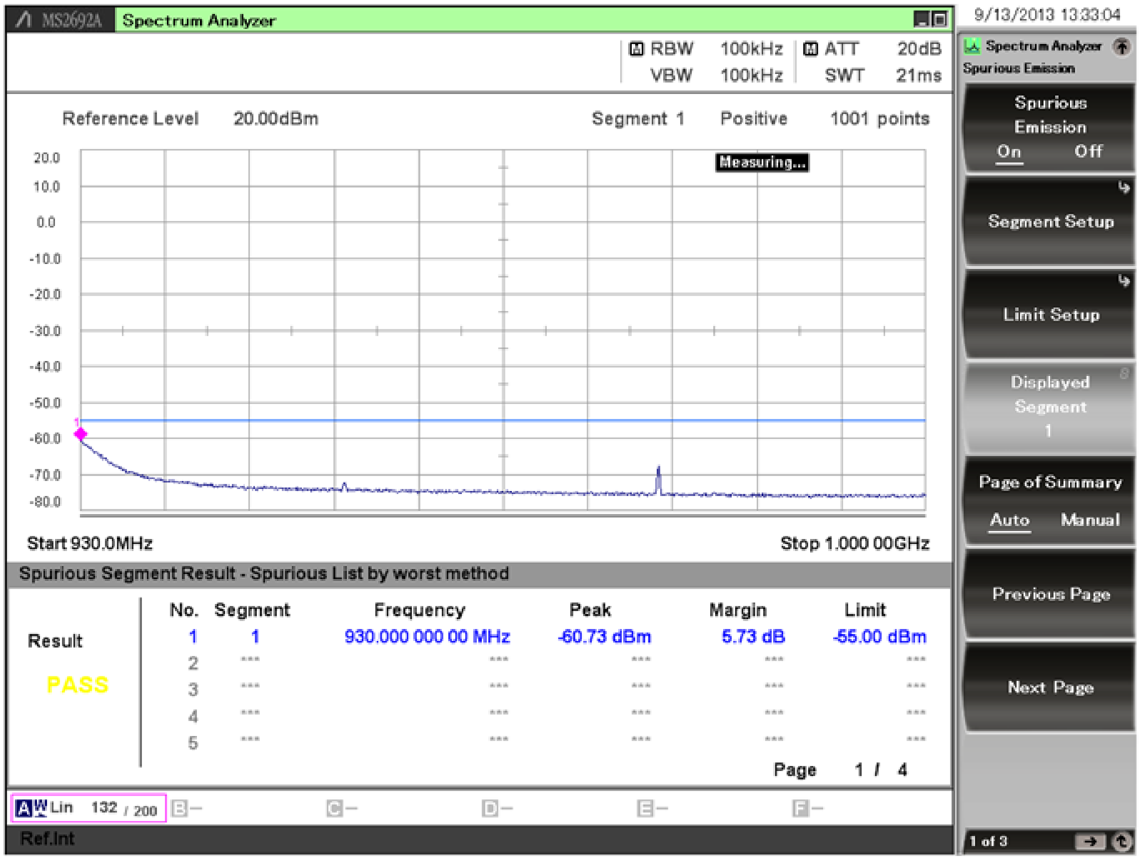


Figure 72. Spurious Emissions (20 mW, 930.0–1000 MHz)

3.8.17. 1000 MHz < F ≤ 1215 MHz, Antenna Power= 20mW

The allowed level of spurious emissions within the 1–1.215 GHz frequency band is specified as less than –48 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 73. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –48 dBm /1 MHz (max)
- Measured: –64.13 dBm
- Margin: 16.13 dB (PASS)

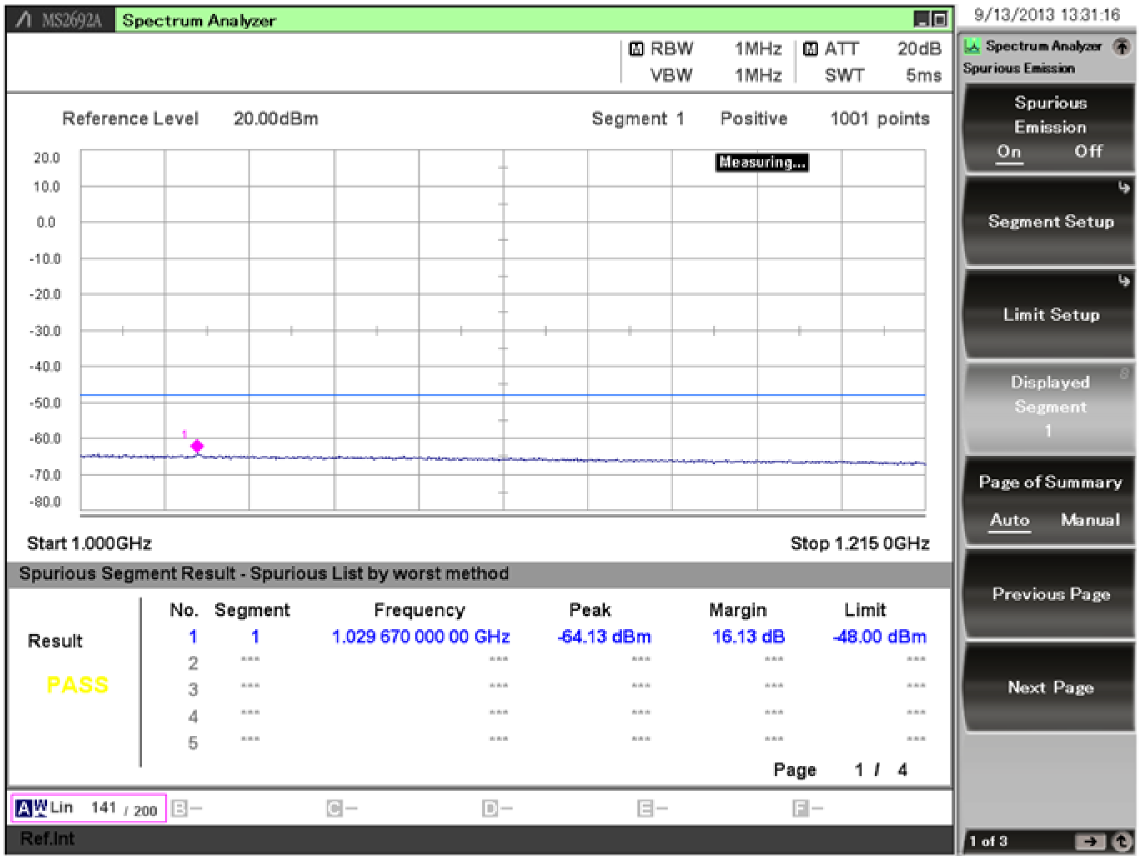


Figure 73. Spurious Emissions (20 mW, 1–1.215 GHz)

3.8.18. F > 1215 MHz, Antenna Power= 20 mW

The allowed level of spurious emissions at frequencies above 1.215 GHz is specified as less than –30 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 74. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –30 dBm /1 MHz (max)
- Measured: –39.69 dBm
- Margin: 9.69 dB (PASS)

