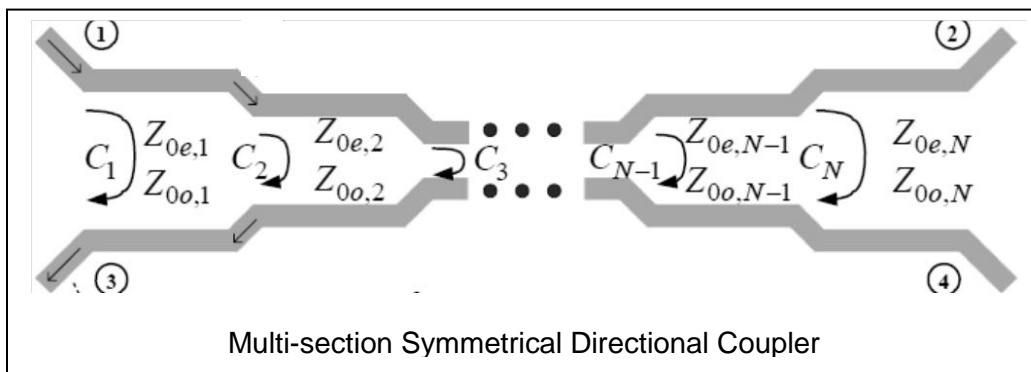# Quick Start User Manual: TEMcoupler

Multi-section Symmetrical Directional Coupler

1.0 Getting Ready:

The software product you purchased is located inside a ZIP file that you can open, by following these steps:

1. Double-click on the ZIP file you purchased. This action starts the ZIP Wizard application, which contains the software product.
2. The ZIP Wizard automatically opens the software product you purchased and stores it inside your computer.
3. Once the software product is unzipped, right-click on the application's *filename* and single-click: "Extract". This action will extract all files located inside the software product and store them inside your computer:
   a. *TEMcoupler.exe*: The executable software product.
   b. *TEMcoupler.DEF*: Default Data File read by *TEMcoupler.exe*
   c. *Quick Start User Manual*: This User Manual.
   d. *License*: License Agreement for the software product.
4. NOTE: All files unzipped inside your computer must be located in the same file folder, since several Data Files are read by the executable software product.
5. Open the License Agreement so you know the terms & conditions for using the software product. Return the software product for a full refund if you do not agree with those terms & conditions, as stated in the License Agreement.
6. Open the Default Data File: *TEMcoupler.DEF* using Notepad and read the description contained inside.

Once the above software files are extracted and stored inside your computer, just double-click on the executable file to start using the product.

2.0 How I Works:

Software product: *TEMcoupler.exe* performs a Frequency Analysis of multi-section Symmetrical or Asymmetrical Directional Couplers. . . . . up to 50 sections, based on the Even-mode and Odd-mode Impedances: Zoe & Zoo of each section. Features are included in the software product to make the even-mode phase velocity different from the odd-mode phase velocity, so one can simulate the impact of the coupler's RF performance when constructed in microstrip.

The executable file: *TEMcoupler.exe* reads the Default Data File: *TEMcoupler.DEF* each time you start the program. As such, you can change Data Entries inside *TEMcoupler.DEF* to suite

your most common multi-section Symmetric or Asymmetric Coupler designs, using the guidelines written in *TEMcoupler.DEF*.

When you start using the software product, you are asked to enter key design parameters for your multi-section Directional Coupler. If you press <ENTER> on your computer's keyboard, the software product uses the Data Entry from your Default Data File: *TEMcoupler.DEF* for that design parameter. As such, you can change any/all Data Entries in *TEMcoupler.DEF* to suite your most common multi-section Coupler designs, without having to enter those values when asked by the executable file: *TEMcoupler.exe*. Just press <ENTER> on your computer's keyboard and your Default Data values are used for that Data entry by the software product.

Figure 2-1 shows the baseline data entries for Default Data file: TEMcoupler.DEF.

