

Example: Use a T-Match to drive the previously designed 5 element UHF Channel 43 Yagi-Uda antenna without boom with a 100Ω twin-lead transmission line. The matching specification is that the $VSWR \leq 1.1$.

Yagi-Uda antenna design (no boom) summary:

$$f_c = 647 \text{ MHz and } \lambda = 46.3 \text{ cm}$$

$$\text{element diameters } d = 2a = 0.25'' = 0.635 \text{ cm} \Rightarrow a = 0.125'' = 0.3175 \text{ cm}$$

$$\text{element spacings } s_{ij} = 0.2\lambda = 9.274 \text{ cm}$$

$$\text{reflector length } l_1' = 0.48\lambda = 22.24 \text{ cm}$$

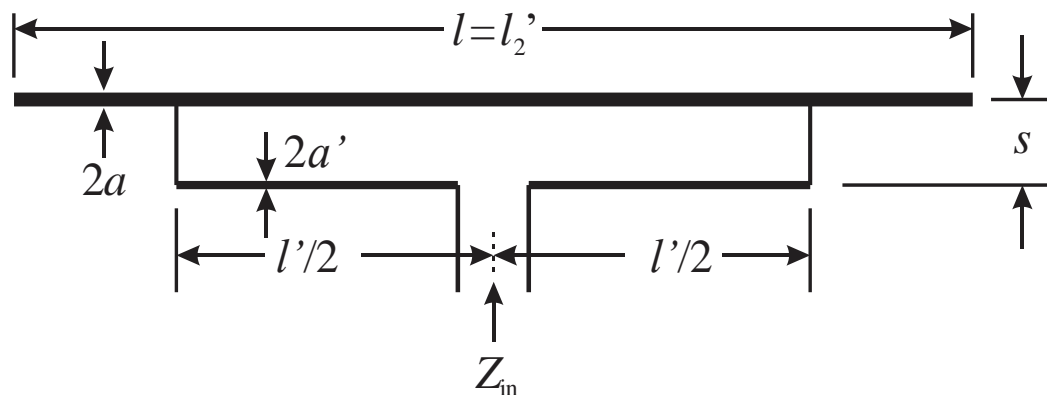
$$\text{director lengths } l_3' = l_5' = 0.419\lambda = 19.41 \text{ cm}$$

$$\text{director length } l_4' = 0.412\lambda = 19.09 \text{ cm}$$

$$\text{selected driven element length } l_2' = (l_1' + l_3')/2 = 0.45\lambda = 20.85 \text{ cm}$$

From NEC-2, $Z_a = 17.35 + j 20.59 \Omega$ and Gain = 11.265 dBi

T-Match:



First attempt at T-Match:

Select T-Match diameter $2a' = 0.125'' = 0.3175 \text{ cm} \Rightarrow a' = 0.15875 \text{ cm}$

Select T-Match spacing $s = 2 \text{ cm}$ and length $l' = 9 \text{ cm}$

Using NEC-2 and MathCad (see attached pages)-

$$Z_a = 14.1 - j 12.86 \Omega \quad \& \quad \text{Gain} = 11.33 \text{ dBi}$$

$Z_0 = 260.3 \Omega$, $\alpha = 1.367$, $a_e = 0.667 \text{ cm}$, $Z_{in} = 114.7 - j 58.7 \Omega$ which yields $|\Gamma| = 0.27$, $VSWR = 1.75 > 1.1$ (high), & suggested $l' = 4.4 \text{ cm}$

NEC input file for first T-Match attempt

```

CM Yagi-Uda Antenna for UHF channel 43 (NO BOOM)
CM
CM THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN
CM ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHz
CM W/ WAVELENGTH OF 0.4634 m.
CM
CM THE DIMENSIONS ARE:
CM element diameters d=0.635cm=0.25in, radius a=d/2=0.3175cm=0.125in,
CM equivalent radius of center portion of driven element (T-Match)
CM is ae=0.00666 m which has a length of l'= 0.09 m < l2
CM
CM l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
CM driven element l2=(l1+l3)/2=0.45 l= 0.2085m
CM ELEMENT SPACINGS Sij=0.2 l=0.09267m
CM SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
CE THE DRIVEN SEGMENT IS #4 on l2 section GW 3/Tag 3.
GW 1 17 -0.1112 0.0 0.0 0.1112 0.0 0.0 0.003175 !Reflector
GW 2 5 -0.10425 0.0 0.09267 -0.045 0.0 0.09267 0.003175 !Driven tip
GW 3 7 -0.045 0.0 0.09267 0.045 0.0 0.09267 0.00666 !Driven middle
GW 4 5 0.045 0.0 0.09267 0.10425 0.0 0.09267 0.003175 !Driven tip
GW 5 15 -0.09705 0.0 0.18534 0.09705 0.0 0.18534 0.003175 !Director 1
GW 6 15 -0.09545 0.0 0.27801 0.09545 0.0 0.27801 0.003175 !Director 2
GW 7 15 -0.09705 0.0 0.37068 0.09705 0.0 0.37068 0.003175 !Director 3
GE 0 0
FR 0 1 0 0 647 0
EX 0 3 4 0 1.0 0.0
RP 0 2 2 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN