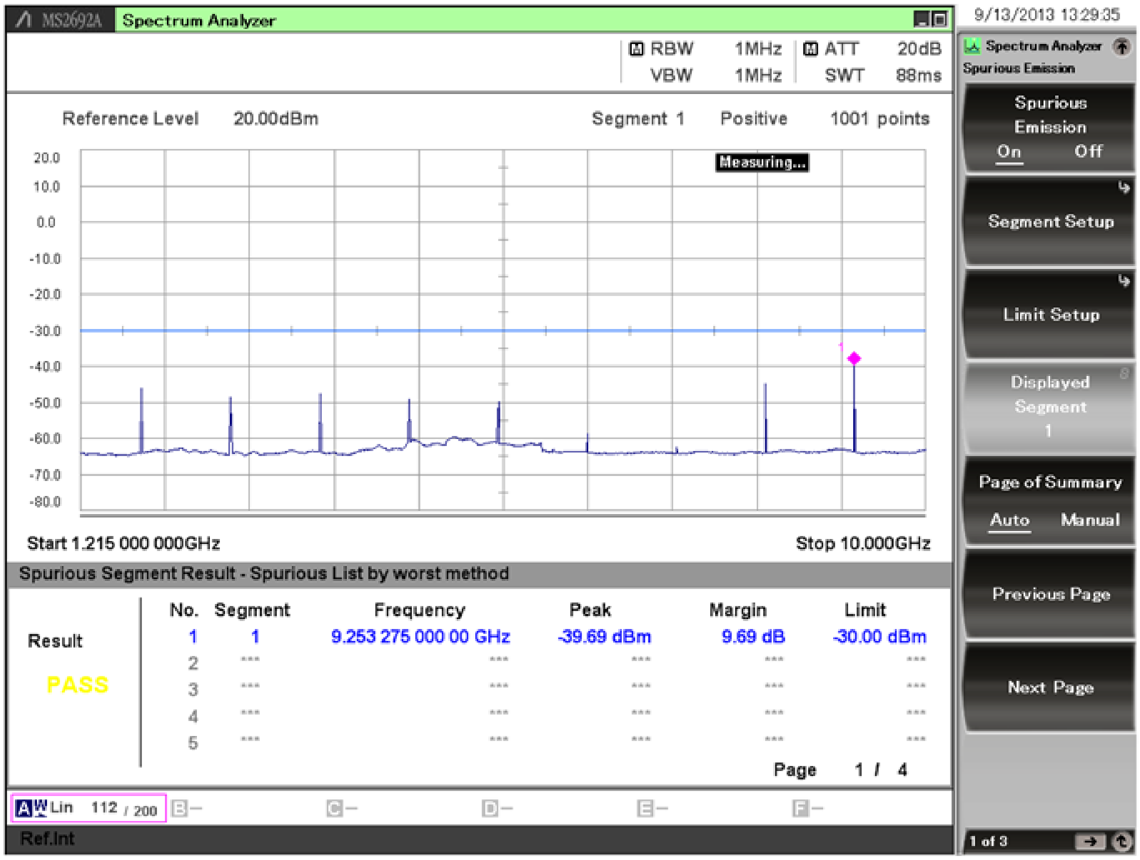


Figure 74. Spurious Emissions (20 mW, above 1.215 GHz)

4. RX Measurement Results

4.1. ARIB STD-T108 3.3 Receiver Conducted Spurious Emissions

The allowed level of conducted spurious emissions at the receiver input is specified in ARIB STD-T108 3.3 and shall not exceed the limits shown in Table 3. The Si4455-B1 device was configured for a channel center frequency of 925.8 MHz for all tests within this section. Since the +10 dBm and +13 dBm schematics are different the compliance must be demonstrated in both cases.

4.1.1. F ≤ 710 MHz, using the +10 dBm schematic

The allowed level of spurious emissions at frequencies below 710 MHz is specified as less than –54 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 75. The Si4455 chip easily complies with the specified level of spurious emissions within this sub-band.

- Limit: –54 dBm /100 kHz (max)
- Measured: –85.21 dBm
- Margin: 31.21 dB (PASS)

Figure 75. RX Conducted Spurious Emissions (F≤710 MHz)

4.1.2. 710 MHz < F ≤ 900 MHz, using the +10 dBm schematic

The allowed level of spurious emissions within the 710–900 MHz frequency band is specified as less than –55 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 76. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /1 MHz (max)
- Measured: –80.38 dBm
- Margin: 25.38 dB (PASS)

Figure 76. RX Conducted Spurious Emissions (710–900 MHz)

4.1.3. 900 MHz < F ≤ 915 MHz, using the +10 dBm schematic

The allowed level of spurious emissions within the 900–915 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 77. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –93.17 dBm
- Margin: 38.17 dB (PASS)

Figure 77. RX Conducted Spurious Emissions (900–915 MHz)

4.1.4. 915 MHz < F ≤ 930 MHz, using the +10 dBm Schematic

The allowed level of spurious emissions within the 915–930 MHz frequency band is specified as less than –54 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 78. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –54 dBm /100 kHz (max)
- Measured: –93.15 dBm
- Margin: 39.15 dB (PASS)