Certain design parameters have a "default answer", shown as an asterisk (*), which enables you to press <ENTER> on your keyboard, if that "default answer" (= *) is your selection.

Lastly, all Data entries (including Default Data entries) are included in the Output Data format so you know the basis for your Frequency Analysis of the multi-section Directional Coupler.

Most data entries are straight-forward and easy to understand for those skill-at-the-art of RF/microwave design…….and those not-so-skilled. So, let us know where improvements are needed as you operate the software product.

3.0   Screen Shots: Input Data

Screen-shots for User Input Data entry are shown in Figure 3-1 and Figure 3- 2 for a multi-section Symmetrical Coupler and for a multi-section Asymmetrical Coupler, respectively.

4.0   Screen Shots: Output Data

Screen-shots of Output Data calculated by the software product are shown in Figures 4-1 and Figure 4-2 for a multi-section Symmetrical Coupler and for a multi-section Asymmetrical Coupler, respectively.

The Output Data from the software product can be stored in a User-defined filename:
   A. Enter a *filename*.**xls** for storage in a spreadsheet.
   B. Enter *filename*.**doc** for Output Data storage in a word processor.
   C. Enter *filename*.**txt** for Output Data storage as a text file.

The Output Data files can be used for presentations to your Customers, e-mails to your colleagues, and for graphical plots of your Output Data.

5.0   User Data Files:

For the Analysis Option, the software product reads a User's Input Data filename to analyze the Frequency response of your multi-section Directional Coupler.

You can create any number of User Input Data files, each of which defines the actual electrical circuit of your multi-section Directional Coupler. Once created, you can enter that Input Data filename when asked by the software product, for Frequency Analysis and for comparison with

actual measured swept-frequency data for that design. Figure 5-1 shows a typical User Input Data File for a 6-section 10dB Asymmetric Directional Coupler.

6.0   Software Bugs

Every effort has been applied to minimize "software bugs" inside the software product. Yet, we invite all Users to notify us if you find one. Many thanks!
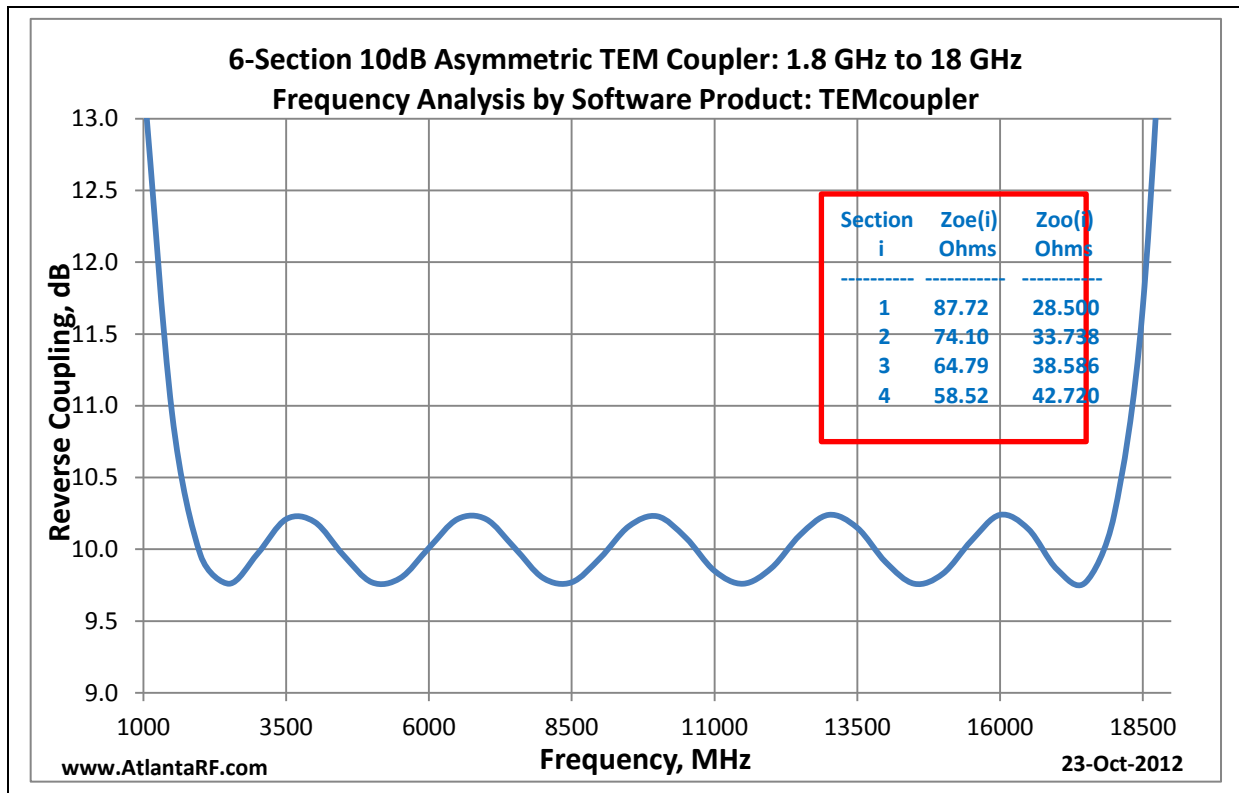
Inside the software product, you will find "User-friendly Error Traps", which identify errors in your Data Entry. The software product notifies you when an error is detected and asks for a different Data Entry, so the software product performs within the proper technical bounds for the technology.