```

NEC output file for first T-Match attempt

Yagi-Uda Antenna for UHF channel 43 (NO BOOM)

THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHz W/ WAVELENGTH OF 0.4634m.

THE DIMENSIONS ARE:

element diameter $d=0.635\text{cm}=0.25\text{in}$, radius $a=d/2=0.3175\text{cm}=0.125\text{in}$, equivalent radius of center portion of driven element (T-Match) is $a_e=0.00666\text{ m}$ which has a length of $l'=0.09 < l_2$

$l_1=0.48\text{ m}$, $l_2=0.2224\text{m}$, $l_3=l_5=0.419\text{ m}$, $l_4=0.1941\text{m}$, $l_6=0.412\text{ m}$, $l_7=0.1909\text{m}$, driven element $l_8=(l_1+l_3)/2=0.45\text{ m}$, $l_9=0.2085\text{m}$

ELEMENT SPACINGS $S_{ij}=0.2\text{ m}$, $l_{10}=0.09267\text{m}$

SELECT SEGMENT LENGTH OF APPROX. $1.25\text{cm}=0.025\text{ m}$

THE DRIVEN SEGMENT IS #4 on l_2 .

- - - STRUCTURE SPECIFICATION - - -

WIRE NO.	X1	Y1	Z1	X2	Y2	Z2	NO. OF RADIUS	FIRST SEG.	LAST SEG.	TAG	SEG. NO.
1	-0.11120	0.0	0.0	0.11120	0.0	0.0	0.00317	17	1	17	1
2	-0.10425	0.0	0.09267	-0.0450	0.0	0.09267	0.00317	5	18	22	2
3	-0.04500	0.0	0.09267	0.04500	0.0	0.09267	0.00666	7	23	29	3
4	0.04500	0.0	0.09267	0.10425	0.0	0.09267	0.00317	5	30	34	4
5	-0.09705	0.0	0.18534	0.09705	0.0	0.18534	0.00317	15	35	49	5
6	-0.09545	0.0	0.27801	0.09545	0.0	0.27801	0.00317	15	50	64	6
7	-0.09705	0.0	0.37068	0.09705	0.0	0.37068	0.00317	15	65	79	7

TOTAL SEGMENTS USED=79 <snip>

- - - - - FREQUENCY - - - - -

FREQUENCY= 6.4700E+02 MHZ WAVELENGTH= 4.6337E-01 METERS

- - - ANTENNA INPUT PARAMETERS - - -

TAG NO.	SEG. NO.	VOLTAGE REAL	IMAG.	IMPEDANCE (OHMS) REAL	IMAG.	ADMITTANCE (MHOS) REAL	IMAG.
3	26	1.0	0.0	1.41289E+01	-1.28563E+01	3.87189E-02	3.52313E-02

- - - RADIATION PATTERNS - - -

THETA DEG	PHI DEG	Gain DB
0.00	0.00	11.32992
180.00	0.00	-0.33110

<snip>

MathCad file for first T-Match attempt

T-Match equations (Try #1)

$$c := 2.9979 \cdot 10^8 \quad fc := 647 \cdot 10^6 \quad \lambda := \frac{c}{fc} \quad \lambda = 0.46335$$

$$k := \frac{2 \cdot \pi}{\lambda} \quad k = 13.56023 \quad Z_{\text{desired}} := 100 \quad \Omega$$

$$d := 0.635 \cdot 10^{-2} \quad \text{m} \quad a := d \cdot 0.5 \quad a = 0.003175 \quad \text{m}$$

$$d_{\text{prime}} := 0.3175 \cdot 10^{-2} \quad \text{m} \quad a_{\text{prime}} := d_{\text{prime}} \cdot 0.5 \quad a_{\text{prime}} = 0.0015875 \quad \text{m}$$

