2024.04.21
JA5IUQ

Consideration of end-fed antenna
About conversion loss of transformer matching box

1. introduction

I have measured the conversion loss of a transformer matching box for an end-fed antenna and will report on it.

The matching boxes used for the measurements all use toroidal core FT-240 core material #43, have 2 turns on the primary side (transmitter side) and 14 turns on the secondary side, and have approximately 100 pF capacitor in parallel in the primary side.

The measurements were performed using nanoVNA and nanoVNA Saver by connecting the secondary sides of two matching boxes to each other to form a 50Ω → high impedance → 50Ω configuration.

As a result, it was found that at frequencies below 30 MHz, the conversion loss was approximately 1 dB per unit, but at frequencies higher than that, the loss suddenly increased.

2. Matching box and measurement system

(1) Matching box

The Matching box overview is shown in Table 2.1. Photos of these are shown in Photos 2.1 and 2.2.

Table 2.1 Matching box overview

	Primary side			Secondary side		
Matching box	turn [times]	Inductance [μH]	capacitor [pF]	turn [times]	Inductance [μH]	Inductance Ratio [-]
white	2	3.95	95.7	14	179.6	45.5
black	2	3.57	106.4	14	161.3	45.2

LCR-700 (at 100kHz)

Photo 2.1 Matching box front

Photo 2.2 Inside the matching box

(2) Characteristics of matching box (white)

A summary of the measurement results for the matching box (white) is shown below. The frequency range is 1MHz to 55MHz, the black line shows data without capacitance, and the red line shows data with capacitor (95.7pF).

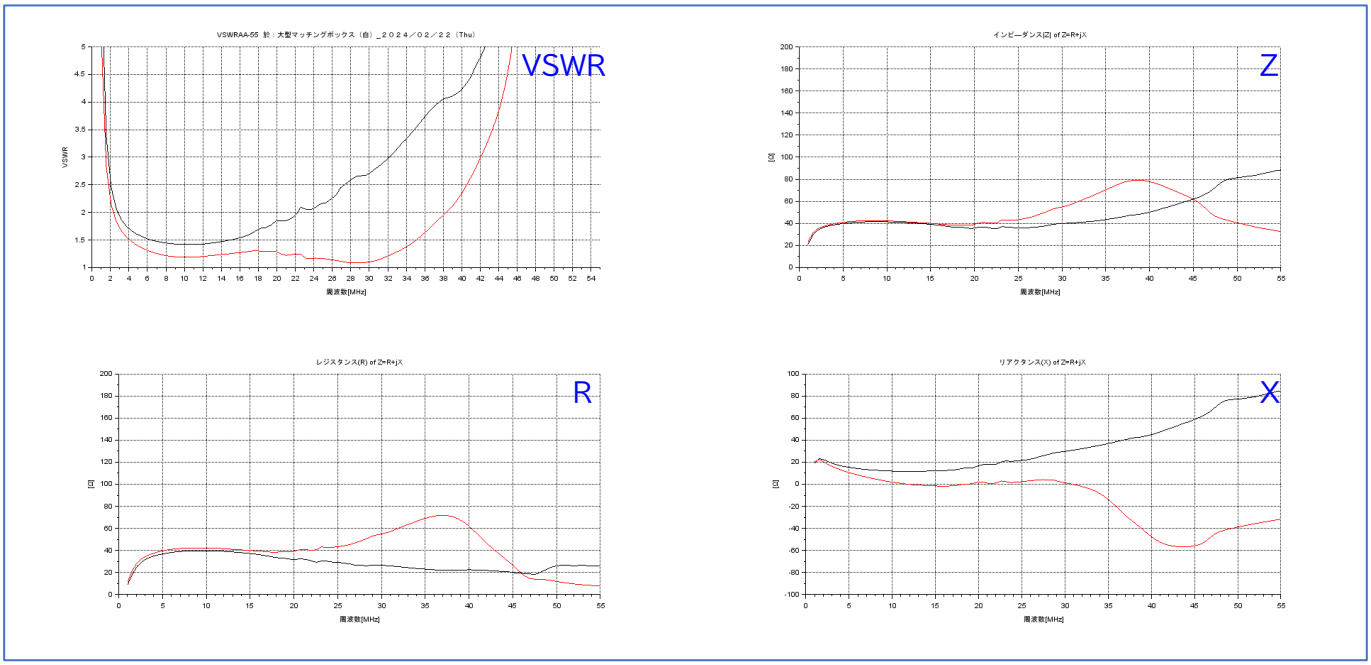

Fig.2.1 Characteristics of matching box (white) (VSWR, Z, R, X)