7.0   Customer Satisfaction:

Many thanks for purchasing our RF/microwave CAE software product. We hope you find the product useful in your high frequency designs, both in Synthesis of your designs and in Analysis of your designs. Please let us know where our software product can be improved, and what your needs are for another software product you could use. . . . .. perhaps we can develop that software product for you.

Our best regards. . . . .

AtlantaRF

6-Section 10dB Asymmetric TEM Coupler: 1.8 GHz to 18 GHz
Frequency Analysis by Software Product: TEMcoupler

Section i	Zoe(i) Ohms	Zoo(i) Ohms
1	87.72	28.500
2	74.10	33.738
3	64.79	38.586
4	58.52	42.720

(Plot: Reverse Coupling, dB vs Frequency, MHz)

```
TEMcoupler.DEF contains all Default Data values read by Program; TEMcoupler.exe
   5.0              :N      = Number of Coupled Sections in the Coupler
   50.0             :Zo     = Impedance level of the System…………Ohms
   2.3              :Er      = Relative Dielectric Constant of the Coupler
   51.6             :Zoe(1) = Even-Mode Impedance of Section 1.....Ohms
 6000.0             :Fo (1) = Center Frequency of Section 1.............MHz
   57.85            :Zoe(2) = Even-Mode Impedance of Section 2.....Ohms
 6000.0             :Fo (2)  = Center Frequency of Section 2............MHz
   94.51            :Zoe(3) = Even-Mode Impedance of Section 3.....Ohms
 6000.0             :Fo (3)  = Center Frequency of Section 3............MHz
   57.85            :Zoe(4) = Even-Mode Impedance of Section 4.....Ohms
 6000.0             :Fo (4)  = Center Frequency of Section 4............MHz
   51.6             :Zoe(5) = Even-Mode Impedance of Section 5.....Ohms
 6000.0             :Fo (5)  = Center Frequency of Section 5.............MHz
 1000.0             :Fstart  = Analysis Start Frequency.....................MHz
11000.0             :Fstop   = Analysis Stop  Frequency....................MHz
  500.0             :Fstep   = Analysis Step  Frequency....................MHz
TEMcoupler.DAT      :FN      = Default filename for your Output Data Storage
                     |
                     |____ The first 20 characters are read by TEMcoupler.exe
```

Default Data File: TEMcoupler.DEF is read by RF/microwave software product:
TEMcoupler.exe when you start the program. As such, the executable file
(TEMcoupler.exe) and this Default Data File (TEMcoupler.DEF) must be located
in the same Folder or Subfolder in your computer.

