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

Yagi-Uda antenna design summary:

f_c = 647 MHz and λ = 46.3 cm

element diameters $d = 2a = 0.25" = 0.635$ cm $\Rightarrow$ $a = 0.125" = 0.3175$ cm

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

reflector length $l_1' = 0.48\lambda = 22.24$ cm

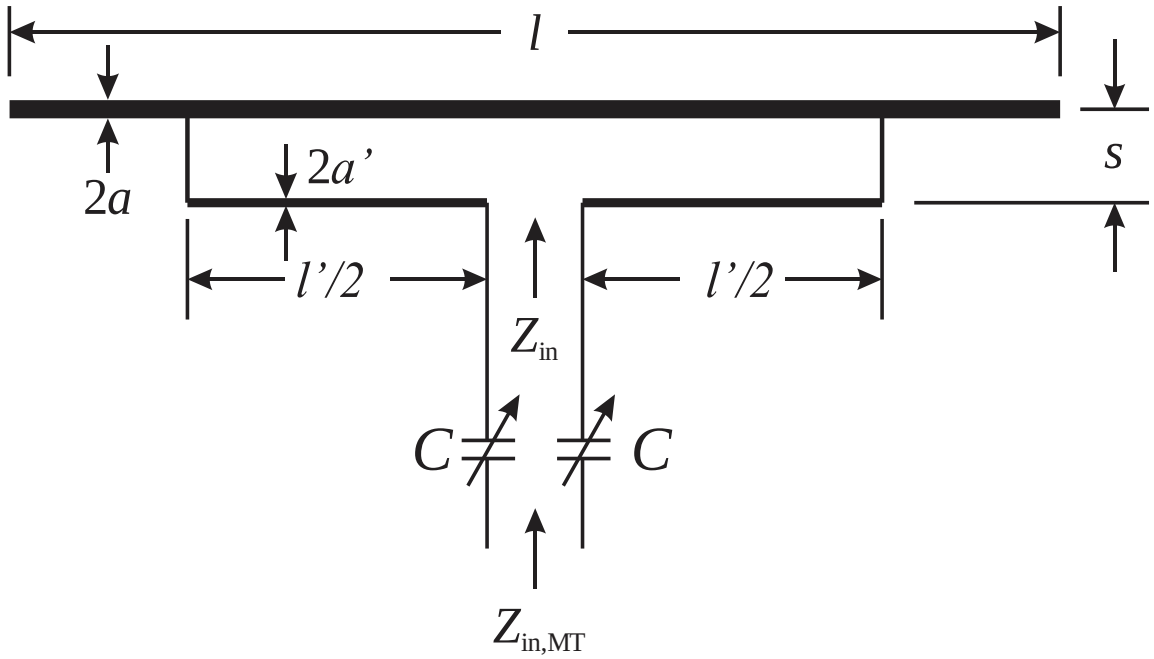
director lengths $l_3' = l_5' = 0.419\lambda = 19.41$ cm

director length $l_4' = 0.412\lambda = 19.09$ cm

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

From NEC-2, $Z_a = 17.35 + j\,20.59\ \Omega$ and Gain = 11.265 dBi w/ no match

Modified or Resonant T-Match:



First attempt at modified T-Match

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

Select T-Match spacing s = 1" = 2.54 cm and length l' = 3.5" = 9 cm

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

- For T-Match (MathCad): Z_0 = 289.734 Ω, current division factor α = 1.32867, effective radius a_e = 0.74075 cm, & transmission line mode input impedance $Z_t = j202.591\ \Omega$
- From NEC: $Z_a = 15.4971 - j\ 15.544\ \Omega$ & Gain = 11.14 dBi
- Using MathCad: Z_{in} = 125.325 - j 73.579 Ω. Since the reactance is capacitive, using a modified T-Match would make things worse, i.e., do NOT add series capacitors. With this input impedance, |Γ| = 0.328, VSWR = 1.977 > 1.1 (high).