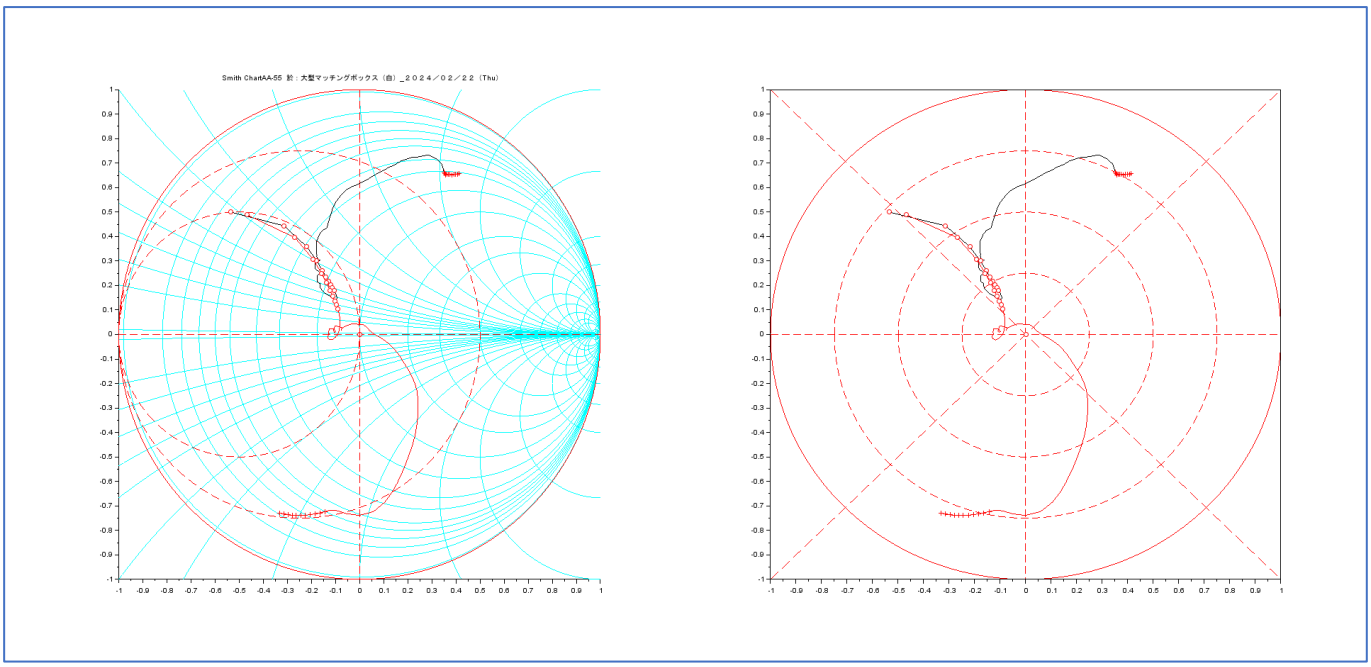

Fig.2.2 Characteristics of matching box (white) (Smith Chart)

(3) Characteristics of matching box (black)

A summary of the measurement results for the matching box (black) is shown below. Similar to the matching box (white), the frequency range is 1 MHz to 55 MHz, the black line shows data without a capacitor, and the red line shows data with a capacitor (106.4 pF).