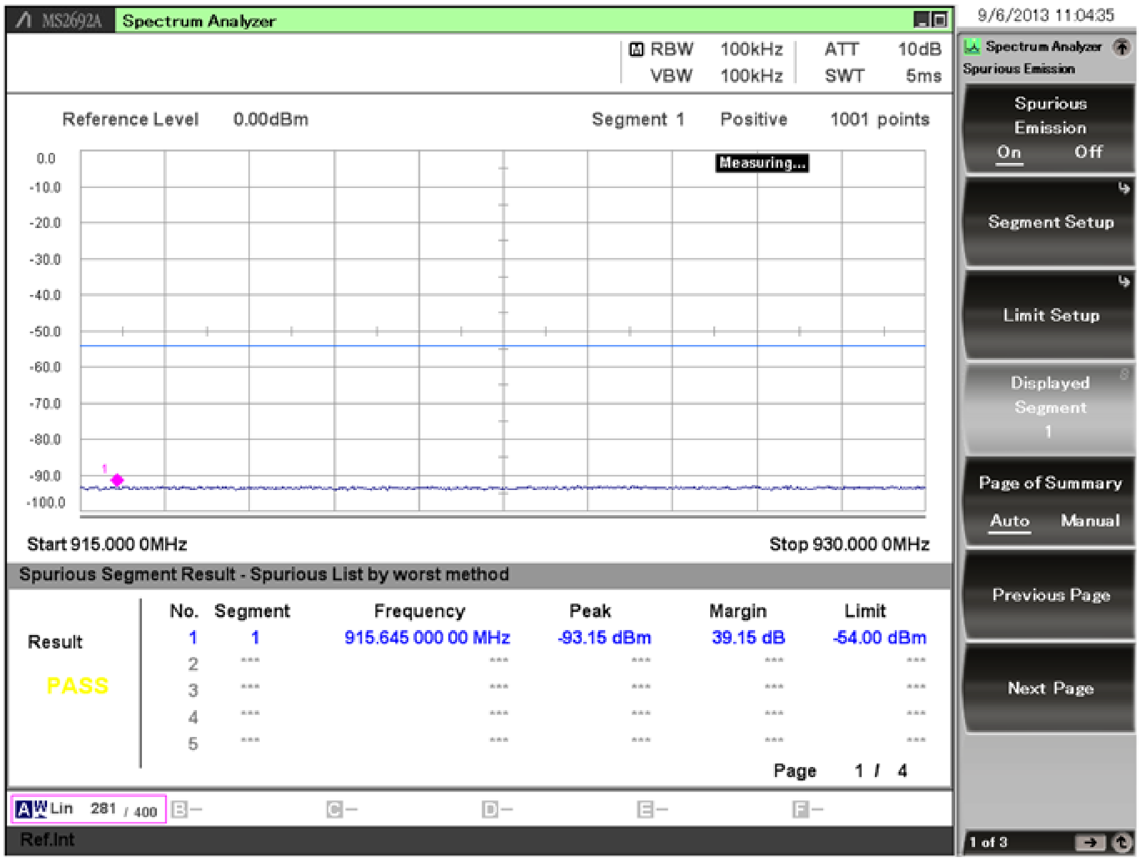


Figure 78. RX Conducted Spurious Emissions (915–930 MHz)

4.1.5. 930 MHz < F ≤ 1000 MHz, using the +10 dBm schematic

The allowed level of spurious emissions within the 930–1000 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 79. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –91.13 dBm
- Margin: 36.13 dB (PASS)

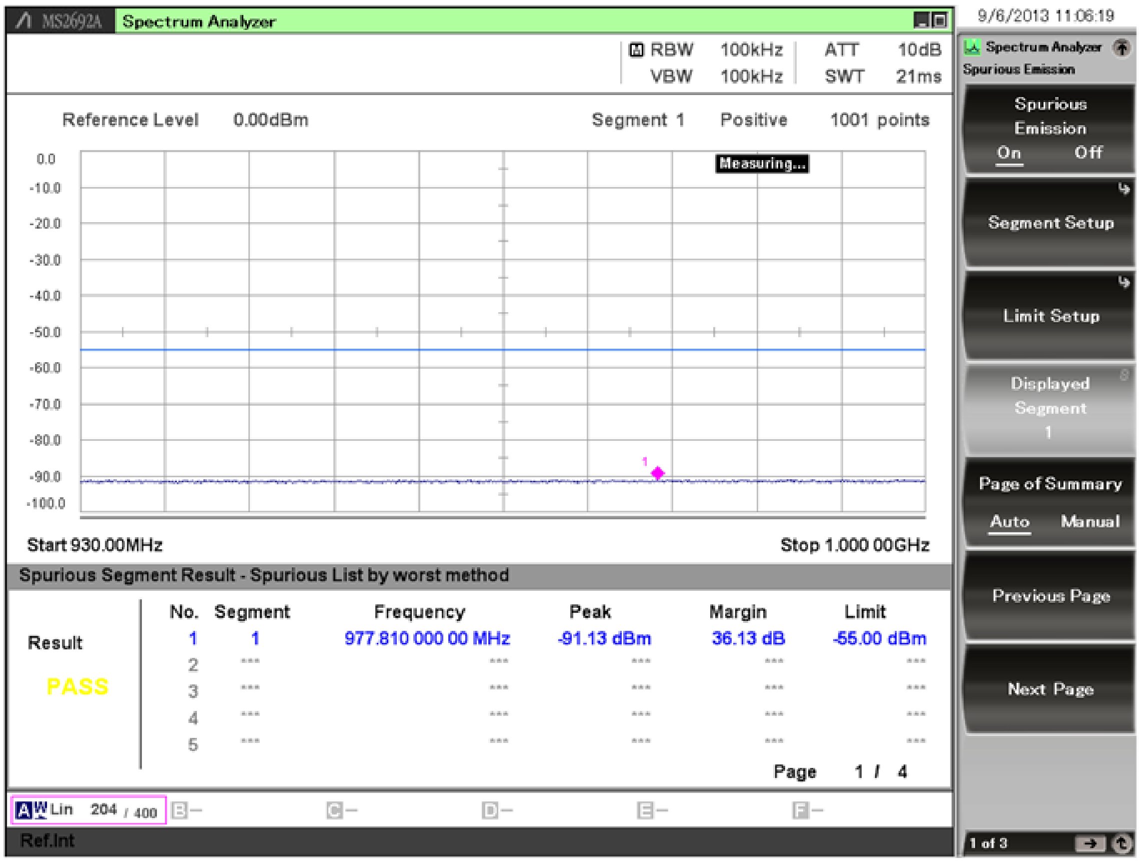


Figure 79. RX Conducted Spurious Emissions (930–1000 MHz)

4.1.6. F > 1 GHz, using the +10 dBm schematic

The allowed level of spurious emissions at frequencies above 1000 MHz is specified as less than –47 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 80. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –47 dBm /1 MHz (max)
- Measured: –72.71 dBm
- Margin: 25.71 dB (PASS)