The executable program (TEMcoupler.exe) reads the first 20 characters in each
line from TEMcoupler.DEF, so keep those first 20 characters for data, and do
not shorten any line in this Default Data File: TEMcoupler.DEF.

The User is invited to change any/all data values in TEMcoupler.DEF to data
values that you commonly use for your RF/microwave designs of TEM-mode
multi-section Symmetric & Asymmetric Directional Coupler, so you do not have
to enter data values when prompted by TEMcoupler.exe (just press ENTER on
your computer's keyboard and your Default Data values will be assigned to
that data entry).

NOTE: The above default data is for a 5-section Symmetrical Directional
Coupler having a Coupling level = -8.34dB with Center Frequency, Fo = 6,000 MHz.

Thank you for choosing Atlanta RF for your RF/microwave CAE software products.

Figure 2-1: Baseline data entries (and Instructions) in **Default Data file**: TEMcoupler.DEF

Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
RF/Microwave Computer-Aided Engineering Software
Program: TEMcoupler (v. 1.0)   Date:10/24/2012

This program performs a Frequency ANALYSIS of N-Section Symmetrical
or Asymmetrical TEM-Mode Directional Couplers described by their
Even-Mode & Odd-Mode Impedances: Zoe & Zoo, with propagation in a
dielectrically-loaded medium, including air-line.

Please select a Program FUNCTION:
 *1: User enters the design parameters for the Coupler
  2: User enters a filename that contains the design parameters
      Program FUNCTION selected =

Please enter the following Design Data:
 -Number of Coupled Sections in Coupler, N= **3**
 -Impedance level of the System: Zo, Ohms = **50.0**
 -Relative Dielectric Constant in Coupler   = **2.3**
 -Even Mode: Zoe of Section 1, Ohms = **56.0**
 -Best Odd Mode: Zoo for Section 1 is : 44.643 Ohms
 -Gives Coupling level in Section 1 of   : 18.950 dB
 -Enter your Zoo in Section 1, Ohms = **44.0**
 -Center Frequency for Section 1, MHz = **5350.0**

 -Even Mode: Zoe of Section 2, Ohms = **107.0**
 -Best Odd Mode: Zoo for Section 2 is : 23.364 Ohms
 -Gives Coupling level in Section 2 of   :   3.855 dB
 -Enter your Zoo in Section 2, Ohms = **23.0**
 -Center Frequency for Section 2, MHz = **5350.0**

 -Even Mode: Zoe of Section 3, Ohms = **56.0**
 -Best Odd Mode: Zoo for Section 3 is : 44.643 Ohms
 -Gives Coupling level in Section 3 of   : 18.950 dB
 -Enter your Zoo in Section 3, Ohms = **44.0**
 -Center Frequency for Section 3, MHz = **5350.0**

 -Are Even/Odd Mode Phase Velocities Equal? (*1=YES) = **1**
 -Are Coupled Sections Lossless(=1*) or Lossy(=2)?= **1**

Enter Frequency Range for Analysis of Coupler:
 -Analysis Start Frequency, MHz = **1000.0**
 -Analysis Stop Frequency, MHz = **9500.0**
 -Analysis Step Frequency, MHz = **500.0**

 Select output data print FORMAT:
    1: Magnitude (dB) and Phase (Degrees) at each port.
   *2: VSWR, Losses (dB) and Phase Quadrature.
 Print FORMAT selected = **2**

 Is Output Data STORAGE desired? (1=YES) = **1**
 Enter a FILENAME (up to 20 characters) for Output Data storage:
   -Enter: Filename.xls for storage in a spreadsheet
   -Enter: Filename.doc for storage in a word processor
   -Enter: Filename.txt for storage as a text document
    Enter your FILENAME for Output Data Storage: **TEMcoupler3sec.DAT**

