Quick Start User Manual: Lange

Actual 4-finger Interdigitated (Lange) Microstrip Coupler
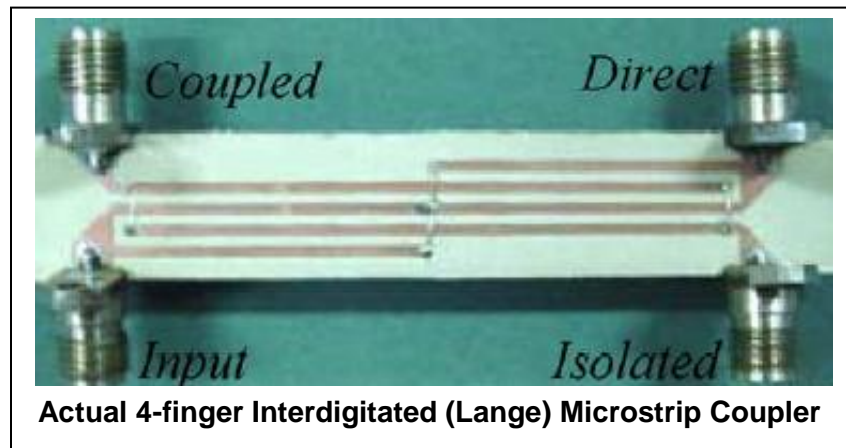
1.0 Getting Ready:

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. *Lange.exe*: The executable software product.
   b. *Lange.DEF*: Default Data File read by *Lange.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: *Lange.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: *Lange.exe* performs Electrical Synthesis, Dimensional Synthesis and Frequency Analysis of 4-finger or 6-finger Interdigitated (Lange-type) Microstrip Directional Couplers.

The executable file: *Lange.exe* reads the Default Data File: *Lange.DEF* each time you start the program. As such, you can change Data Entries inside *Lange.DEF* to suite your most common Interdigitated (Lange) Microstrip Coupler designs, using the guidelines written in *Lange.DEF*.

When you start using the software product, you are asked to enter key design parameters for your Interdigitated (Lange) Microstrip Coupler. If you press <ENTER> on your computer's keyboard, the software product uses the Data Entry from your Default Data File: *Lange.DEF* for that design parameter. As such, you can change any/all Data Entries in *Lange.DEF* to suite your most common Interdigitated (Lange) Microstrip Coupler designs, without having to enter those values when asked by the executable file: *Lange.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: Lange.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 Synthesis and for your Analysis of the Microstrip 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 Figures 3-1 and Figure 3- 2 for Dimensional Synthesis and for Frequency Analysis of your Interdigitated (Lange) Microstrip Directional 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 Dimensional Synthesis and for Frequency Analysis of your Interdigitated (Lange) Microstrip Directional 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 physical dimensions planned for manufacture of your Interdigitated (Lange) Microstrip Directional Coupler.

You can create any number of User Input Data files, each of which defines the actual physical dimensions of your Interdigitated (Lange) Microstrip 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.

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

Coupling dB	Coupling Numeric	Zoe Ohms	Zoo Ohms
-3.01	0.7400778	129.37	19.32
-4.77	0.6206425	103.34	24.19
-6.02	0.5477151	92.49	27.03
-8.34	0.4343086	79.62	31.40
-9.03	0.4053518	76.87	32.52
-10.00	0.3678794	73.55	33.99
-12.00	0.3011942	68.23	36.64
-14.00	0.246597	64.32	38.87
-16.00	0.2018965	61.36	40.74
-18.00	0.1652989	59.08	42.32
-20.00	0.1353353	57.29	43.63
-22.00	0.1108032	55.88	44.74
-24.00	0.090718	54.76	45.65
-26.00	0.0742736	53.86	46.41
-28.00	0.0608101	53.14	47.05
-30.00	0.0497871	52.55	47.57
-40.00	0.0183156	50.92	49.09
-50.00	0.0067379	50.34	49.66
-60.00	0.0024788	50.12	49.88