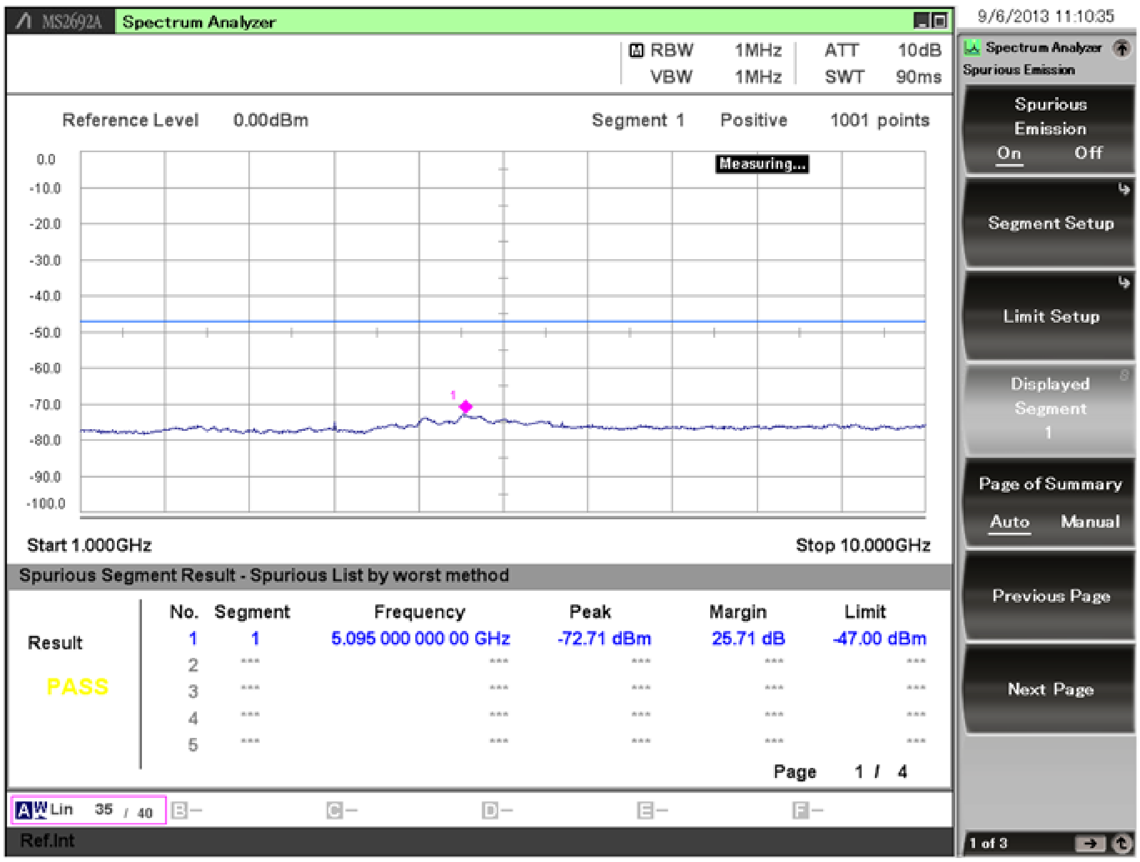


Figure 80. RX Conducted Spurious Emissions (above 1 GHz)

4.1.7. F ≤ 710 MHz, using the +13 dBm schematic

The allowed level of spurious emissions at frequencies below 710 MHz is specified as less than –54 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 81. The Si4455 chip easily complies with the specified level of spurious emissions within this sub-band.

- Limit: –54 dBm /100 kHz (max)
- Measured: –88.30 dBm
- Margin: 34.30 dB (PASS)

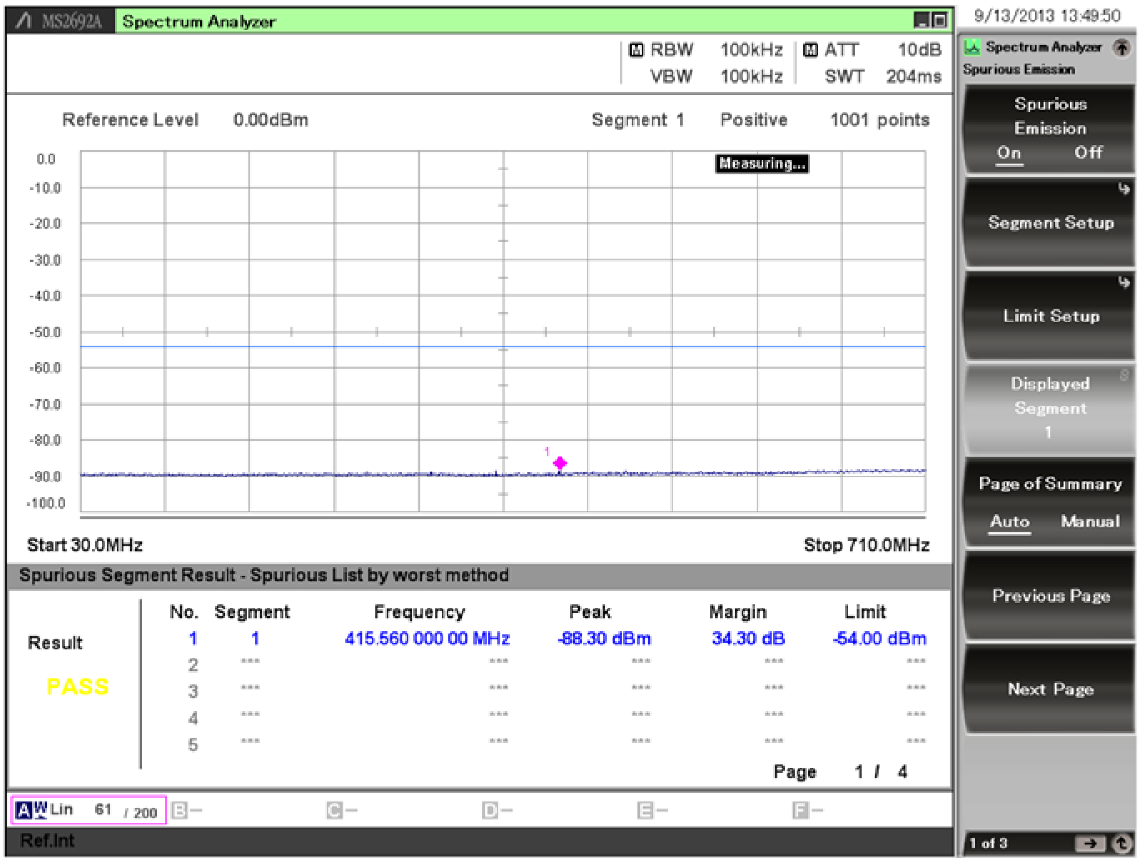


Figure 81. RX Conducted Spurious Emissions (F≤710 MHz)

4.1.8. 710 MHz < F ≤ 900 MHz, using the +13 dBm schematic

The allowed level of spurious emissions within the 710–900 MHz frequency band is specified as less than –55 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 82. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /1 MHz (max)
- Measured: –80.24 dBm
- Margin: 25.24 dB (PASS)

