2019.10.31

JA1NFD

JA1IWP

Performance study of shortened end-fed antenna

1. Introduction

Consider the performance of a shortened end-fed (EF) antenna for a half-wave (λ / 2) full-size EF antenna

To. In consideration, the following assumptions are made.

a. Antenna performance (radioactivity performance) can be regarded as the total area of the current distribution of the antenna wire.

b. The current distribution of the antenna wire of the EF antenna can be expressed by $I(x) = Imax \sin(2\pi x / \lambda)$.

2. Calculation of current distribution area

As assumed in Section 1, the current distribution of the antenna,

$I(x) = Imax \sin(2\pi x / \lambda)$

far.

Integrating along x (antenna wire),

$S = \int I(x)\, dx$

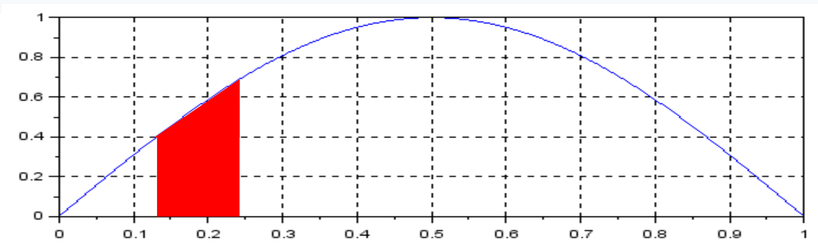
$= \int Imax \sin(2\pi x / \lambda)\, dx$

$= -Imax\, \lambda / (2\pi) \cdot [\cos(2\pi x / \lambda)] +$ (constant of integration)

The definite integral between a and b is

$S(a\text{-}b) = -Imax\, \lambda / (2\pi) \cdot \{\cos(2\pi b / \lambda) - \cos(2\pi a / \lambda)\}$

$= Imax\, \lambda / (2\pi) \cdot Cab$

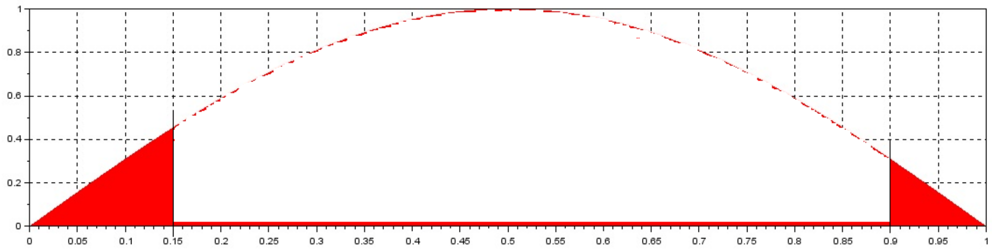


3. Calculation example of each antenna wire

(1) 5m long antenna wire for 7MHz (wht01)

・ Wavelength λ = 40m, inner wire 3.0m, outer wire 2.0m

$$S(0\text{-}3) + S(18\text{-}20) = -Imax20 / \pi \cdot [\{\cos(2\pi \cdot 3/40) - \cos(0)\}$$
$$-\{\cos(2\pi \cdot 20/40) - \cos(2\pi \cdot 18/40)\}$$
$$= 0.158$$



(2) 4.3m long antenna wire for 7MHz (wht02)

・ Wavelength λ = 40m, inner wire 3.0m, outer wire 1.3m

$$S(0\text{-}3) + S(18.7\text{-}20) = -Imax20 / \pi \cdot [\{\cos(2\pi \cdot 3/40) - \cos(0)\}$$
$$-\{\cos(2\pi \cdot 20/40) - \cos(2\pi \cdot 18.7/40)\}]$$
$$= 0.130$$

(3) 3.3m long antenna wire for 10MHz (wht10)

・ Wavelength λ = 30m, inner wire 3.0m, outer wire 0.3m

$$S(0\text{-}3) + S(14.7\text{-}15) = -Imax15 / \pi \cdot [\{\cos(2\pi \cdot 3/30) - \cos(0)\}$$
$$-\{\cos(2\pi \cdot 15/30) - \cos(2\pi \cdot 14.7/30)\}]$$
$$= 0.193$$

(4) 8.6m long antenna wire for 7 / 21MHz (red01)

・ 7MHz: Wavelength λ = 40m, inner wire 6.5m, outer wire 2.1m

$$S(0\text{-}6.5) + S(17.9\text{-}20) = -Imax20 / \pi \cdot [\{\cos(2\pi \cdot 6.5/40) - \cos(0)\}$$
$$-\{\cos(2\pi \cdot 20/40) - \cos(2\pi \cdot 17.9/40)\}]$$
$$= 0.531$$

・ 21MHz: Wavelength λ = 7m, inner wire 6.5m

$$S(0\text{-}6.5) = -Imax7 / \pi \cdot [\{\cos(2\pi \cdot 6.5/7) - \cos(0)\}] = 2$$