Lange.DEF contains all Default Data values read by Program: Lange.exe
```
  0.0005          :DLTAN = Substrate's Dielectric Loss Tangent
 10.0             :Er       = Substrate's Relative Dielectric Constant
 10.0             :F        = Frequency .........................................GHz
 12.0             :Fmax   = Maximum Frequency for Analysis ....GHz
  8.0             :Fmin   = Minimum Frequency for Analysis …..GHz
  0.2             :Fstep  = Analysis Frequency Step Size .........GHz
  0.025           :H       = Substrate's Dielectric Thickness…....Inches
 -3.0103          :Co      = Desired Midband Coupling level.......dB
  0.1219          :L        = Length of Coupled Section..............Inches
  4.0             :N       = Number of Coupled Strips (= 4.0 or 6.0)
  2.8             :RES    = Conductor's Resisitivity....................Micro-Ohm-cm
 32.0             :SR      = Conductor's Surface Roughness…....Micro-inches
 50.0             :RI       = Load Termination ...........................Ohms
 50.0             :Rs      = Source Termination .........................Ohms
  0.0021          :S        = Spacing between Coupled lines….....Inches
  0.02            :Smax   = Maximum Strip Spacing ...................Inches
  0.001           :Smin   = Minimum Strip Spacing ....................Inches
  0.001           :Sstep  = Strip Spacing Step Size ...................Inches
  0.0003          :T        = Center Conductor's Strip Thickness...Inches
  0.0013          :W       = Center Conductor's Strip Width.........Inches
  0.005           :Wmax   = Maximum Strip Width......................Inches
  0.001           :Wmin   = Minimum Strip Width.......................Inches
  0.0005          :Wstep  = Strip Width Step Size.......................Inches
 50.0000          :Zo      = Coupler's Impedance Level..............Ohms
120.7107          :Zoe     = Coupler's Even Mode Impedance…...Ohms
 20.7107          :Zoo     = Coupler's Odd  Mode Impedance…...Ohms
LANGE.DAT        :FN      = Default filename for your Output Data Storage
                 |
                 |____ The first 20 characters are read by Lange.exe
```

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

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

The User is invited to change any/all data values in Lange.DEF to data values
you commonly use for your RF/microwave designs of interdigitated Lange-type
Couplers, so you do not have to enter data values when prompted by Lange.exe
(just press ENTER on your computer's keyboard and your Default Data values
will be assigned to that data entry).

NOTE: The default data values shown above are for 4-strip 3dB Lange Coupler.

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**: Lange.DEF

Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
RF/Microwave Computer-Aided Engineering Software
Program: Lange (v. 1.0)   Date:10/22/2012

This program performs Impedance ANALYSIS, Dimensional SYNTHESIS and
Frequency RESPONSE for Microstrip Interdigitated (Lange) Couplers.

Please select a Program FUNCTION:
   *1 : ANALYSIS of Impedances from known Dimensions.
    2 : SYNTHESIS of Dimensions from known Impedances.
Program FUNCTION selected = **2**

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

Please select a Synthesis OPTION:
  *Option 1: Synthesis of S and W from D.C. Impedances.
   Option 2: Synthesis of S and W from Dispersive Impedances.
Synthesis OPTION selected = **2**

Please select a Synthesis SUBOPTION:
  *Suboption 1: Synthesis of S and W from Zo and Coupling.
   Suboption 2: Synthesis of S and W from Zoe and Zoo.
Synthesis SUBOPTION selected = **1**