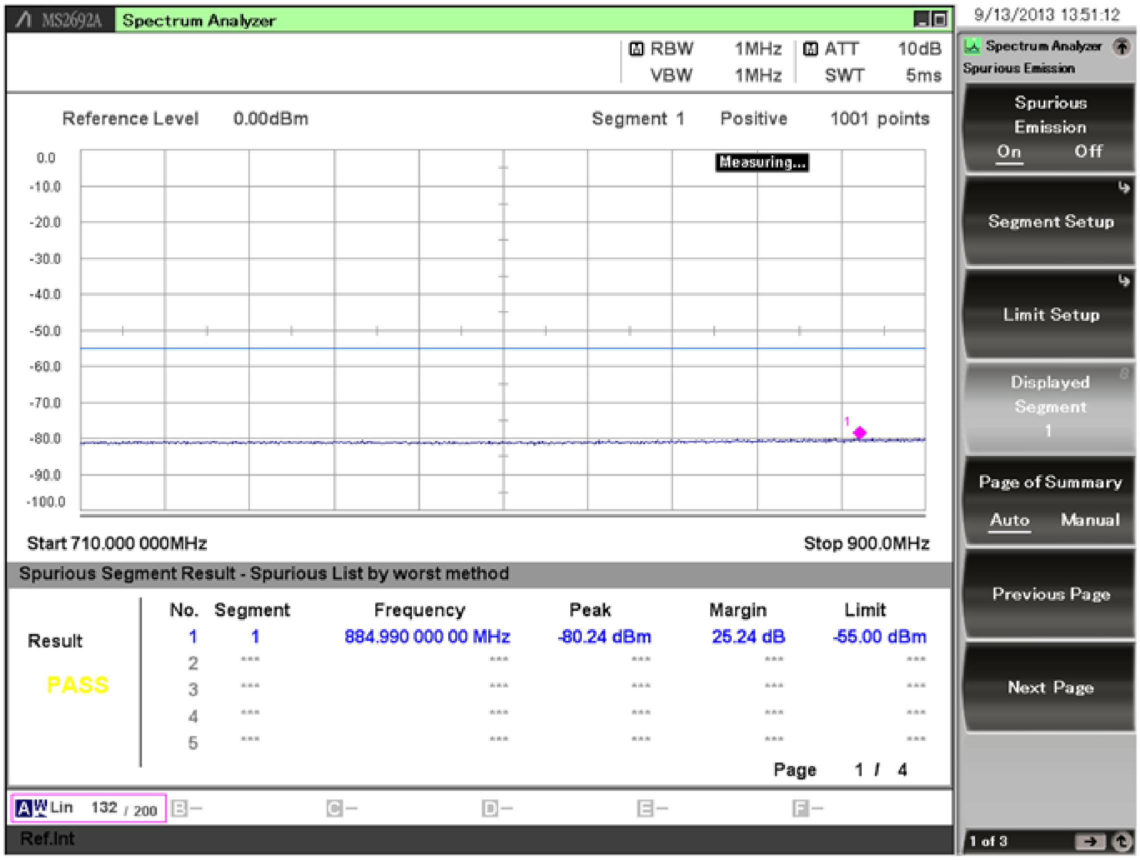


Figure 82. RX Conducted Spurious Emissions (710–900 MHz)

4.1.9. 900 MHz < F ≤ 915 MHz, using the +13 dBm schematic

The allowed level of spurious emissions within the 900–915 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 83. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –92.83 dBm
- Margin: 37.83 dB (PASS)

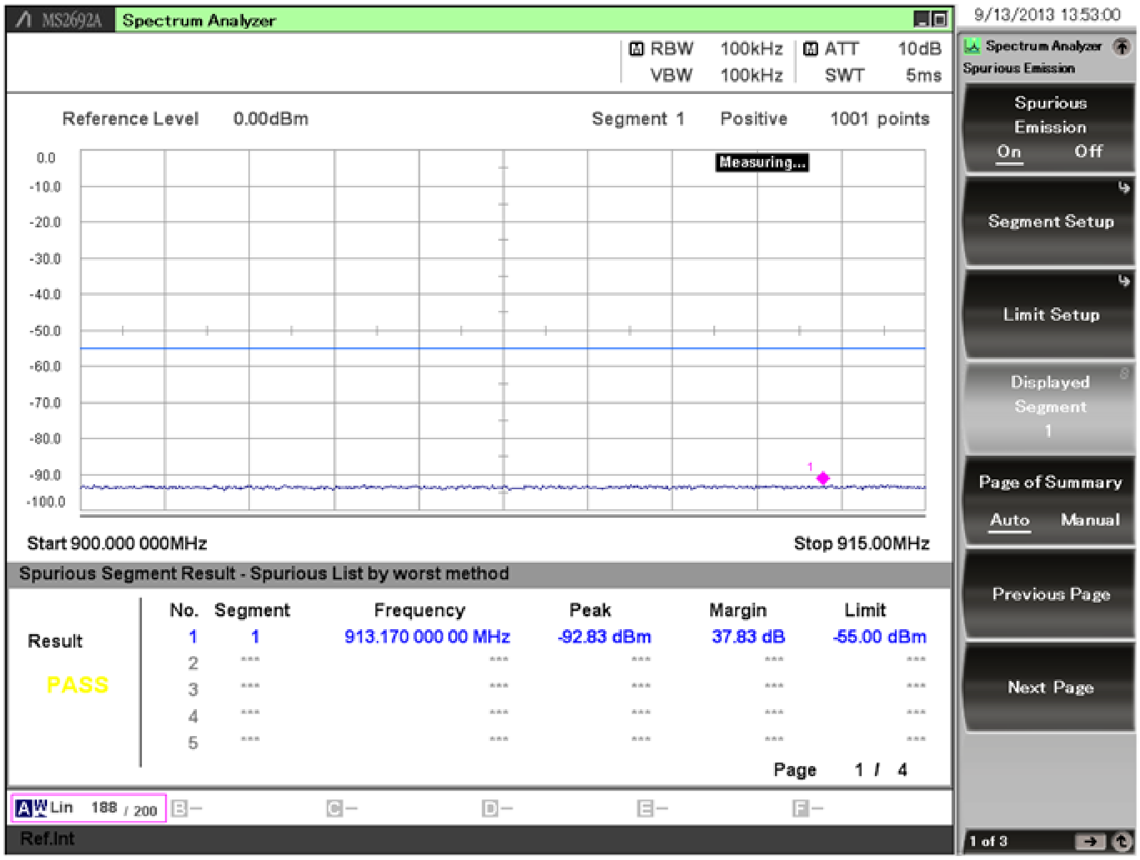


Figure 83. RX Conducted Spurious Emissions (900–915 MHz)

4.1.10. 915 MHz < F ≤ 930 MHz, using the +13 Bm schematic

The allowed level of spurious emissions within the 915–930 MHz frequency band is specified as less than –54 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 84. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –54 dBm /100 kHz (max)
- Measured: –92.88 Bm
- Margin: 38.88 dB (PASS)