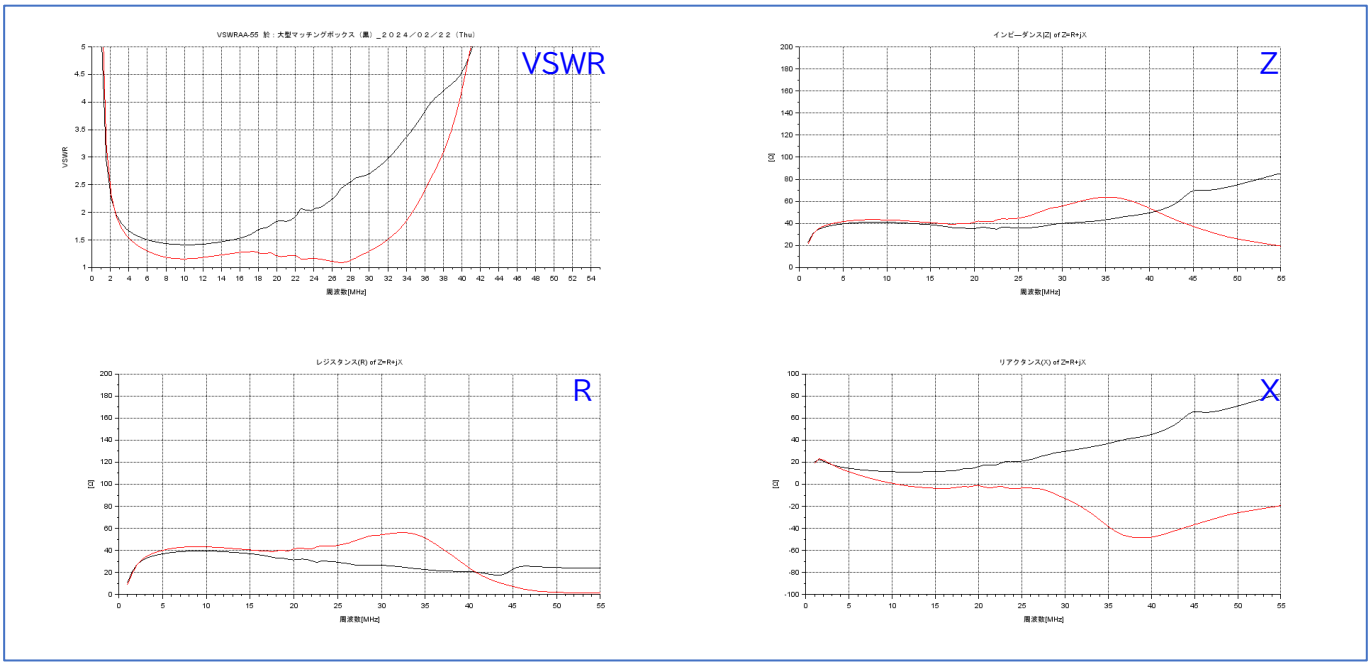

Fig.2.3 Characteristics of matching box (black) (VSWR, Z, R, X)