Please enter the following DIMENSIONAL DATA:
   -Substrate`s Dielectric Thickness   (H), Inches = **0.025**
   -Center Conductor`s Strip Thickness (T), Inches = **0.0003**
   -Substrate`s Relative Dielectric Constant   (Er) = **10.0**
   -Number of Coupled Strips in Coupler, (N=4 or 6) = **4**
   -Frequency for Synthesis (F), GHz = **10.0**
   -Impedance of Coupler (Zo),Ohms = **50.0**
   -Midband Coupling Factor (Co), dB = **3.0103**
   -Even Mode Impedance(Zoe>Zo),Ohms = 120.71
   -Odd Mode Impedance   (Zoo),Ohms =   20.71
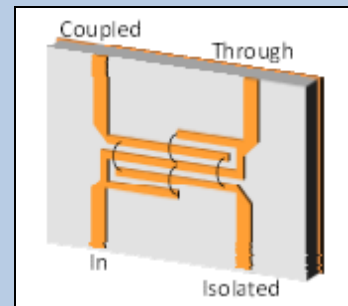
Is Output Data STORAGE desired? (1=YES) = **1**
Enter a FILENAME (up to 20 characters) for Output Data storage:
   -Enter: Filename.xls for storage in a spreadsheet
   -Enter: Filename.doc for storage in a word processor
   -Enter: Filename.txt for storage as a text document
   Enter your FILENAME for Output Data Storage: **Lange-SYN.DAT**

Figure 3-1: Typical Input Data entry for **Dimensional Synthesis** in Lange.exe

Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
RF/Microwave Computer-Aided Engineering Software
Program: Lange (v. 1.0)   Date:10/22/2012

This program performs Impedance ANALYSIS, Dimensional SYNTHESIS and
Frequency RESPONSE for Microstrip Interdigitated (Lange) Couplers.

Please select a Program FUNCTION:
   *1 : ANALYSIS of Impedances from known Dimensions.
    2 : SYNTHESIS of Dimensions from known Impedances.
Program FUNCTION selected = **1**

Please select an Analysis OPTION:
   *Option 1: Impedance   Analysis from Strip Dimensions.
    Option 2: Frequency   Analysis of Coupler.
    Option 3: Sensitivity Analysis of Coupler Impedances.
 Analysis OPTION selected = **2**

Select Frequency Analysis SUBOPTION:
   *Suboption 1: Four port Coupler Response.
    Suboption 2: Dispersion of Cross section.
Frequency Analysis SUBOPTION selected = **2**

Select to enter(=1) or Compute(=2*) Coupler Length: **2**

Please enter the following DIMENSIONAL DATA:
   -Substrate`s Dielectric Thickness   (H), Inches = **0.025**
   -Strip Width of Coupled Strips   (W), Inches = **0.0013**
   -Center Conductor`s Strip Thickness   (T), Inches = **0.0003**
   -Spacing/Gap between Coupled Strips(S), Inches = **0.0021**
   -Conductor`s Resistivity (RES),   Mico-Ohm-cm = **2.8**
   -Conductor`s Surface Roughness (SR),Micro-Inch = **32.0**
   -Substrate`s Relative Dielectric Constant (Er)   = **10.0**
   -Substrate`s Dielectric Loss Tangent   (DLTAN)   = **0.0005**
   -Number of Coupled Strips in Coupler, (N=4 or 6) = **4**

Please enter Frequency Range:
   -Analysis Start Frequency, GHz = **8.0**
   -Analysis Stop Frequency, GHz = **12.0**
   -Analysis Step Frequency, GHz = **0.2**
   -Design Center Freq. (Fo), GHz = **10.0**
   -Length of Coupler (L), Inches = 0.1215

Enter Load and Source Terminations:
   -Source Termination (Rs), Ohms = **50.0**
   -Load   Termination (Rl), Ohms = **50.0**