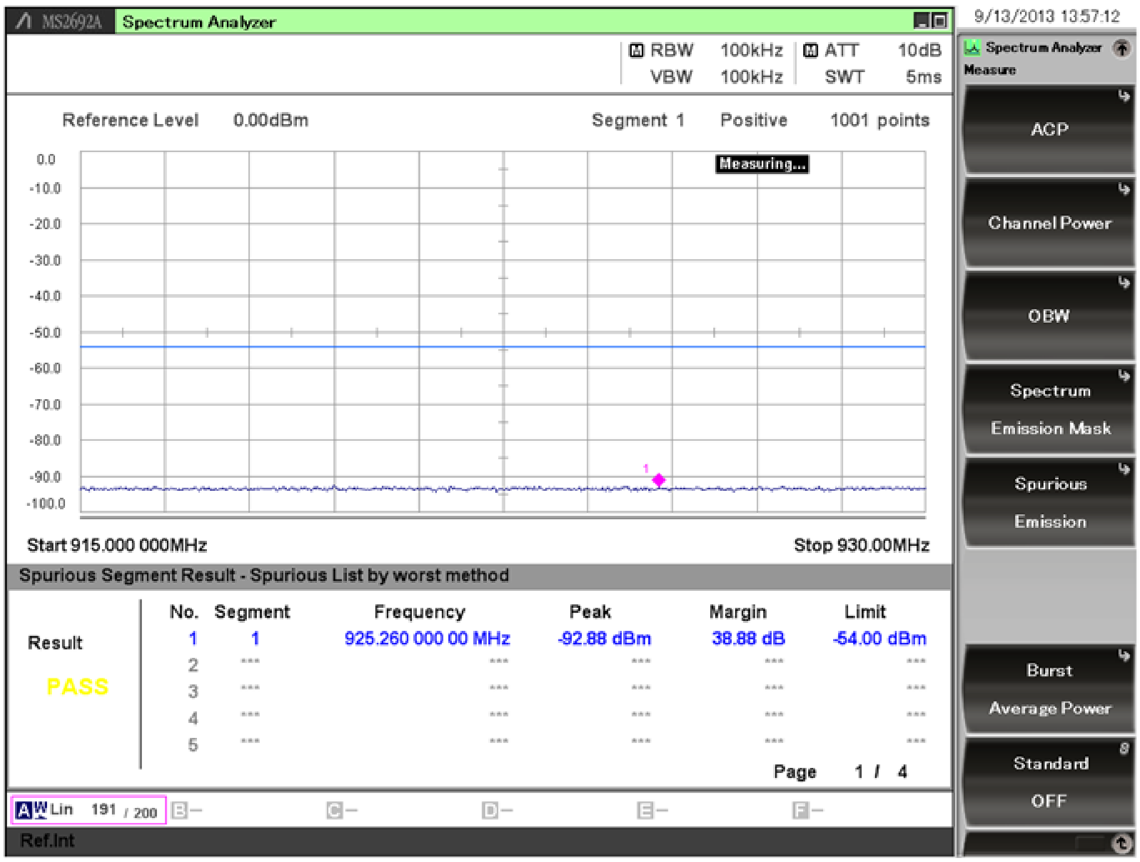


Figure 84. RX Conducted Spurious Emissions (915–930 MHz)

4.1.11. 930 MHz < F ≤ 1000 MHz, using the +13 dBm schematic

The allowed level of spurious emissions within the 930–1000 MHz frequency band is specified as less than –55 dBm in any 100 kHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 85. The Si4455 chip complies with the specified level of spurious emissions within this sub-band.

- Limit: –55 dBm /100 kHz (max)
- Measured: –90.85 dBm
- Margin: 35.85 dB (PASS)

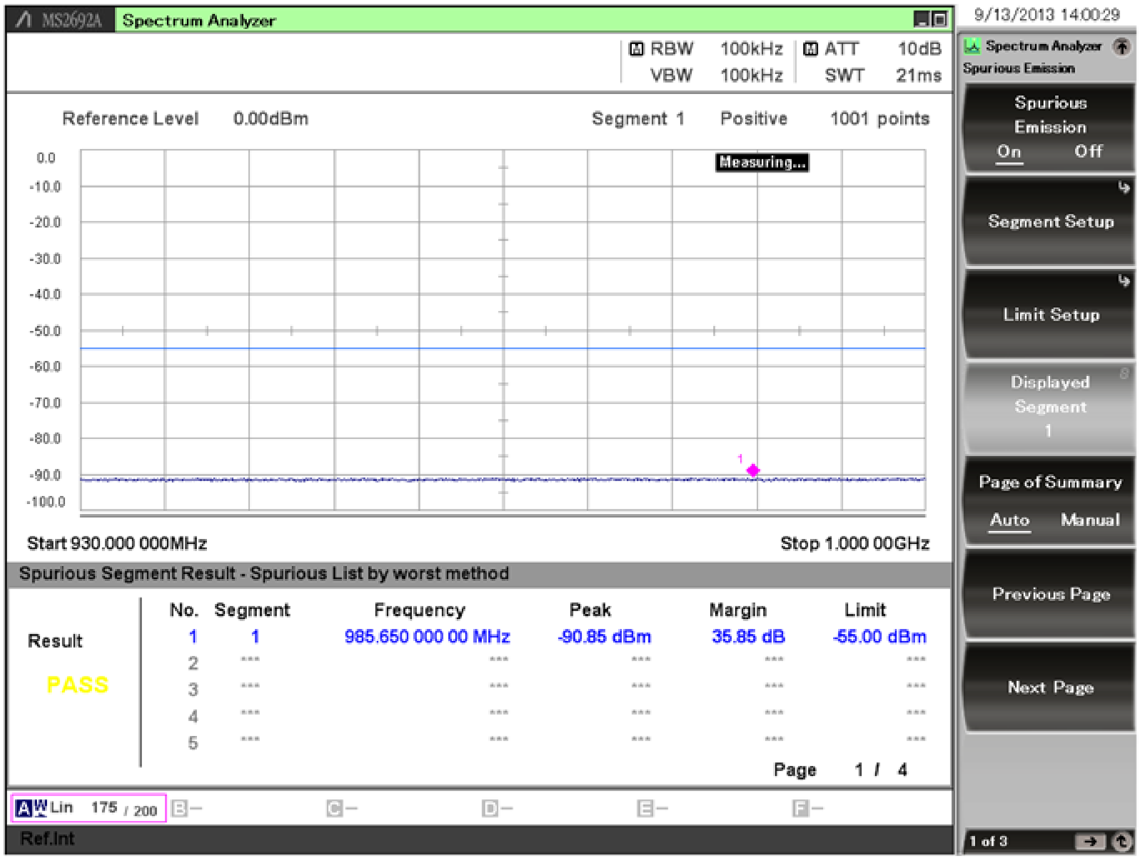


Figure 85. RX Conducted Spurious Emissions (930–1000 MHz)

4.1.12. F > 1 GHz, using the +13 dBm schematic

The allowed level of spurious emissions at frequencies above 1000 MHz is specified as less than –47 dBm in any 1 MHz bandwidth. The measured spurious emissions within this frequency band are shown in Figure 86. The Si4455 chip complies with the specified level of spurious emissions within this sub-band. The appearance of the spur observed at around 3.7 GHz is due the coupling of the VCO signal to bond wires of the LNA input (i.e., RXp and RXn). Here, this spur appears because of the weaker filtering in the direct-tie path compared with +10 dBm case.

- Limit: –47 dBm /1 MHz (max)
- Measured: –69.68 dBm
- Margin: 22.68 dB (PASS)