$$s := 2 \cdot 10^{-2} \quad \text{m}$$

$$Z_0 := \frac{376.73}{2 \cdot \pi} \cdot \operatorname{acosh} \left[\frac{(s^2 - a^2 - a_{\text{prime}}^2)}{2 \cdot a \cdot a_{\text{prime}}} \right] \quad Z_0 = 260.329 \quad \Omega$$

$$u := \frac{a}{a_{\text{prime}}} \quad u = 2 \quad v := \frac{s}{a_{\text{prime}}} \quad v = 12.59843$$

$$\alpha := \frac{\operatorname{acosh} \left[\frac{(v^2 - u^2 + 1)}{2 \cdot v} \right]}{\operatorname{acosh} \left[\frac{(v^2 + u^2 - 1)}{2 \cdot v \cdot u} \right]} \quad \alpha = 1.36748 \quad a_e := a_{\text{prime}} \cdot e^{\frac{1}{(1+u)^2} \cdot (u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v))}$$

$$a_e = 0.00666 \quad \text{m} \quad a_e \cdot 100 = 0.6661 \quad \text{cm}$$

$$l_{\text{prime}} := 9.0 \cdot 10^{-2} \quad \text{m}$$

$$Z_t := j \cdot Z_0 \cdot \tan \left(\frac{k \cdot l_{\text{prime}}}{2} \right) \quad Z_t = 182.0301i \quad \Omega \quad Y_t := \frac{1}{Z_t} \quad Y_t = -5.494i \times 10^{-3} \quad \text{S}$$

$$\frac{Y_t}{2} = -2.747i \times 10^{-3} \quad \text{S}$$

Za from NEC (a MoM program)

$$Z_a := 14.1289 - j \cdot 12.8563 \quad \Omega \quad Y_a := \frac{1}{Z_a} \quad Y_a = 0.03872 + 0.03523i \quad \text{S}$$

$$Y_{\text{in}} := \frac{Y_t}{2} + \frac{Y_a}{(1 + \alpha)^2} \quad Y_{\text{in}} = 6.908 \times 10^{-3} + 3.539i \times 10^{-3} \quad \text{S} \quad \frac{1}{Z_{\text{desired}}} = 0.01 \quad \text{S}$$

$$Z_{\text{in}} := \frac{1}{Y_{\text{in}}} \quad \boxed{Z_{\text{in}} = 114.666 - 58.744i} \quad \Omega \quad Z_{\text{desired}} = 100 \quad \Omega$$

$$\Gamma := \frac{(Z_{\text{in}} - Z_{\text{desired}})}{Z_{\text{in}} + Z_{\text{desired}}} \quad \Gamma = 0.133 - 0.237i \quad |\Gamma| = 0.272$$

$$\text{VSWR} := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \quad \text{VSWR} = 1.747 \quad > 1.1 \text{ Too High (Try 1)}$$

$$l_{\text{suggested}} := \frac{2}{k} \cdot \operatorname{atan} \left[\frac{1}{2 \cdot Z_0 \cdot \operatorname{Im} \left[\frac{Y_a}{(1 + \alpha)^2} \right]} \right] \quad l_{\text{suggested}} = 0.04374 \quad l_{\text{suggested}} \cdot 0.5 = 0.022$$

Second attempt at T-Match

Leave T-Match diameter $2a' = 0.125'' = 0.3175 \text{ cm} \Rightarrow a' = 0.15875 \text{ cm}$

Leave T-Match spacing $s = 2 \text{ cm}$

Change T-Match length to $l' = 6.5 \text{ cm}$ (down from 9 cm)

Using NEC-2 and MathCad (see attached pages)-

$Z_a = 14.84 - j 8.397 \Omega$ & Gain = 11.37 dBi

$Z_0 = 260.3 \Omega$, $\alpha = 1.367$, $a_e = 0.667 \text{ cm}$, $Z_{in} = 108.3 - j 12.85 \Omega$ which yields $|\Gamma| = 0.073$, VSWR = 1.16 > 1.1 (high), & suggested $l' = 5.3 \text{ cm}$