NEC input file for first modified 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 l=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=0.00741 m which has a length of l'=0.09m  < l2
CM l1=0.48l=0.2224m, l3=l5=0.419l=0.1941m, l4=0.412l=0.1909m,
CM driven element l2=0.46 l= 0.211m
CM ELEMENT SPACINGS Sij=0.2 l=0.09267m
CM SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
CM THE DRIVEN SEGMENT IS #4 on l2 GW 3/Tag 3.
CE
GW 1 17 -0.115   0.0 0.0      0.115   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 0.00741  !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 3 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN
```

NEC output file for first modified 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'=0.045m  < l2

   l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
   driven element l2=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 #9 on l2.
   ************************************************************

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

 WIRE        NO. OF   FIRST  LAST  TAG
NO.   X1       Y1   Z1       X2       Y2  Z2     RADIUS SEG SEG SEG NO
 1  -0.1112   0.0 0.0      0.1112  0.0 0.0     0.00317  17  1 17  1
 2  -0.10425  0.0 0.09267 -0.04500 0.0 0.09267 0.00317   5 18 22  2
 3  -0.04500  0.0 0.09267  0.04500 0.0 0.09267 0.00741   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  SEG.   VOLTAGE (V)    IMPEDANCE (OHMS)    ADMITTANCE (MHOS)
 NO.  NO.    REAL IMAG.    REAL      IMAG.        REAL        IMAG.
 3   26     1.0  0.0  1.54971E+01 -1.55440E+01 3.2167E-02 3.2264E-02

 - - - RADIATION PATTERNS - - -

 THETA     PHI    Gain
 DEGREES DEGREES  DB
   0.00  0.00   11.14139
 180.00  0.00    0.77669
<snip>
```

MathCad file for first modified T-Match attempt

Modified T-Match equations

$c := 2.9979 \cdot 10^8$ $fc := 647 \cdot 10^6$ $\lambda := \frac{c}{fc}$ $\lambda = 0.46335$ $k := \frac{2 \cdot \pi}{\lambda}$ $k = 13.56023$

$Zdesired := 100$ Ohms $d := 0.635 \cdot 10^{-2}$ m $a := d \cdot 0.5$ $a = 0.003175$ m

$dprime := 0.3175 \cdot 10^{-2}$ m $aprime := dprime \cdot 0.5$ $aprime = 0.0015875$ m $s := 2.54 \cdot 10^{-2}$ m

$$Z0 := \frac{376.73}{2 \cdot \pi} \cdot acosh\left[\frac{\left(s^2 - a^2 - aprime^2\right)}{2 \cdot a \cdot aprime}\right] \qquad Z0 = 289.734 \text{ Ohms}$$

$u := \frac{a}{aprime}$ $v := \frac{s}{aprime}$

$u = 2$ $v = 16$

$$\alpha := \frac{acosh\left[\frac{\left(v^2 - u^2 + 1\right)}{2 \cdot v}\right]}{acosh\left[\frac{\left(v^2 + u^2 - 1\right)}{2 \cdot v \cdot u}\right]} \qquad \alpha = 1.32827$$

$$ae := aprime \cdot e^{\frac{1}{(1+u)^2} \cdot \left(u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v)\right)}$$

$ae = 0.00741$ $ae \cdot 100 = 0.74075$ cm

$lprime := 9.0 \cdot 10^{-2}$ m

$$Zt := j \cdot Z0 \cdot \tan\left(\frac{k \cdot lprime}{2}\right) \qquad Zt = 202.59106i$$

$Yt := \frac{1}{Zt}$ $Yt = -4.936 \cdot 10^{-3} i$

$\frac{Yt}{2} = -2.468 \cdot 10^{-3} i$

Za from NEC (a MoM program)

$Za := 15.4971 + j \cdot 15.544$ Ohms $Ya := \frac{1}{Za}$ $Ya = 0.03217 + 0.03226i$ Mhos

$$Yint := \frac{Yt}{2} + \frac{Ya}{(1+\alpha)^2} \qquad Yint = 5.934 \cdot 10^{-3} + 3.484 \cdot 10^{-3} i$$