> User Data
> Entries are
> shown in
> **RED text**

> 3-section 6dB
> Symmetrical
> Directional
> Coupler

Figure 3-1: Typical Input Data entry for **Frequency Analysis** in TEMcoupler.exe

Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
RF/Microwave Computer-Aided Engineering Software
Program: TEMcoupler (v. 1.0)   Date:10/24/2012

This program performs a Frequency ANALYSIS of N-Section Symmetrical
or Asymmetrical TEM-Mode Directional Couplers described by their
Even-Mode & Odd-Mode Impedances: Zoe & Zoo, with propagation in a
dielectrically-loaded medium, including air-line.

Please select a Program FUNCTION:
 *1: User enters the design parameters for the Coupler
  2: User enters a filename that contains the design parameters
      Program FUNCTION selected = **1**

Please enter the following Design Data:
  -Number of Coupled Sections in Coupler, N= **3**
  -Impedance level of the System: Zo, Ohms = **50.0**
  -Relative Dielectric Constant in Coupler = **2.3**
  -Even Mode: Zoe of Section 1,   Ohms = **111.**
  -Best Odd Mode: Zoo for Section 1 is   : 22.523 Ohms
  -Gives Coupling level in Section 1 of   : 3.574 dB
  -Enter your Zoo in Section 1,   Ohms = **22.0**
  -Center Frequency for Section 1,   MHz = **5000.0**

  -Even Mode: Zoe of Section 2,   Ohms = **69.**
  -Best Odd Mode: Zoo for Section 2 is   : 36.232 Ohms
  -Gives Coupling level in Section 2 of   : 10.134 dB
  -Enter your Zoo in Section 2,   Ohms = **36.**
  -Center Frequency for Section 2,   MHz = **5000.0**

  -Even Mode: Zoe of Section 3,   Ohms = **54.**
  -Best Odd Mode: Zoo for Section 3 is   : 46.296 Ohms
  -Gives Coupling level in Section 3 of   : 22.292 dB
  -Enter your Zoo in Section 3,   Ohms = **46.**
  -Center Frequency for Section 3,   MHz = **5000.0**

  -Are Even/Odd Mode Phase Velocities Equal? (*1=YES) = **1**
  -Are Coupled Sections Lossless(=1*) or Lossy(=2)?= **1**

 Enter Frequency Range for Analysis of Coupler:
  -Analysis Start Frequency, MHz = **1000**
  -Analysis Stop Frequency, MHz = **10000**
  -Analysis Step Frequency, MHz = **500**

  Select output data print FORMAT:
      1: Magnitude (dB) and Phase (Degrees) at each port.
     *2: VSWR, Losses (dB) and Phase Quadrature.
  Print FORMAT selected = **1**

  Is Output Data STORAGE desired? (1=YES) = **1**
  Enter a FILENAME (up to 20 characters) for Output Data storage:
    -Enter: Filename.xls for storage in a spreadsheet
    -Enter: Filename.doc for storage in a word processor
    -Enter: Filename.txt for storage as a text document
     Enter your FILENAME for Output Data Storage: **TEMcup3secAsym.DAT**

> User Data
> Entries are
> shown in
> **RED text**

> 3-Section
> Asymmetrical
> Directional
> Coupler

Figure 3-2: Typical Input Data entry for **Frequency Analysis** in TEMcoupler.exe

```
---------------------------------------------------------------------------------------------
TEMcoupler (v. 1.0)                    Date:10/24/2012 at  8:56:14Hours
          Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
          RF/Microwave Computer-Aided Engineering Design Data For
                  N-Section TEM-Mode Directional Couplers:

          The following Analysis is for a  3-Section TEM-Mode
           Directional Coupler with Input at Port 1. All Phase
          Angles are in Degrees. The Coupled, Isolated and Loss
           values are in Decibels.
```