NEC input file for second T-Match attempt

```

CM Yagi-Uda Antenna for UHF channel 43 (NO BOOM)
CM
CM THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN
CM ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHz
CM W/ WAVELENGTH OF 0.4634m.
CM
CM THE DIMENSIONS ARE:
CM element diameter d=0.635cm=0.25in, radius a=d/2=0.3175cm=0.125in,
CM equivalent radius of center portion of driven element (T-Match)
CM is ae=0.00666 m which has a length of l'=0.065m < l2
CM
CM l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
CM driven element l2=(l1+l3)/2=0.45 l= 0.2085m
CM ELEMENT SPACINGS Sij=0.2 l=0.09267m
CM SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
CE THE DRIVEN SEGMENT IS #3 on l2 Tag 3.
GW 1 17 -0.1112 0.0 0.0 0.1112 0.0 0.0 0.003175 !Reflector
GW 2 6 -0.10425 0.0 0.09267 -0.0325 0.0 0.09267 0.003175 !Driven tip
GW 3 5 -0.0325 0.0 0.09267 0.0325 0.0 0.09267 0.00666 !Driven middle
GW 4 6 0.0325 0.0 0.09267 0.10425 0.0 0.09267 0.003175 !Driven tip
GW 5 15 -0.09705 0.0 0.18534 0.09705 0.0 0.18534 0.003175 !Director 1
GW 6 15 -0.09545 0.0 0.27801 0.09545 0.0 0.27801 0.003175 !Director 2
GW 7 15 -0.09705 0.0 0.37068 0.09705 0.0 0.37068 0.003175 !Director 3
GE 0 0
FR 0 1 0 0 647 0
EX 0 3 3 0 1.0 0.0
RP 0 2 2 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN

```

NEC output file for second T-Match attempt

Yagi-Uda Antenna for UHF channel 43 (NO BOOM)

THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHz W/ WAVELENGTH OF 0.4634m.

THE DIMENSIONS ARE:

element diameter $d=0.635\text{cm}=0.25\text{in}$, radius $a=d/2=0.3175\text{cm}=0.125\text{in}$, equivalent radius of center portion of driven element (T-Match) is $a_e=0.00666\text{ m}$ which has a length of $l'=0.065\text{ m} < l_2$

$l_1=0.48\text{ m}$, $l_2=0.2224\text{m}$, $l_3=15=0.419\text{ m}$, $l_4=0.1941\text{m}$, $l_5=0.412\text{ m}$, $l_6=0.1909\text{m}$, driven element $l_7=(l_1+l_3)/2=0.45\text{ m}$, $l_8=0.2085\text{m}$

ELEMENT SPACINGS $S_{ij}=0.2\text{ m}$, $l_9=0.09267\text{m}$

SELECT SEGMENT LENGTH OF APPROX. $1.25\text{cm}=0.025\text{ m}$

THE DRIVEN SEGMENT IS #9 on l_2 .

- - - STRUCTURE SPECIFICATION - - -

COORDINATES MUST BE INPUT IN METERS OR BE SCALED TO METERS BEFORE STRUCTURE INPUT IS ENDED

WIRE NO.	NO. OF X1	Y1	FIRST Z1	LAST X2	Y2	Z2	RADIUS	SEG	SEG	SEG	NO.
1	-0.11120	0.0	0.0	0.11120	0.0	0.0	0.00317	17	1	17	1
2	-0.10425	0.0	0.09267	-0.03250	0.0	0.09267	0.00317	6	18	23	2
3	-0.03250	0.0	0.09267	0.03250	0.0	0.09267	0.00666	5	24	28	3
4	0.03250	0.0	0.09267	0.10425	0.0	0.09267	0.00317	6	29	34	4
5	-0.09705	0.0	0.18534	0.09705	0.0	0.18534	0.00317	15	35	49	5
6	-0.09545	0.0	0.27801	0.09545	0.0	0.27801	0.00317	15	50	64	6
7	-0.09705	0.0	0.37068	0.09705	0.0	0.37068	0.00317	15	65	79	7

TOTAL SEGMENTS USED=79 <snip>

- - - - - FREQUENCY - - - - -

FREQUENCY= 6.4700E+02 MHZ WAVELENGTH= 4.6337E-01 METERS

- - - ANTENNA INPUT PARAMETERS - - -

TAG NO.	SEG. NO.	VOLTAGE		IMPEDANCE (OHMS)		ADMITTANCE (MHOS)	
		REAL	IMAG.	REAL	IMAG.	REAL	IMAG.
3	26	1.0	0.0	1.48402E+01	-8.39722E+00	5.1042E-02	2.88818E-02