Select output data print FORMAT:
   *1: Magnitude (dB) and Phase (Degrees) at each port.
    2: VSWR, Losses (dB) and Phase Quadrature.
Print FORMAT selected = **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
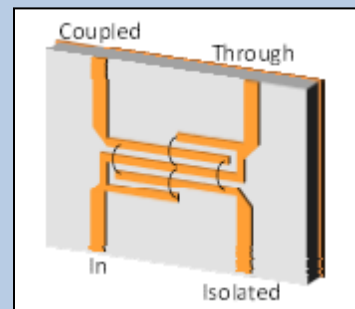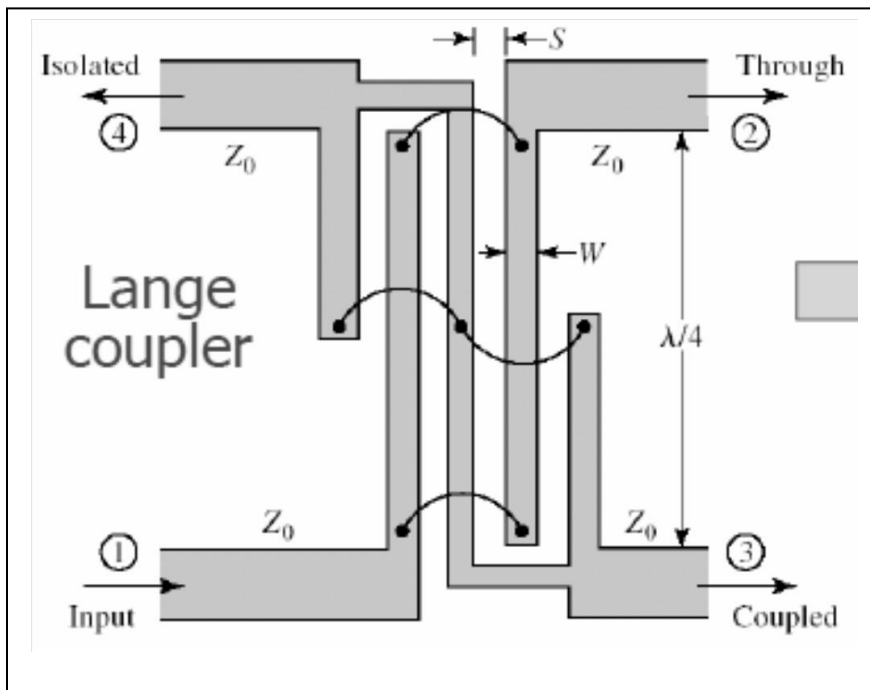   Enter your FILENAME for Output Data Storage: **Lange-ANA.DAT**

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

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

```
--------------------------------------------------------------------------------------------
Lange (v. 1.0)                              Date:10/22/2012 at 21:29:47Hours
             Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
             RF/Microwave Computer-Aided Engineering Design Data For
                  Microstrip Interdigitated (Lange) Couplers:

     Er = 10.00        Strip Width and Spacing Synthesis      H = 0.0250"
     N = 4 Strips      ============================          T =.000300"
                              (Option 2.1)


                            Dispersive Impedances
            Strip Dimensions  --------------------------------        Dispersive
            --------------------------   Even    Odd   Midband  Effective Er
    Fre-      Width   Spacing Coupler  Mode    Mode  Coupling -------------------
    quency     W        S       Zo      Zoe     Zoo     Co     Even   Odd
    (GHz)    (In.)    (In.)   (Ohms)  (Ohms)  (Ohms)  (dB)    Mode   Mode
--------------------------------------------------------------------------------------------
   10.0000  0.00130  0.00213  50.00   120.71   20.71  -3.010   6.55   5.37
--------------------------------------------------------------------------------------------
Output data stored in User filename: Lange-SYN.DAT

Interdigitated Coupler calculations completed. Select next OPERATION:
      1. Select new OPTION.
      2. RECYCLE and CONTINUE.
     *3. EXIT to operating system.
OPERATION selected =
```