Coupled Section I	Impedances Zoe(I) Ohms	Zoo(I) Ohms	Phase Velocity Even Mode	Odd Mode	Loss,dB/In Even Mode	Odd Mode	Length(I) Inches
1	56.000	44.000	1.000	1.000	0.000	0.000	0.3639
2	107.000	23.000	1.000	1.000	0.000	0.000	0.3639
3	56.000	44.000	1.000	1.000	0.000	0.000	0.3639

Frequency Response of your Directional Coupler:

Frequency (MHZ)	Port 1 VSWR	Port 2 Coupled	Port 3 Isolated	Port 4 - Loss	*PHI2 - *PHI4,Deg	*Deviation* *from 90deg
1000.000	1.011	10.78	53.45	0.379	90.00	-0.002
1500.000	1.013	8.20	51.27	0.713	90.00	-0.001
2000.000	1.012	6.83	50.29	1.011	90.00	0.001
2500.000	1.009	6.13	49.93	1.214	90.00	0.001
3000.000	1.006	5.84	49.91	1.311	90.00	0.001
3500.000	1.004	5.82	50.09	1.318	90.00	0.000
4000.000	1.005	5.96	50.40	1.272	90.00	0.001
4500.000	1.008	6.14	50.73	1.210	90.00	0.001
5000.000	1.010	6.28	50.97	1.166	90.00	0.001
5500.000	1.010	6.31	51.01	1.158	90.00	0.000
6000.000	1.009	6.21	50.84	1.189	90.00	0.001
6500.000	1.006	6.03	50.54	1.247	90.00	0.001
7000.000	1.004	5.86	50.21	1.304	90.00	0.000
7500.000	1.005	5.81	49.96	1.322	90.00	-0.001
8000.000	1.008	5.97	49.89	1.265	90.00	-0.002
8500.000	1.011	6.49	50.09	1.105	90.00	-0.001
9000.000	1.013	7.55	50.78	0.841	90.00	0.000
9500.000	1.012	9.54	52.37	0.512	90.00	0.001

```
   Total Length of Coupler =   1.092 Inches in Er = 2.300
---------------------------------------------------------------------------------------------
 Output Data stored in User filename: TEMcoupler-3sec.DAT
```