- - - RADIATION PATTERNS - - -

THETA DEG	PHI DEG	Gain DB
0.00	0.00	11.37197
180.00	0.00	-0.31343

<snip>

MathCad file for second T-Match attempt

T-Match equations (Try #2)

$$c := 2.9979 \cdot 10^8 \quad fc := 647 \cdot 10^6 \quad \lambda := \frac{c}{fc} \quad \lambda = 0.46335$$

$$k := \frac{2 \cdot \pi}{\lambda} \quad k = 13.56023 \quad Z_{\text{desired}} := 100 \quad \Omega$$

$$d := 0.635 \cdot 10^{-2} \quad \text{m} \quad a := d \cdot 0.5 \quad a = 0.003175 \quad \text{m}$$

$$d_{\text{prime}} := 0.3175 \cdot 10^{-2} \quad \text{m} \quad a_{\text{prime}} := d_{\text{prime}} \cdot 0.5 \quad a_{\text{prime}} = 0.0015875 \quad \text{m}$$

$$s := 2 \cdot 10^{-2} \quad \text{m}$$

$$Z_0 := \frac{376.73}{2 \cdot \pi} \cdot \operatorname{acosh} \left[\frac{(s^2 - a^2 - a_{\text{prime}}^2)}{2 \cdot a \cdot a_{\text{prime}}} \right] \quad Z_0 = 260.329 \quad \Omega$$

$$u := \frac{a}{a_{\text{prime}}} \quad u = 2 \quad v := \frac{s}{a_{\text{prime}}} \quad v = 12.59843$$

$$\alpha := \frac{\operatorname{acosh} \left[\frac{(v^2 - u^2 + 1)}{2 \cdot v} \right]}{\operatorname{acosh} \left[\frac{(v^2 + u^2 - 1)}{2 \cdot v \cdot u} \right]} \quad \alpha = 1.36748 \quad a_e := a_{\text{prime}} \cdot e^{\frac{1}{(1+u)^2} \cdot (u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v))}$$

$$a_e = 0.00666 \quad \text{m} \quad a_e \cdot 100 = 0.6661 \quad \text{cm}$$

$$l_{\text{prime}} := 6.5 \cdot 10^{-2} \quad \text{m}$$

$$Z_t := j \cdot Z_0 \cdot \tan \left(\frac{k \cdot l_{\text{prime}}}{2} \right) \quad Z_t = 122.7827i \quad \Omega \quad Y_t := \frac{1}{Z_t} \quad Y_t = -8.144i \times 10^{-3} \quad \text{S}$$

$$\frac{Y_t}{2} = -4.072i \times 10^{-3} \quad \text{S}$$

Za from NEC (a MoM program)

$$Z_a := 14.8402 - j \cdot 8.39722 \quad \Omega \quad Y_a := \frac{1}{Z_a} \quad Y_a = 0.05104 + 0.02888i \quad \text{S}$$

$$Y_{\text{in}} := \frac{Y_t}{2} + \frac{Y_a}{(1 + \alpha)^2} \quad Y_{\text{in}} = 9.107 \times 10^{-3} + 1.081i \times 10^{-3} \quad \text{S} \quad \frac{1}{Z_{\text{desired}}} = 0.01 \quad \text{S}$$

$$Z_{\text{in}} := \frac{1}{Y_{\text{in}}} \quad \boxed{Z_{\text{in}} = 108.286 - 12.85i} \quad \Omega \quad Z_{\text{desired}} = 100 \quad \Omega$$

$$\Gamma := \frac{(Z_{\text{in}} - Z_{\text{desired}})}{Z_{\text{in}} + Z_{\text{desired}}} \quad \Gamma = 0.043 - 0.059i \quad |\Gamma| = 0.073$$

$$\text{VSWR} := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \quad \text{VSWR} = 1.158 \quad > 1.1 \text{ Too High (Try 2)}$$

$$l_{\text{suggested}} := \frac{2}{k} \cdot \operatorname{atan} \left[\frac{1}{2 \cdot Z_0 \cdot \operatorname{Im} \left[\frac{Y_a}{(1 + \alpha)^2} \right]} \right] \quad l_{\text{suggested}} = 0.05262 \quad l_{\text{suggested}} \cdot 0.5 = 0.026$$

Third attempt at T-Match

Leave T-Match diameter $2a' = 0.125'' = 0.3175 \text{ cm} \Rightarrow a' = 0.15875 \text{ cm}$