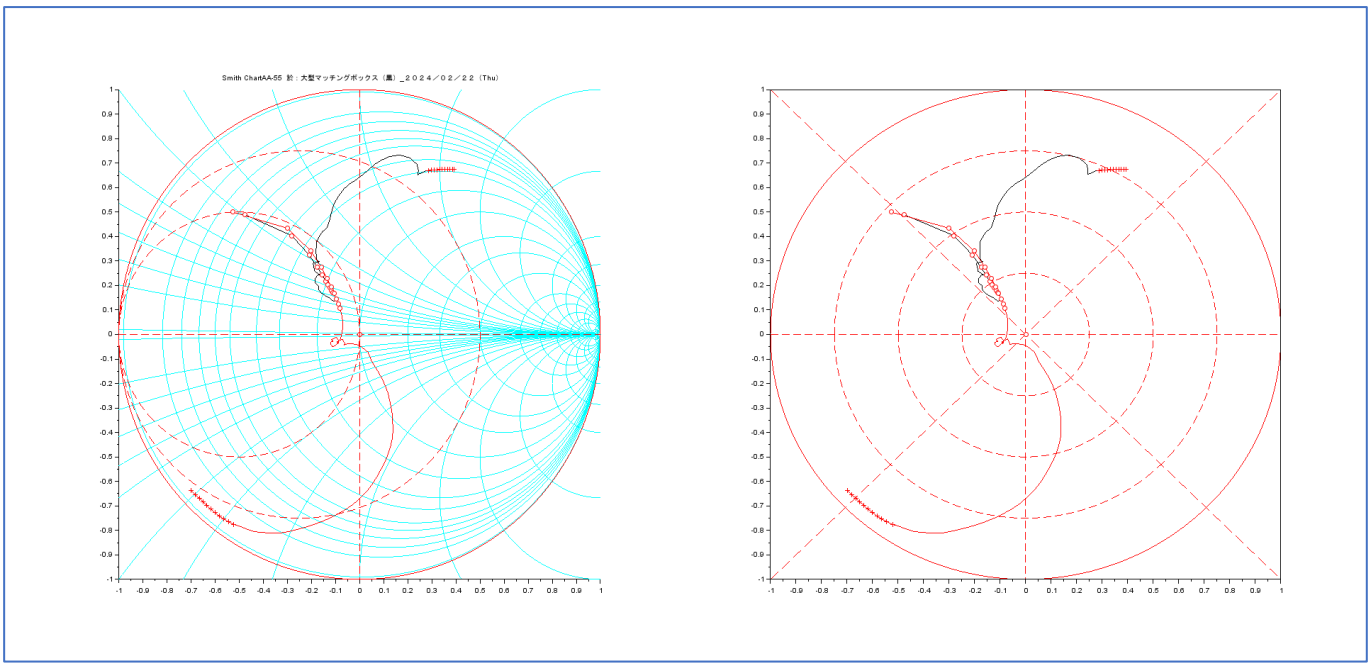

Fig.2.4 Characteristics of matching box (black) (Smith Chart)

(4) Measurement system

An overview of the measurement system is shown in Fig.2.5. Photo 2.3 shows the measurement process.

The measurements were performed by controlling the nanoVNA via the nanoVNA Saver app on the PC, measuring the propagation characteristics (S_{21}), and saving the data on the PC.