$\frac{1}{Zdesired} = 0.01$ Mhos

$Zint := \frac{1}{Yint}$ $Zint = 125.325 - 73.579i$ Ohms $Zdesired = 100$ Ohms

$$C := if\left(Im(Zint) > 0, \frac{1}{\pi \cdot fc \cdot Im(Zint)}, 0\right) \qquad C = 0$$

$$Zcap := if\left(C > 0, \frac{1}{j \cdot 2 \cdot \pi \cdot fc \cdot C}, 0\right) \qquad Zcap = 0 \text{ Ohms}$$

$Zin := 2 \cdot Zcap + Zint$ $Zin = 125.325 - 73.579i$ Ohms

$$\Gamma := \frac{(Zin - Zdesired)}{Zin + Zdesired} \qquad \Gamma = 0.198 - 0.262i$$

$|\Gamma| = 0.328$

$$VSWR := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \qquad VSWR = 1.977$$

Second attempt at modified T-Match

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

Leave T-Match spacing $s = 2.54$ cm

Change T-Match length to $l' = 10$ cm (longer) **and** change driven element length to $l_2' = 21.8$ cm $= 0.47\lambda$ (longer) in hope of giving Z_{in} an inductive reactance.

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

- For T-Match (MathCad): $Z_0 = 289.734\ \Omega$, $\alpha = 1.32867$, $a_e = 0.741$ cm, & transmission line mode input impedance $Z_t = j233.345\ \Omega$
- From NEC: $Z_a = 16.4017 + j\ 1.7047\ \Omega$ & Gain = 11.335 dBi
- Using MathCad: $Z_{in} = 82.609 + j\ 24.494\ \Omega$. Since the reactance is inductive, add series capacitors with $2Z_{cap} = -j\ 24.494\ \Omega$ ($C = 20.1$ pF). Now, $Z_{in,MT} = 82.609\,\Omega$, $|\Gamma| = 0.095$, and VSWR = 1.211 > 1.1 (high).

NEC input file for second modified 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=0.00741 m which has a length of l'=0.1m  < l2
CM
CM l1=0.48l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412l=0.1909m,
CM driven element l2=0.47l= 0.218m
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 Tag 3.
GW 1 17 -0.1112  0.0 0.0      0.1112  0.0 0.0     0.003175 !Reflector
GW 2  5 -0.109   0.0 0.09267 -0.05    0.0 0.09267 0.003175 !Driven tip
GW 3  7 -0.05    0.0 0.09267  0.05    0.0 0.09267 0.00741  !Driven middle
GW 4  5  0.05    0.0 0.09267  0.109   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 3 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN
```

NEC output file for second modified T-Match attempt

```
Yagi-Uda Antenna for UHF channel 43 THIS PROGRAM ASSUMES THAT THERE IS 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=0.00741 m which has a length of l'=0.1 m  < l2

  l1=0.48 l=0.2224m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
  driven element l2=0.47 l= 0.218m
  ELEMENT SPACINGS Sij=0.2 l=0.09267m
  SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
  THE DRIVEN SEGMENT IS #9 on l2.

  ************************************************************

     - - - STRUCTURE SPECIFICATION - - -

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

  WIRE       NO. OF   FIRST   LAST   TAG
  NO.   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    -0.10900  0.0   0.09267  -0.05000  0.0   0.09267   0.00317   5    18   22    2
  3    -0.05000  0.0   0.09267   0.05000  0.0   0.09267   0.00741   7    23   29    3
  4   0.05000   0.0   0.09267   0.10900   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  NO. SEG. IN A SYMMETRIC CELL= 79  SYMMETRY FLAG=  0

 ***** INPUT LINE  1  FR   0  1  0  0  6.47000E+02  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  2  EX   0  3  4  0  1.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  3  RP   0  2  3  0  0.0  0.0  1.800E+02  9.00E+01  0.0  0.0