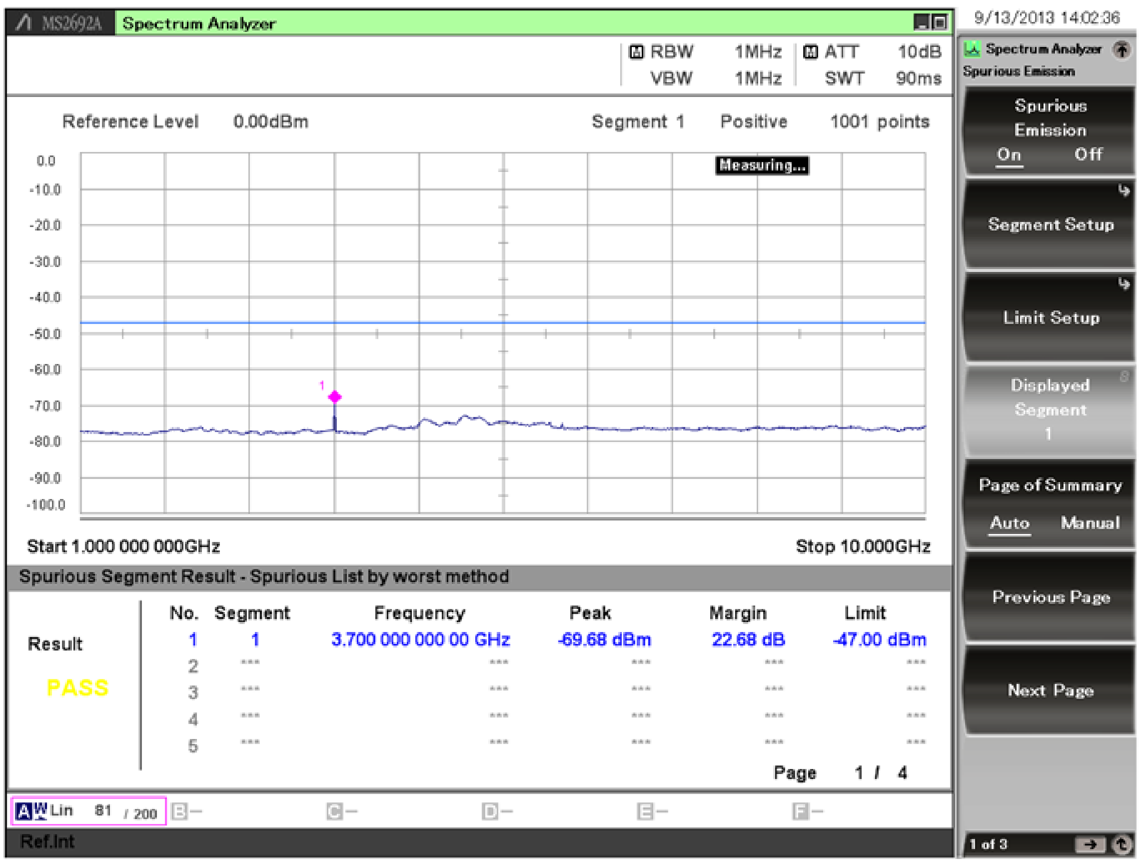
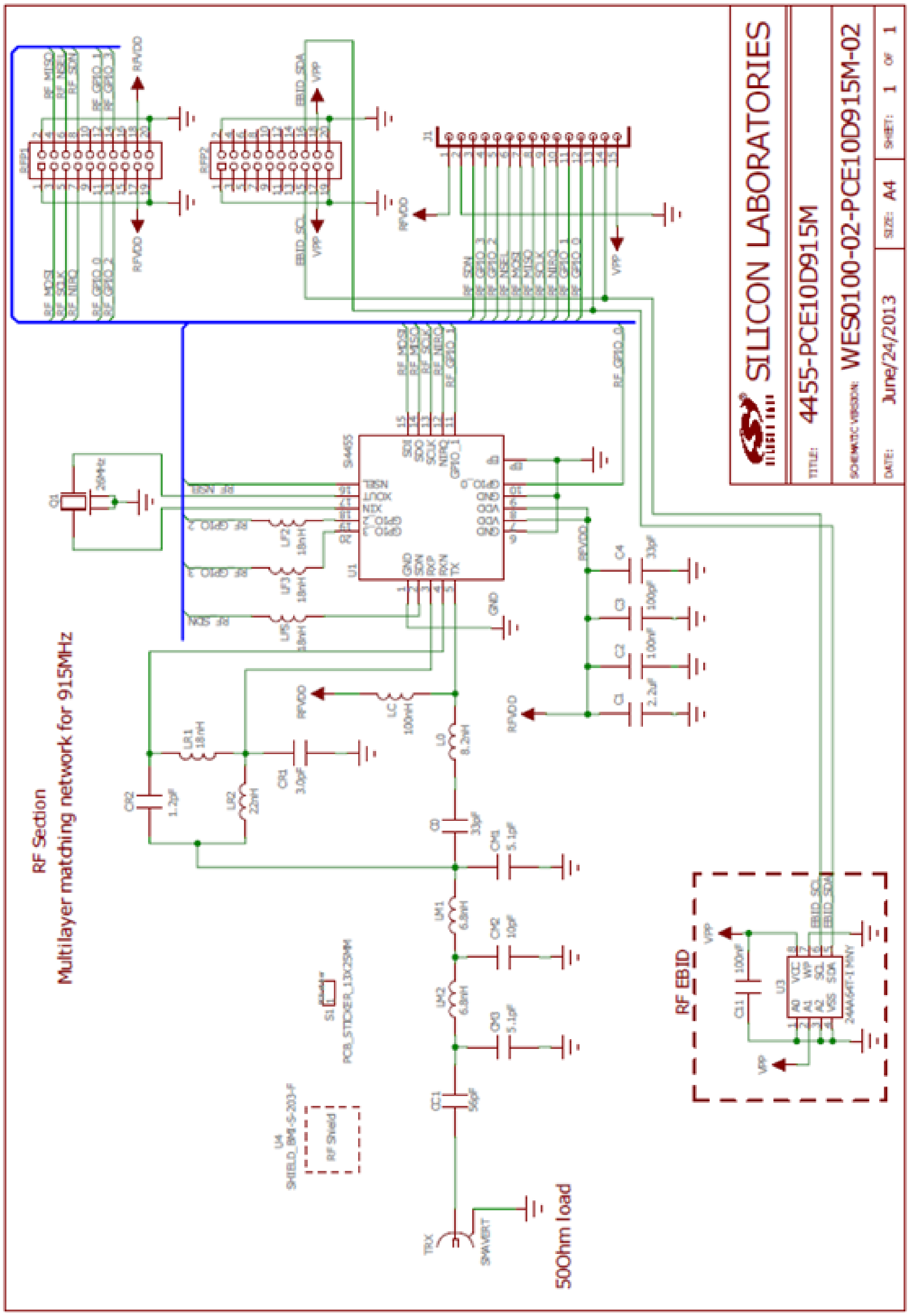