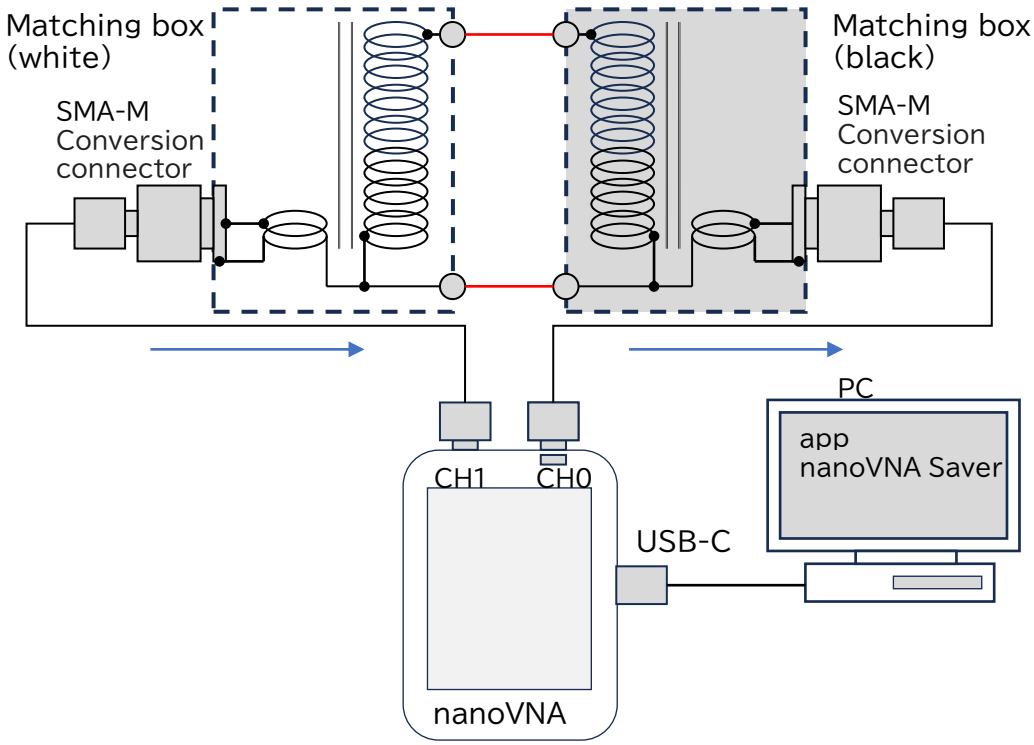

Fig.2.5 overview of the measurement system

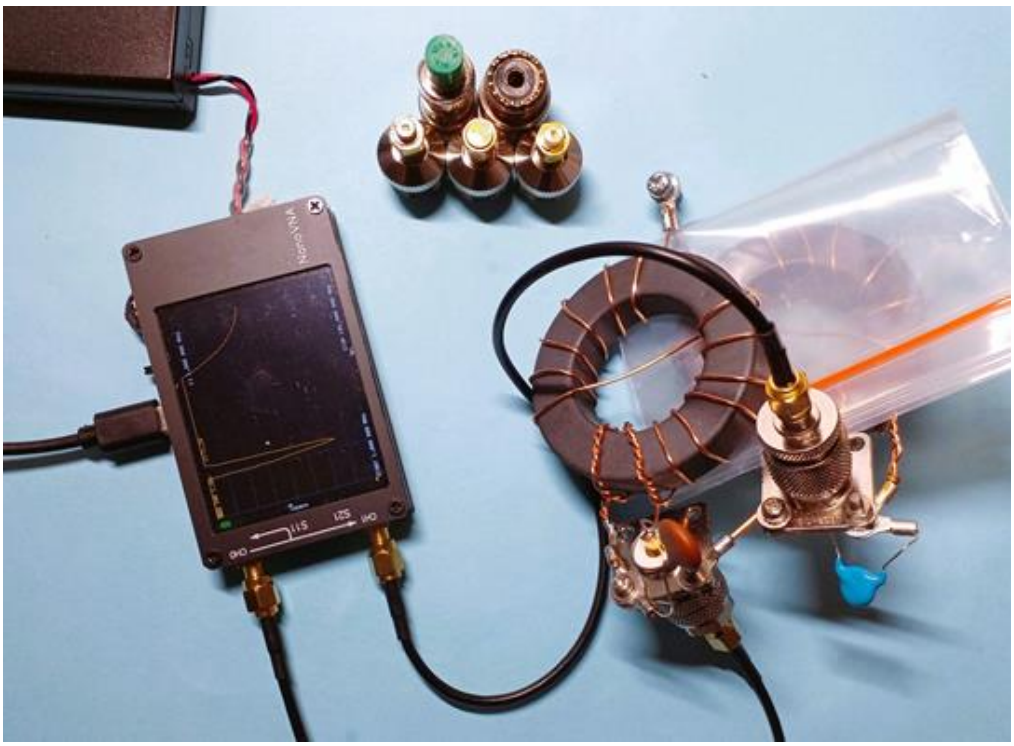

Photo 2.3 measurement process

3. Measurement result

The measurement results (screenshot of nanoVNA Saver) are shown in Fig.3.1.

In Fig.3.1, the upper left graph (red) shows S_{21} (dB), and the lower left graph shows S_{21} (antilog number). A zoomed-in view of the upper left graph is shown in Fig.3.2.

As shown in these graphs, the two matching boxes provide about 2 dB attenuation over the entire HF band, and about 3 dB attenuation in the 28 MHz band.

Therefore, it can be seen that for each matching box, there is a loss of about 1 dB (about 10% loss) over the entire HF band, and a loss of about 1.5 dB (about 15% loss) at 28MHz.

It can also be seen that frequencies above 30MHz rapidly attenuate and are not suitable for use.