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

    - - - ANTENNA INPUT PARAMETERS - - -

TAG   SEG.  VOLTAGE (VOLTS)    IMPEDANCE (OHMS)  ADMITTANCE (MHOS)
 NO.   NO.  REAL  IMAG.  REAL  IMAG.   REAL  IMAG.
 3  26 1.0 0.0 1.64017E+01 1.70470E+00 6.03178E-02-6.26911E-03 3.01589E-02

    - - - RADIATION PATTERNS - - -
  THETA  PHI  Gain
 DEGREES  DEGREES   DB
  0.00  0.00  11.33515
  180.00  0.00  -0.36647

 ***** INPUT LINE  4  PT  -1  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  5  XQ   0  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  6  EN   0  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
```

Try 2

Z_{ant}

MathCad file for second modified T-Match attempt

Modified T-Match equations

$c := 2.9979 \cdot 10^{8}$ $fc := 647 \cdot 10^{6}$ $\lambda := \frac{c}{fc}$ $\lambda = 0.46335$ $k := \frac{2 \cdot \pi}{\lambda}$ $k = 13.56023$

$Zdesired := 100$ Ohms $d := 0.635 \cdot 10^{-2}$ m $a := d \cdot 0.5$ $a = 0.003175$ m

$dprime := 0.3175 \cdot 10^{-2}$ m $aprime := dprime \cdot 0.5$ $aprime = 0.0015875$ m $s := 2.54 \cdot 10^{-2}$ m

$$Z0 := \frac{376.73}{2 \cdot \pi} \cdot acosh\left[\frac{\left(s^2 - a^2 - aprime^2\right)}{2 \cdot a \cdot aprime}\right] \qquad Z0 = 289.734 \text{ Ohms}$$

$u := \frac{a}{aprime}$ $v := \frac{s}{aprime}$

$u = 2$ $v = 16$

$$\alpha := \frac{acosh\left[\frac{\left(v^2 - u^2 + 1\right)}{2 \cdot v}\right]}{acosh\left[\frac{\left(v^2 + u^2 - 1\right)}{2 \cdot v \cdot u}\right]} \qquad \alpha = 1.32827$$

$$ae := aprime \cdot e^{\frac{i}{(1+u)^2} \cdot \left(u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v)\right)}$$

$ae = 0.00741$ $ae \cdot 100 = 0.74075$ cm

$lprime := 10.0 \cdot 10^{-2}$ m

$$Zt := j \cdot Z0 \cdot \tan\left(\frac{k \cdot lprime}{2}\right) \qquad Zt = 233.34507i$$

$Yt := \frac{1}{Zt}$ $Yt = -4.285 \cdot 10^{-3} i$

$\frac{Yt}{2} = -2.143 \cdot 10^{-3} i$

Za from NEC (a MoM program)

$Za := 16.4017 + j \cdot 1.7047$ Ohms $Ya := \frac{1}{Za}$ $Ya = 0.06032 - 0.00627i$ Mhos

$$Yint := \frac{Yt}{2} + \frac{Ya}{(1+\alpha)^2} \qquad Yint = 0.011 - 3.299 \cdot 10^{-3} i$$

$\frac{1}{Zdesired} = 0.01$ Mhos

$Zint := \frac{1}{Yint}$ $Zint = 82.609 + 24.494i$ Ohms $Zdesired = 100$ Ohms

$$C := if\left(Im(Zint) > 0, \frac{1}{\pi \cdot fc \cdot Im(Zint)}, 0\right) \qquad C = 2.009 \cdot 10^{-11}$$

$$Zcap := if\left(C > 0, \frac{1}{j \cdot 2 \cdot \pi \cdot fc \cdot C}, 0\right) \qquad Zcap = -12.247i \text{ Ohms}$$

$Zin := 2 \cdot Zcap + Zint$ $Zin = 82.609$ Ohms

$$\Gamma := \frac{(Zin - Zdesired)}{Zin + Zdesired} \qquad \Gamma = -0.095 \qquad |\Gamma| = 0.095$$

$$VSWR := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \qquad VSWR = 1.211$$

Third attempt at modified T-Match

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

Leave T-Match spacing $s = 2.54$ cm and T-Match length $l' = 10$ cm

Change driven element length to $l_2' = 21.7$ cm $= 0.4683\lambda$ (shorter) **and** reflector length $l_1' = 23$ cm (longer) in hopes of increasing real part of Z_a.

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

- For T-Match (MathCad): $Z_0 = 289.734\ \Omega$, $\alpha = 1.32867$, $a_e = 0.741$ cm, & transmission line mode input impedance $Z_t = j233.345\ \Omega$
- From NEC: $Z_a = 18.3917 + j\ 0.86962\ \Omega$ & Gain = 11.155 dBi
- Using MathCad: $Z_{in} = 93.531 + j\ 24.448\ \Omega$. Since the reactance is inductive, add series capacitors with $2Z_{cap} = -j\ 24.448\ \Omega$ ($C = 20.12$ pF). Now, $Z_{in,MT} = 93.53\ \Omega$, $|\Gamma| = 0.033$, & VSWR = 1.069 < 1.1 (**DONE!**).

NEC input file for third modified 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=0.00741 m which has a length of l'=0.1 m < l2
CM l1=0.23m, l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m, and
CM driven element l2= 0.217m
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 Tag 3.
GW 1 17 -0.115   0.0 0.0      0.115   0.0 0.0     0.003175 !Reflector
GW 2  5 -0.1084  0.0 0.09267 -0.05    0.0 0.09267 0.003175 !Driven tip
GW 3  7 -0.05    0.0 0.09267  0.05    0.0 0.09267 0.00741  !Driven middle
GW 4  5  0.05    0.0 0.09267  0.1084  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 3 0000 0.0 0.0 180.0 90.0
PT -1
XQ 0
EN
```