Figure 4-1: Typical Output Data for **Dimensional Synthesis** from Lange.exe

```
-----------------------------------------------------------------------------------------
Lange (v. 1.0)                               Date:10/22/2012 at 21:11: 9Hours
           Copyright 2012 Atlanta RF Software (www.AtlantaRF.com)
           RF/Microwave Computer-Aided Engineering Design Data For
                  Microstrip Interdigitated (Lange) Couplers:

 DLTAN =.00050           Frequency Analysis         N = 4 Strips
   RES = 2.800           ====================        H = 0.0250"
     SR = 32.00u"            (Option 2.1)            W = 0.0013"
     Rs = 50.00 Ohms                                 S = 0.0021"
     Rl = 50.00 Ohms    Design Center Frequency,     L = 0.1215"
     Er = 10.00             Fo = 10.0000 GHz         T =.000300"

                    Baseline Coupler Parameters:
```

		Effective Dielectric Constants		Impedances in Ohms		
Frequency (GHz)	Even Mode	Odd Mode	Coupler	Even Mode Zoe	Odd Mode Zoo	Coupler Zo
0.0000	6.33	5.37	5.81	119.87	20.84	49.98
10.0000	6.55	5.37	5.90	120.78	20.63	49.91

```
          The above baseline coupler parameters yield the
          following frequency response:
```

	Port One Reflected		Port Two Coupled		Port Three Isolated		Port Four Thru Path	
Analysis Frequency (GHz)	Amplitude (dB)	Phase (Degrees)	Amplitude (dB)	Phase (Degrees)	Amplitude (dB)	Phase (Degrees)	Amplitude (dB)	Phase (Degrees)
8.0000	-30.3	-57.4	-3.399	12.7	-29.6	-170.8	-2.875	-76.9
8.2000	-30.1	-60.2	-3.356	11.4	-29.5	-171.3	-2.915	-78.3
8.4000	-29.9	-63.0	-3.318	10.1	-29.4	-171.6	-2.952	-79.6
8.6000	-29.8	-65.7	-3.286	8.8	-29.3	-172.0	-2.984	-81.0
8.8000	-29.6	-68.5	-3.259	7.5	-29.1	-172.3	-3.012	-82.3
9.0000	-29.4	-71.2	-3.237	6.2	-29.0	-172.6	-3.037	-83.6
9.2000	-29.2	-73.9	-3.220	4.9	-28.8	-172.8	-3.056	-85.0
9.4000	-29.0	-76.6	-3.207	3.6	-28.6	-173.0	-3.072	-86.3
9.6000	-28.8	-79.3	-3.199	2.3	-28.4	-173.2	-3.083	-87.6
9.8000	-28.6	-82.0	-3.196	1.0	-28.2	-173.4	-3.091	-88.9
10.0000	-28.4	-84.7	-3.198	-0.3	-28.0	-173.5	-3.094	-90.2
10.2000	-28.2	-87.4	-3.204	-1.6	-27.8	-173.7	-3.092	-91.6
10.4000	-28.0	-90.1	-3.215	-2.8	-27.6	-173.9	-3.087	-92.9
10.6000	-27.7	-92.8	-3.230	-4.1	-27.3	-174.1	-3.077	-94.2
10.8000	-27.5	-95.5	-3.251	-5.4	-27.1	-174.3	-3.063	-95.6
11.0000	-27.3	-98.3	-3.277	-6.7	-26.8	-174.6	-3.044	-96.9
11.2000	-27.0	-101.0	-3.308	-8.0	-26.5	-174.9	-3.022	-98.3
11.4000	-26.8	-103.8	-3.344	-9.3	-26.2	-175.2	-2.995	-99.6
11.6000	-26.5	-106.6	-3.385	-10.6	-25.9	-175.6	-2.965	-101.0
11.8000	-26.3	-109.4	-3.433	-12.0	-25.5	-176.1	-2.930	-102.4
12.0000	-26.0	-112.2	-3.486	-13.3	-25.2	-176.6	-2.891	-103.8

```
Output data stored in User filename: Lange-ANA.DAT
```

Figure 4-2: Typical Output Data for **Frequency Analysis** from Lange.exe