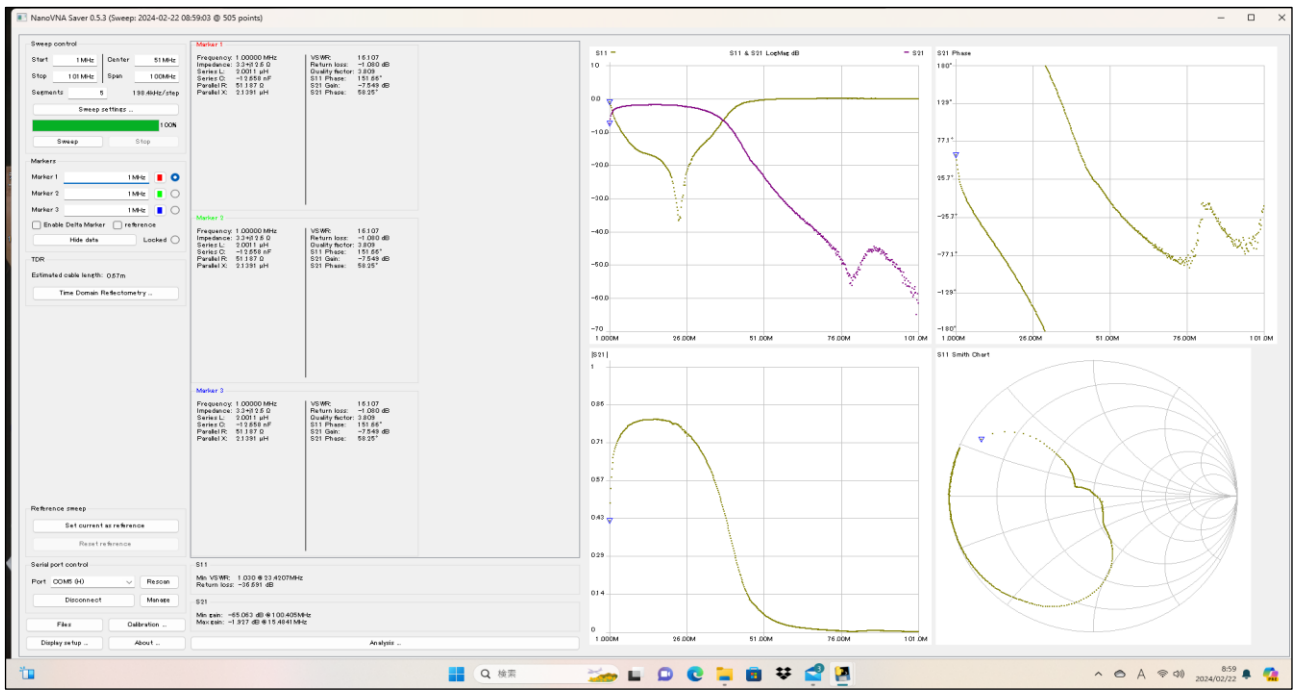

Fig.3.1 Measurement result

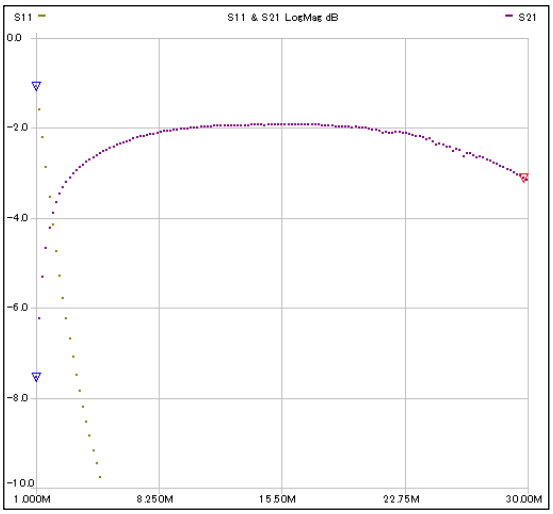

Fig.3.2 Measurement result(zoom up)

4. afterword

This time, I measured the conversion loss of a matching box for an end-fed antenna that uses a large toroidal core (FT-240, #43).

The result was a loss of approximately 1 dB (approximately 10% loss) across the entire HF band, which is consistent with the experience of using it to date.

In the future, we plan to measure medium-sized matching boxes (FT-140, etc.). We also plan to measure LC circuit type matching boxes.