NEC output file for third modified T-Match attempt:

```
Yagi-Uda Antenna for UHF channel 43 THIS PROGRAM ASSUMES THAT THERE IS 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=0.00741 m which has a length of l'=0.1 m  < l2

   l1=0.23 m , l3=l5=0.419 l=0.1941m, l4=0.412 l=0.1909m,
   driven element l2=0.211m
   ELEMENT SPACINGS Sij=0.2 l=0.09267m
   SELECT SEGMENT LENGTH OF APPROX. 1.25cm=0.025 l
   THE DRIVEN SEGMENT IS #9 on l2.

  ************************************************************

- - - STRUCTURE SPECIFICATION - - -

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

  WIRE      NO. OF   FIRST   LAST   TAG
  NO.    X1      Y1      Z1   X2      Y2      Z2    RADIUS    SEG.   SEG.    SEG.   NO.
  1    -0.11500   0.0   0.0   0.11500   0.0   0.0   0.00317   17     1    17   1
  2    -0.10840   0.0   0.09267   -0.05000   0.0   0.09267   0.00317    5   18   22   2
  3    -0.05000   0.0   0.09267   0.05000   0.0   0.09267   0.00741    7   23   29   3
  4   0.05000   0.0   0.09267   0.10840   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   NO. SEG. IN A SYMMETRIC CELL= 79   SYMMETRY FLAG=   0

 ***** INPUT LINE  1  FR   0  1  0  0  6.47000E+02  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  2  EX   0  3  4  0  1.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  3  RP   0  2  3  0  0.0  0.0  1.800E+02  9.0E+01  0.0  0.0

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

    - - - ANTENNA INPUT PARAMETERS - - -
   TAG   SEG.  VOLTAGE (VOLTS)   IMPEDANCE (OHMS)   ADMITTANCE (MHOS)
   NO.   NO.  REAL   IMAG.  REAL   IMAG.   REAL   IMAG.
3  26 1.0 0.0 1.83917E+01 8.69629E-01 5.42509E-02 -2.56518E-03

    - - - RADIATION PATTERNS - - -
  THETA  PHI Gain
 DEGREES  DEGREES  DB
  0.00  0.00  11.15446
  180.00  0.00  0.71645

 ***** INPUT LINE  4  PT  -1  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  5  XQ   0  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
 ***** INPUT LINE  6  EN   0  0  0  0  0.0  0.0  0.0  0.0  0.0  0.0
```