Leave T-Match spacing $s = 2 \text{ cm}$

Change T-Match length to $l' = 6 \text{ cm}$ (down from 6.5 cm)

Using NEC-2 and MathCad (see attached pages)-

$Z_a = 14.97 - j 7.08 \Omega$ & Gain = 11.4 dBi

$Z_0 = 260.3 \Omega$, $\alpha = 1.367$, $a_e = 0.667 \text{ cm}$, $Z_{in} = 102.7 - j 1.5 \Omega$ which yields $|\Gamma| = 0.015$, VSWR = 1.03 < 1.1 \Rightarrow **Meets spec!**

NEC input file for third T-Match attempt:

```

CM Yagi-Uda Antenna for UHF channel 43 (NO BOOM)
CM
CM THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN
CM ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHZ
CM W/ WAVELENGTH OF 0.4634m.
CM
CM THE DIMENSIONS ARE:
CM element diameter d=0.635cm=0.25in, radius a=d/2=0.3175cm=0.125in,
CM equivalent radius of center portion of driven element (T-Match)
CM is ae=0.00666 m which has a length of l'=0.06 m < l2
CM
CM l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
CM driven element l2=(l1+l3)/2=0.45 l= 0.2085m
CM ELEMENT SPACINGS Sij=0.2 l=0.09267m
CM SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
CE THE DRIVEN SEGMENT IS #3 on l2 Tag 3.
GW 1 17 -0.1112 0.0 0.0 0.1112 0.0 0.0 0.003175 !Reflector
GW 2 6 -0.10425 0.0 0.09267 -0.03 0.0 0.09267 0.003175 !Driven tip
GW 3 5 -0.03 0.0 0.09267 0.03 0.0 0.09267 0.00666 !Driven middle
GW 4 6 0.03 0.0 0.09267 0.10425 0.0 0.09267 0.003175 !Driven tip
GW 5 15 -0.09705 0.0 0.18534 0.09705 0.0 0.18534 0.003175 !Director 1
GW 6 15 -0.09545 0.0 0.27801 0.09545 0.0 0.27801 0.003175 !Director 2
GW 7 15 -0.09705 0.0 0.37068 0.09705 0.0 0.37068 0.003175 !Director 3
GE 0 0
FR 0 1 0 0 647 0
EX 0 3 3 0 1.0 0.0
RP 0 2 2 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN

```


NEC output file for third T-Match attempt

Yagi-Uda Antenna for UHF channel 43 (NO BOOM)

THIS FILE IS USED TO DETERMINE THE INPUT IMPEDANCE OF THE DRIVEN ELEMENT OF A 5 ELEMENT ANTENNA. CENTER FREQUENCY IS 647 MHz W/ WAVELENGTH OF 0.4634m.

THE DIMENSIONS ARE:

element diameter d=0.635cm=0.25in, radius a=d/2=0.3175cm=0.125in, equivalent radius of center portion of driven element (T-Match) is ae=0.00666 m which has a length of l'=0.06 m < l2

l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m, driven element l2=(l1+l3)/2=0.45 l= 0.2085m

ELEMENT SPACINGS Sij=0.2 l=0.09267m

SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l

THE DRIVEN SEGMENT IS #3 on l2 Tag 3.

- - - STRUCTURE SPECIFICATION - - -

COORDINATES MUST BE INPUT IN METERS OR BE SCALED TO METERS BEFORE STRUCTURE INPUT IS ENDED

WIRE NO.	NO.	OF	FIRST	LAST	TAG							
	X1	Y1	Z1	X2	Y2	Z2	RADIUS	SEG	SEG	SEG	NO	
1	-0.11120	0.0	0.0	0.11120	0.0	0.0	0.00317	17	1	17	1	
2	-0.10425	0.0	0.09267	-0.03000	0.0	0.09267	0.00317	6	18	23	2	
3	-0.03000	0.0	0.09267	0.03000	0.0	0.09267	0.00666	5	24	28	3	
4	0.03000	0.0	0.09267	0.10425	0.0	0.09267	0.00317	6	29	34	4	
5	-0.09705	0.0	0.18534	0.09705	0.0	0.18534	0.00317	15	35	49	5	
6	-0.09545	0.0	0.27801	0.09545	0.0	0.27801	0.00317	15	50	64	6	
7	-0.09705	0.0	0.37068	0.09705	0.0	0.37068	0.00317	15	65	79	7	