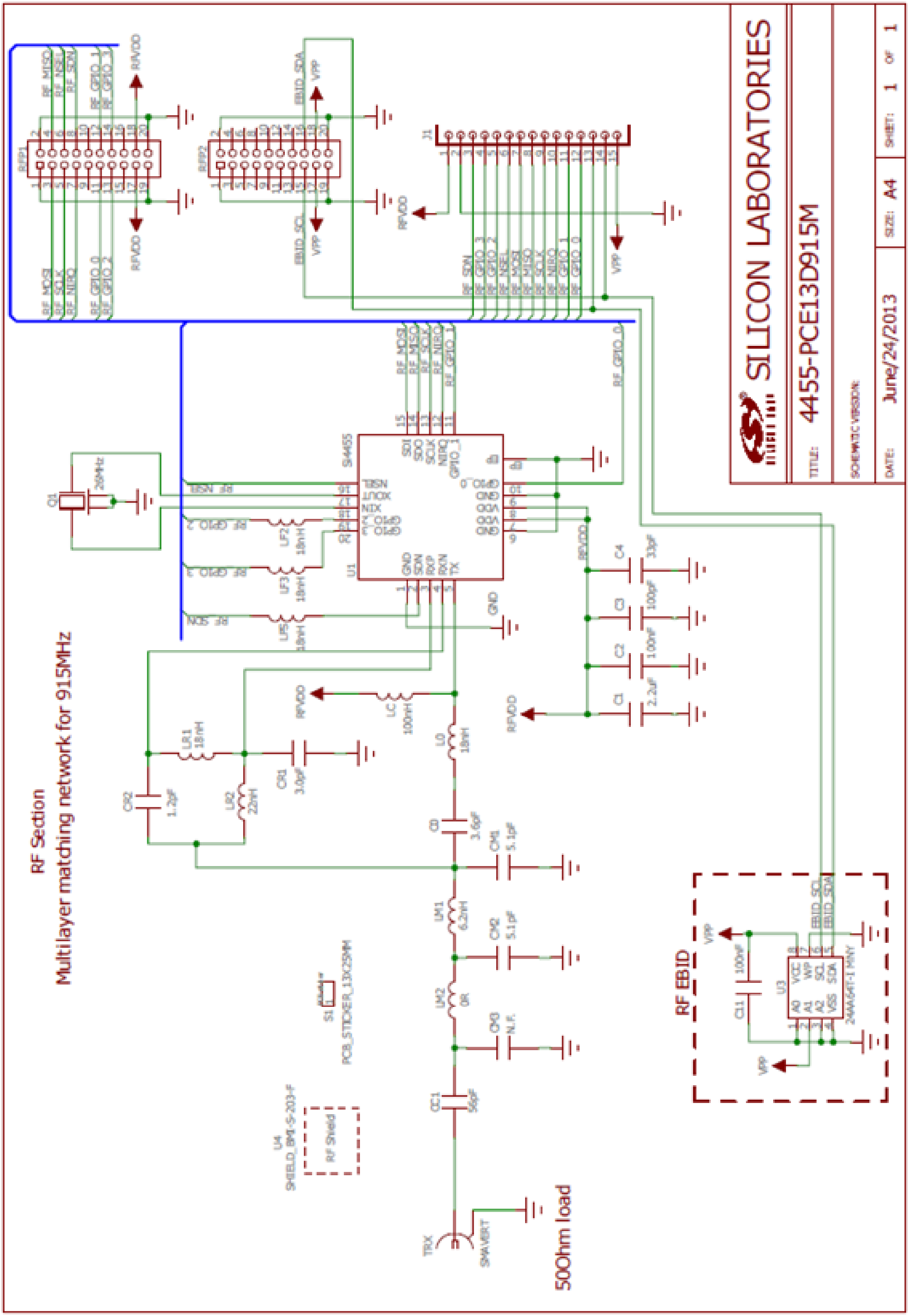
Figure 86. RX Conducted Spurious Emissions (above 1 GHz)

5. Reference Design Schematics

5.1. Antenna Power Optimized for +10 mW or Below



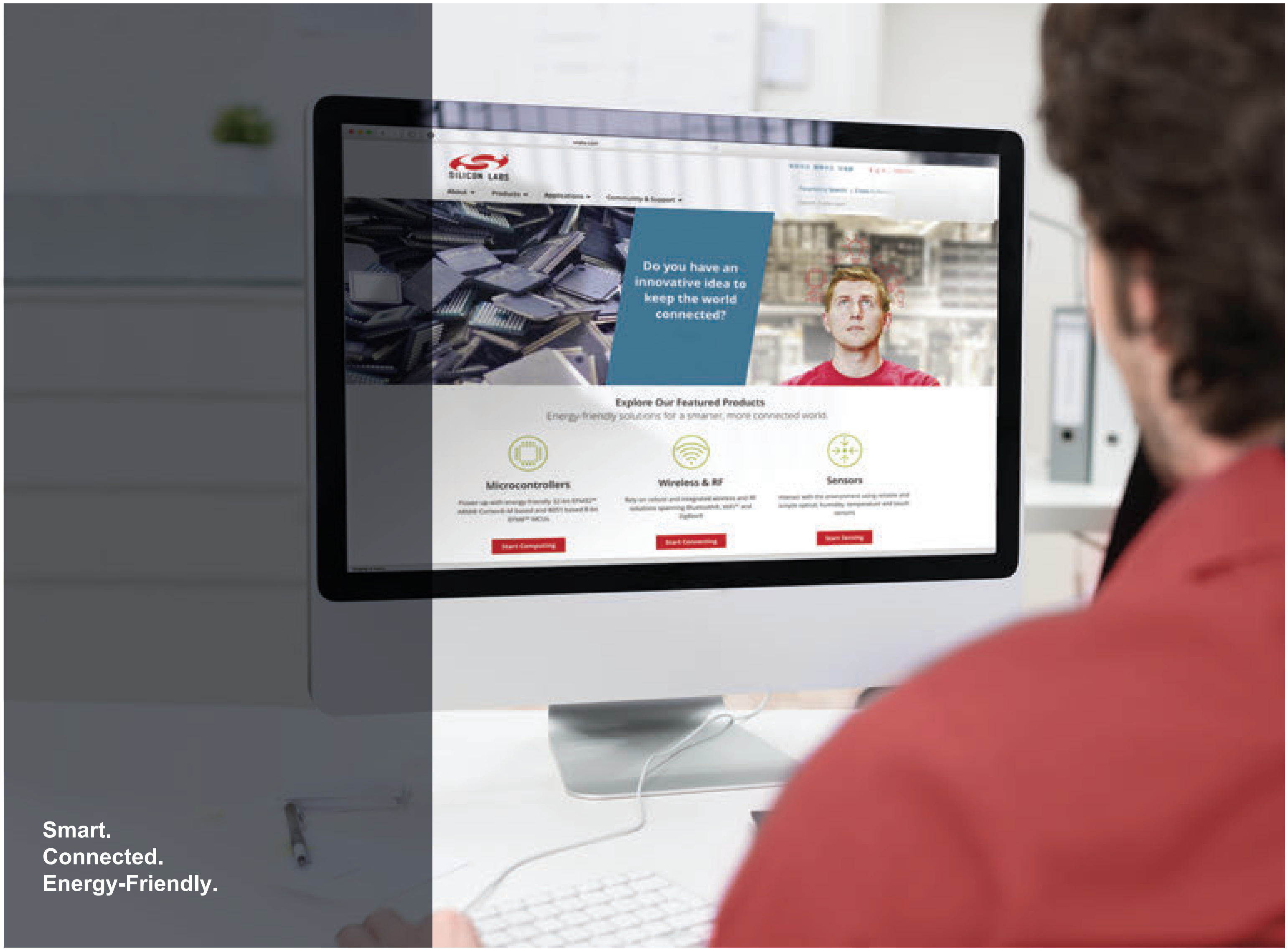
5.2. Antenna Power Optimized for +20 mW



DOCUMENT CHANGE LIST

Revision 0.1 to Revision 0.2

- B0, B1, C0, C1, C2 were added in a bracket to page 1.
- On page 1, 4455CPCE10D915M and 4455CPCE13D915M were added.
- Si4455-B1 was changed to Si4455 on several pages.



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