MathCad file for third modified T-Match attempt:

Modified T-Match equations

$c := 2.9979 \cdot 10^{8}$ $fc := 647 \cdot 10^{6}$ $\lambda := \frac{c}{fc}$ $\lambda = 0.46335$ $k := \frac{2 \cdot \pi}{\lambda}$ $k = 13.56023$

$Zdesired := 100$ Ohms $d := 0.635 \cdot 10^{-2}$ m $a := d \cdot 0.5$ $a = 0.003175$ m

$dprime := 0.3175 \cdot 10^{-2}$ m $aprime := dprime \cdot 0.5$ $aprime = 0.0015875$ m $s := 2.54 \cdot 10^{-2}$ m

$$Z0 := \frac{376.73}{2 \cdot \pi} \cdot acosh\left[\frac{\left(s^2 - a^2 - aprime^2\right)}{2 \cdot a \cdot aprime}\right] \qquad Z0 = 289.734 \text{ Ohms}$$

$u := \frac{a}{aprime}$ $v := \frac{s}{aprime}$

$u = 2$ $v = 16$

$$\alpha := \frac{acosh\left[\frac{\left(v^2 - u^2 + 1\right)}{2 \cdot v}\right]}{acosh\left[\frac{\left(v^2 + u^2 - 1\right)}{2 \cdot v \cdot u}\right]} \qquad \alpha = 1.32827$$

$$ae := aprime \cdot e^{\frac{1}{(1+u)^2} \cdot \left(u^2 \cdot \ln(u) + 2 \cdot u \cdot \ln(v)\right)}$$

$ae = 0.00741$ $ae \cdot 100 = 0.74075$ cm

$lprime := 10.0 \cdot 10^{-2}$ m

$$Zt := j \cdot Z0 \cdot \tan\left(\frac{k \cdot lprime}{2}\right) \qquad Zt = 233.34507i$$

$Yt := \frac{1}{Zt}$ $Yt = -4.285 \cdot 10^{-3} i$

$\frac{Yt}{2} = -2.143 \cdot 10^{-3} i$

Za from NEC (a MoM program)

$Za := 18.3917 + j \cdot 0.86962$ Ohms $Ya := \frac{1}{Za}$ $Ya = 0.05425 - 0.00257i$ Mhos

$$Yint := \frac{Yt}{2} + \frac{Ya}{(1+\alpha)^2} \qquad Yint = 0.01 - 2.616 \cdot 10^{-3} i$$

$\frac{1}{Zdesired} = 0.01$ Mhos

$Zint := \frac{1}{Yint}$ $Zint = 93.531 + 24.448i$ Ohms $Zdesired = 100$ Ohms

$$C := if\left(Im(Zint) > 0, \frac{1}{\pi \cdot fc \cdot Im(Zint)}, 0\right) \qquad C = 2.012 \cdot 10^{-11}$$

$$Zcap := if\left(C > 0, \frac{1}{j \cdot 2 \cdot \pi \cdot fc \cdot C}, 0\right) \qquad Zcap = -12.224i \text{ Ohms}$$

$Zin := 2 \cdot Zcap + Zint$ $Zin = 93.531$ Ohms

$$\Gamma := \frac{(Zin - Zdesired)}{Zin + Zdesired} \qquad \Gamma = -0.033 \qquad |\Gamma| = 0.033$$