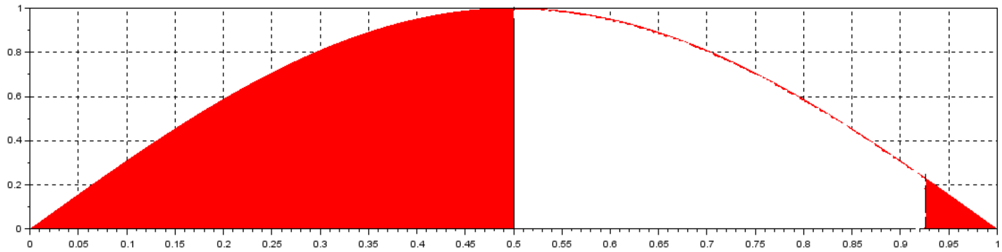
(5) 11.5m long antenna wire for 7/14 / (28) (blk01)

・ 7MHz: Wavelength λ = 40m, inner wire 10.0m, outer wire 1.5m

$$S(0\text{-}10.0) + S(18.5\text{-}20) = -Imax20/\pi \cdot [\{\cos(2\pi \cdot 10.0/40) - \cos(0)\}$$

$$-\{\cos(2\pi \cdot 20.0/40) - \cos(2\pi \cdot 18.5/40)\}]$$

$$= 1.030$$



・ 14MHz: Wavelength λ = 20m, inner wire 10.0m

$$S(0\text{-}10.0) = -Imax10/\pi \cdot [\{\cos(2\pi \cdot 10.0/10) - \cos(0)\}] = 2$$

・ 28MHz: Wavelength λ = 10m, inner wire 10.0m

$$S(0\text{-}10.0) = -Imax5/\pi \cdot [\{\cos(2\pi \cdot 10.0/10) - \cos(0)\}] = 4$$

No	Antenna wire	f [MHz]	λ/2 [m]	Inner Wire [m / λ]	Outer Wire [m / λ]	Current distribution area Ca*	Current distribution area of Full-size Ant. Cf	Antenna performance [dBd]※
1	wht01	7	20	3.0 / 0.15λ	2.0 / 0.100λ	0.158	2	-11.0dB
2	wht02	7	20	3.0 / 0.15λ	1.3 / 0.065λ	0.130	2	-11.9dB
3	wht10	10	15	3.0 / 0.20λ	0.3 / 0.020λ	0.193	2	-10.2dB
4	red01	7	20	6.5 / 0.325λ	2.1 / 0.105λ	0.531	2	-5.8dB
5		21	7	6.5 / 0.93λ	–	2.000	2	-0.1dB
6	blk01	7	20	10.0 / 0.50λ	1.5 / 0.075λ	1.030	2	-2.9dB
7		14	10	10.0 / 1.00λ	–	2.000	2	0dB
8		28	5	10.0 / 2.00λ	–	4.000	2	3.0dB

4. Further consideration

Antenna power when 7MHz ($\lambda = 40$m) is placed on a 5m antenna wire (loading coil at the base)Calculate the flow.

$$S05 = S(0\text{-}5) = \int Imax \sin(2\pi x / \lambda)\, dx$$

$$= -Imax\ \lambda / (2\pi) \cdot \{\cos(2\pi 5 / 40) - \cos(2\pi 0 / 40)\}$$

$$= -Imax\ \lambda / (2\pi) \cdot \{\cos(\pi / 4) - \cos(0)\}$$

$$= Imax\ \lambda / (2\pi) \cdot 0.293$$

Gain = 10 log (0.293 / 2) = -8.34 [dBd] (dBd: dipole ratio)

Therefore, the gain reduction is smaller than inserting a loading coil in the middle between 3m and 2m.

From the above, unlike the λ / 4 GP, the EF antenna has the loading coil closer to the root than the middle (trial and error is required). It seems that the gain can be obtained higher by putting it in (Kana). However, because it is inserted in the part where the current is small, it is a carp.It seems necessary to increase the number of turns.

Appendix

For the time being, it is a Scilab program for calculation. (If you calculate with a calculator, you may make a typo, so hi)

```
// Antenna Gain calcuration 2019.10.31
// input: ram,w1,w2 output: s5,Gain
// Sab=S(a-b)=-Imaxλ/(2π)・{cos(2πb/λ)-cos(2πa/λ)}=Imax λ/(2π)・Cab

clear

ram = 40; //[m] 波長　7MHz:40m, 14MHz:20m, 21MHz:14m, 28MHz:10m
ram2 = ram/2;
w1 = 3; //[m] 内側ワイヤー
w2 = 2; //[m] 外側ワイヤー

c1 = -(cos(2*%pi*w1/ram)-cos(0));
c2 = -(cos(2*%pi*ram2/ram)-cos(2*%pi*(ram2-w2)/ram));
ca = c1+c2;
Gain = 10*log10(ca/2) //[dB] アンテナゲイン

disp(Gain,ca,w2,w1,ram)
```