Figure 4-1: Typical Output Data for **Frequency Analysis** from TEMcoupler.exe
(3-Section 6dB Symmetrical Directional Coupler)

```
---------------------------------------------------------------------------------------
TEMcoupler (v. 1.0)                    Date:10/24/2012 at  9:49:27Hours
        Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
        RF/Microwave Computer-Aided Engineering Design Data For
           N-Section TEM-Mode Directional Couplers:

      The following Analysis is for a  3-Section TEM-Mode
       Directional Coupler with Input at Port 1. All Phase
       Angles are in Degrees. The Coupled, Isolated and Loss
       values are in Decibels.

   Coupled      Impedances     Phase Velocity   Loss,dB/In
   Section    Zoe(I)   Zoo(I)   Even   Odd    Even   Odd   Length(I)
     I        Ohms     Ohms    Mode   Mode   Mode   Mode   Inches
  ------------ ------------ ------------ --------- --------- ---------- --------- -----------
     1       111.000   22.000  1.000  1.000  0.000 0.000  0.3894
     2        69.000   36.000  1.000  1.000  0.000 0.000  0.3894
     3        54.000   46.000  1.000  1.000  0.000 0.000  0.3894

              Frequency Response of your Directional Coupler:
 Frequency    Port 1            Port 2           Port 3          Port 4
  (MHz)   VSWR   Phase  Coupled Phase  Isolated  Phase   Loss    Phase
 ----------------------------------------------------------------------------------------
  1000.000  1.01  -141.10   9.065  52.82   50.85   -10.29  0.575   -59.08
  1500.000  1.01  -157.61   6.926  38.23   49.58   -52.78  0.985   -86.01
  2000.000  1.01  -166.53   6.013  26.60   49.59   -89.12  1.252  -111.77
  2500.000  1.01  -166.90   5.745  17.80   50.06  -118.55  1.345  -137.31
  3000.000  1.01  -159.91   5.804  11.73   50.03  -141.59  1.324  -163.29
  3500.000  1.01  -154.91   5.930   8.02   48.85  -165.10  1.280   170.15
  4000.000  1.01  -158.51   5.951   5.54   47.26   164.46  1.273   143.31
  4500.000  1.02  -168.10   5.877   3.00   46.14   128.41  1.299   116.56
  5000.000  1.02   180.00   5.832   0.00   45.76    90.00  1.315    90.00
  5500.000  1.02   168.10   5.877  -3.00   46.14    51.59  1.299    63.44
  6000.000  1.01   158.51   5.951  -5.54   47.26    15.54  1.273    36.69
  6500.000  1.01   154.91   5.930  -8.02   48.85   -14.91  1.280     9.85
  7000.000  1.01   159.91   5.804 -11.73   50.03   -38.41  1.324   -16.71
  7500.000  1.01   166.90   5.745 -17.80   50.06   -61.45  1.345   -42.69
  8000.000  1.01   166.53   6.013 -26.60   49.59   -90.88  1.252   -68.23
  8500.000  1.01   157.61   6.926 -38.23   49.58  -127.22  0.985   -93.99
  9000.000  1.01   141.11   9.065 -52.82   50.84  -169.71  0.575  -120.92
  9500.000  1.01   117.80  14.091 -70.38   55.20   142.10  0.173  -149.69
 10000.000  1.00   -90.00 138.810  90.00  179.66   -90.00  0.000   180.00

    Total Length of Coupler =   1.168 Inches in Er = 2.300
 ---------------------------------------------------------------------------------------
 Output Data stored in User filename: TEMcup3secAsym.DAT
```

Figure 4-2: Typical Output Data for **Frequency Analysis** from TEMcoupler.exe
(3-Section 6dB Asymmetrical Directional Coupler)

```
6-section 10dB Asymmetrical Coupler: 1.8 GHz to 18 GHz with +/-0.3dB ripple
   6.0             :N        = Number of Coupled Sections in the Coupler
   50.0            :Zo       = Impedance level of the System………..Ohms
   5.9             :Er       = Relative Dielectric Constant of the Coupler
   87.72           :Zoe(1)   = Even-Mode Impedance of Section 1.....Ohms
  9900.0           :Fo (1)   = Center Frequency of Section 1.............MHz
   74.1            :Zoe(2)   = Even-Mode Impedance of Section 2.....Ohms
  9900.0           :Fo (2)   = Center Frequency of Section 2.............MHz
   64.79           :Zoe(3)   = Even-Mode Impedance of Section 3.....Ohms
  9900.0           :Fo (3)   = Center Frequency of Section 3.............MHz
   58.52           :Zoe(4)   = Even-Mode Impedance of Section 4.....Ohms
  9900.0           :Fo (4)   = Center Frequency of Section 4............MHz
   54.44           :Zoe(5)   = Even-Mode Impedance of Section 5.....Ohms
  9900.0           :Fo (5)   = Center Frequency of Section 5............MHz
   51.92           :Zoe(6)   = Even-Mode Impedance of Section 5.....Ohms
  9900.0           :Fo (6)   = Center Frequency of Section 5.............MHz
  1000.0           :Fstart   = Analysis Start Frequency.....................MHz
 19000.0           :Fstop    = Analysis Stop  Frequency……………...MHz
  500.0            :Fstep    = Analysis Step  Frequency……………...MHz
 TEMcoupler.DAT    :FN       = Default filename for your Output Data Storage
                   |
                   |____ The first 20 characters are read by TEMcoupler.exe


 Thank you for choosing Atlanta RF for your RF/microwave CAE software products.
```

Figure 5-1: Typical **User Input Data File** (for a 6-section 10dB Asymmetrical Coupler).