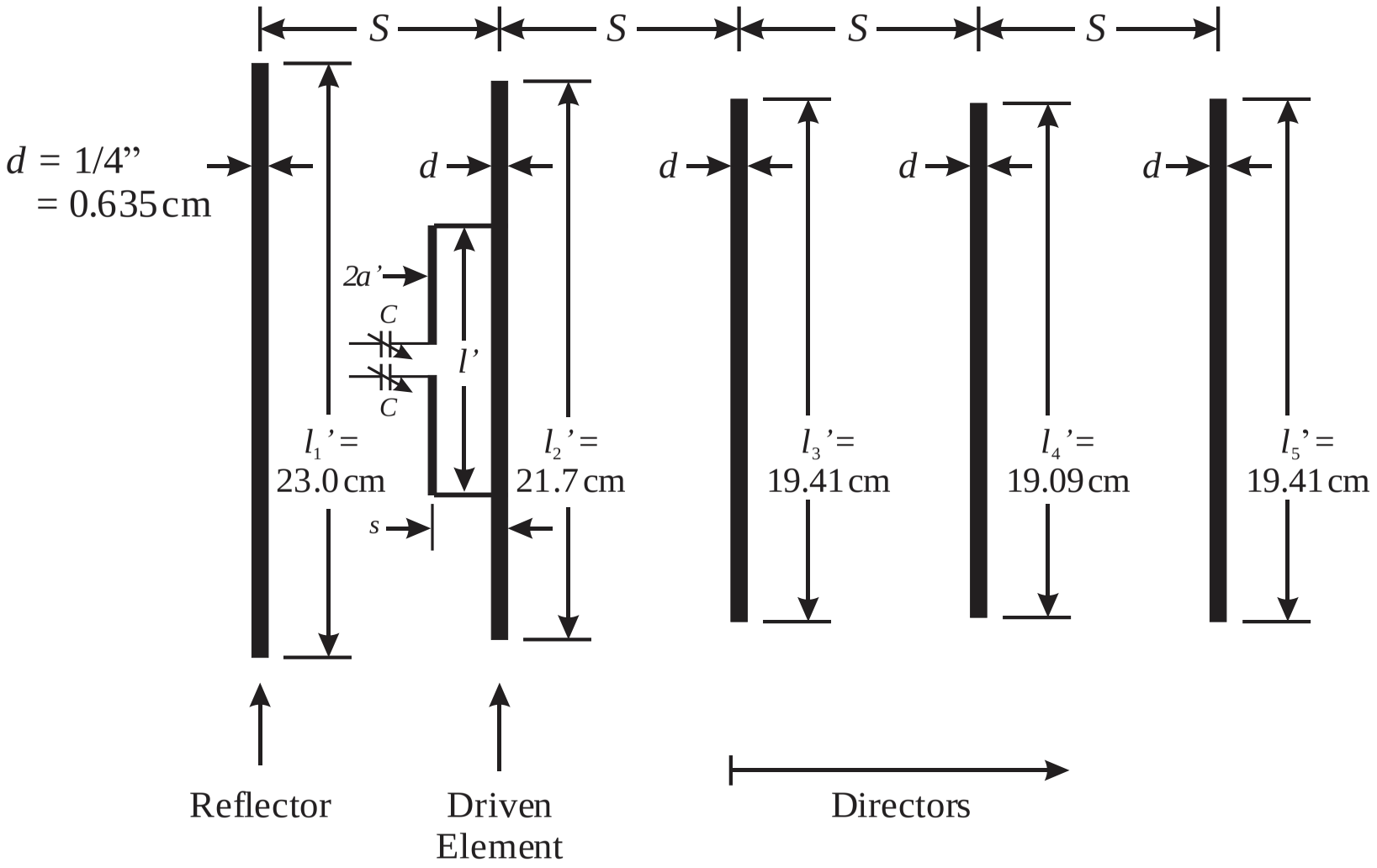
$$VSWR := \frac{(1 + |\Gamma|)}{1 - |\Gamma|} \qquad VSWR = 1.069$$

3rd Try

Done !

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

(element spacing S = 3.651” = 9.274 cm)



T-Match Dimensions: $2a'$ = 1/8” = 0.3175cm, s = 2.54 cm, l' = 10 cm, and C = 20.12 pF