TOTAL SEGMENTS USED= 79 <snip>

- - - - - FREQUENCY - - - - -

FREQUENCY= 6.4700E+02 MHZ WAVELENGTH= 4.6337E-01 METERS

- - - ANTENNA INPUT PARAMETERS - - -

TAG NO.	SEG. NO.	VOLTAGE REAL	IMAG.	IMPEDANCE REAL	IMAG.	ADMITTANCE REAL	IMAG.
3	26	1.0	0.0	1.49736E+01	-7.07901	5.45842E-02	2.58056E-02

- - - RADIATION PATTERNS - - -

THETA DEGREES	PHI DEGREES	Gain DB
0.00	0.00	11.38537
180.00	0.00	-0.30466

MathCad file for third T-Match attempt

T-Match equations (Try #3)

$$\underline{c} := 2.9979 \cdot 10^8 \quad f_c := 647 \cdot 10^6 \quad \lambda := \frac{c}{f_c} \quad \lambda = 0.46335$$

$$k := \frac{2 \cdot \pi}{\lambda} \quad k = 13.56023 \quad Z_{\text{desired}} := 100 \quad \Omega$$

$$d := 0.635 \cdot 10^{-2} \quad \text{m} \quad a := d \cdot 0.5 \quad a = 0.003175 \quad \text{m}$$

$$d_{\text{prime}} := 0.3175 \cdot 10^{-2} \quad \text{m} \quad a_{\text{prime}} := d_{\text{prime}} \cdot 0.5 \quad a_{\text{prime}} = 0.0015875 \quad \text{m}$$

$$s := 2 \cdot 10^{-2} \quad \text{m}$$

$$Z_0 := \frac{376.73}{2 \cdot \pi} \cdot \operatorname{acosh} \left[\frac{(s^2 - a^2 - a_{\text{prime}}^2)}{2 \cdot a \cdot a_{\text{prime}}} \right] \quad Z_0 = 260.329 \quad \Omega$$

$$u := \frac{a}{a_{\text{prime}}} \quad u = 2 \quad v := \frac{s}{a_{\text{prime}}} \quad v = 12.59843$$

$$\alpha := \frac{\operatorname{acosh} \left[\frac{(v^2 - u^2 + 1)}{2 \cdot v} \right]}{\operatorname{acosh} \left[\frac{(v^2 + u^2 - 1)}{2 \cdot v \cdot u} \right]} \quad \alpha = 1.36748 \quad a_e := a_{\text{prime}} \cdot e^{\frac{1}{(1+u)^2} \cdot (u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v))}$$

$$a_e = 0.00666 \quad \text{m} \quad a_e \cdot 100 = 0.6661 \quad \text{cm}$$

$$l_{\text{prime}} := 6.0 \cdot 10^{-2} \quad \text{m}$$

$$Z_t := j \cdot Z_0 \cdot \tan \left(\frac{k \cdot l_{\text{prime}}}{2} \right) \quad Z_t = 112.16i \quad \Omega \quad Y_t := \frac{1}{Z_t} \quad Y_t = -8.916i \cdot 10^{-3} \quad \text{S}$$

$$\frac{Y_t}{2} = -4.458i \cdot 10^{-3} \quad \text{S}$$

Za from NEC (a MoM program)

$$Z_a := 14.9736 - j \cdot 7.07901 \quad \Omega \quad Y_a := \frac{1}{Z_a} \quad Y_a = 0.05458 + 0.02581i \quad \text{S}$$

$$Y_{\text{in}} := \frac{Y_t}{2} + \frac{Y_a}{(1 + \alpha)^2} \quad Y_{\text{in}} = 9.739 \times 10^{-3} + 1.461i \times 10^{-4} \quad \text{S} \quad \frac{1}{Z_{\text{desired}}} = 0.01 \quad \text{S}$$

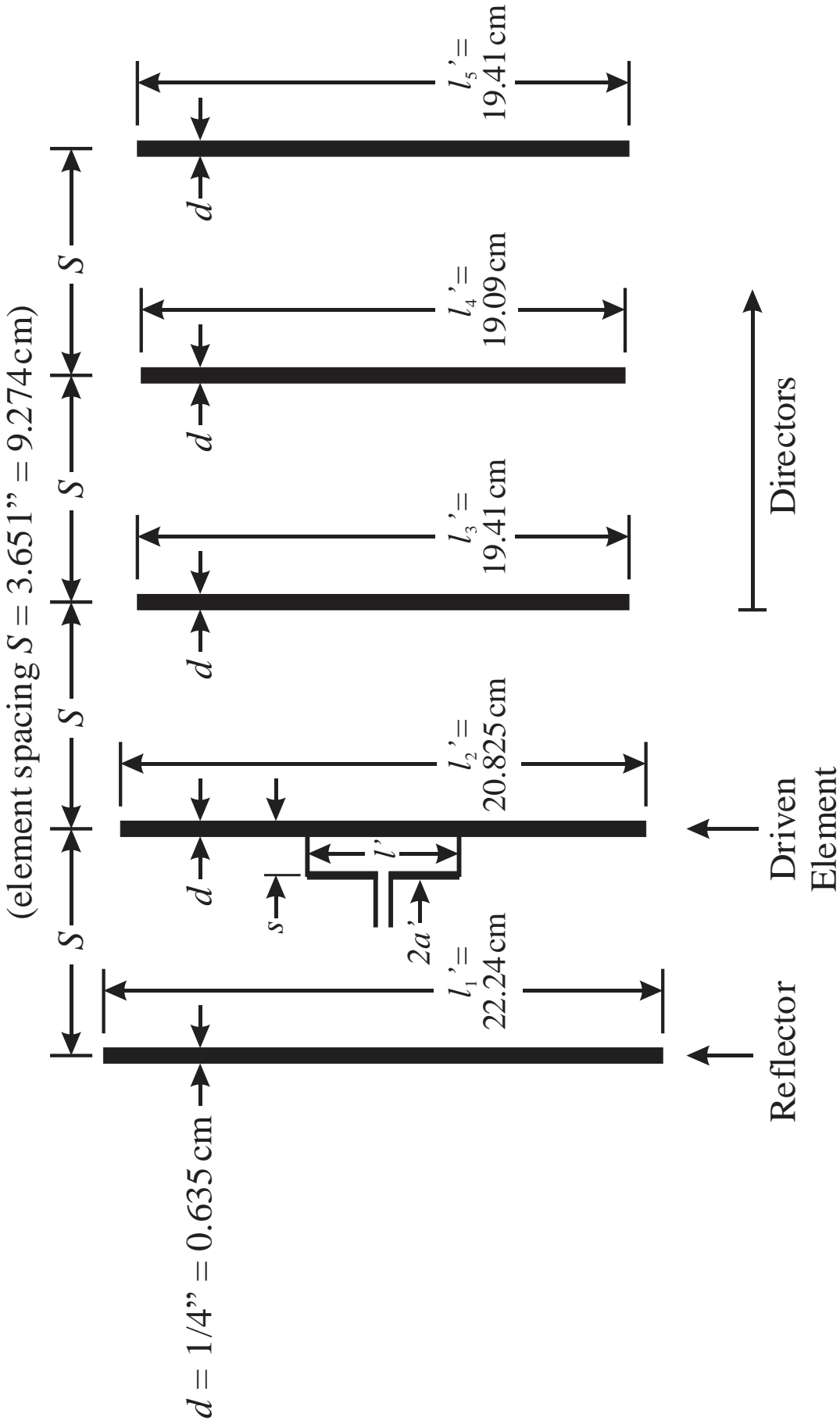
$$Z_{\text{in}} := \frac{1}{Y_{\text{in}}} \quad \boxed{Z_{\text{in}} = 102.662 - 1.541i} \quad \Omega \quad Z_{\text{desired}} = 100 \quad \Omega$$

$$\underline{\Gamma} := \frac{(Z_{\text{in}} - Z_{\text{desired}})}{Z_{\text{in}} + Z_{\text{desired}}} \quad \Gamma = 0.013 - 7.501i \times 10^{-3} \quad |\Gamma| = 0.015$$

$$\text{VSWR} := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \quad \text{VSWR} = 1.031 \quad < \mathbf{1.1 \text{ Meets Spec! (Try 3)}}$$

$$l_{\text{suggested}} := \frac{2}{k} \cdot \operatorname{atan} \left[\frac{1}{2 \cdot Z_0 \cdot \operatorname{Im} \left[\frac{Y_a}{(1 + \alpha)^2} \right]} \right] \quad l_{\text{suggested}} = 0.05829 \quad l_{\text{suggested}} \cdot 0.5 = 0.029$$

5 element, channel 43 Yagi-Uda antenna w/ T-Match



T-Match Dimensions: $2a' = 1/8'' = 0.3175 \text{ cm}$, $s = 2 \text{ cm}$, $l' = 6 \text{ cm}$