

MARTHA

MARTHA

MARTHA

Computer

MARTHA

Aided

MARTHA

Circuit

MARTHA

Design

MARTHA

# ▽N←NETWORK

N←(WP C 7E-6)WC(WS L .015)WC(WP C

**MARTHA is convenient**—as convenient as a local telephone call from your own terminal—as convenient as possible in describing networks and requesting output.

**MARTHA is easy**—you don't have to be a programmer—get useful results within minutes of your *very first* introduction.

**MARTHA is fast**—log on and off in a hurry for short jobs.

**MARTHA is versatile**—it is imbedded in a versatile general-purpose conversational language—it is limited only by your imagination, not by the tasks the author thought you would want.

**MARTHA is extendable**—make your own collection of elements, models, and networks—write your own programs to work with MARTHA—write your own programs to define new elements—write your own programs to make use of the results produced by MARTHA.

**MARTHA is forgiving**—helpful error messages—easy recovery from errors.

## Use MARTHA to analyze

Low-frequency and audio circuits  
RF and video circuits  
VHF and UHF circuits  
Microwave circuits  
Passive lumped filters  
Distributed filters  
Active filters  
Amplifiers—audio, i.f., r.f., video, microwave  
Feedback systems  
Waveguide-beyond-cutoff filters  
Mixers  
Matching networks

## Use MARTHA to

Compare a tentative design with desired response.  
Compare a tentative model with measured data.  
Show feasibility of your design.  
Document your proposals, using MARTHA's attractive plots and prints.  
Simulate your circuit before you spend money to build it.  
Check the effects of parameter variations and tolerances.

**What is MARTHA?** MARTHA is a set of cooperating computer programs that analyze electrical networks.

**What kinds of circuits does MARTHA handle?** Linear circuits that have an input and an output, and for which, at every stage, the wiring consists of connections of two-port subnetworks. This includes most filters, amplifiers, and microwave networks, even with feedback and parallel paths, with various kinds of side branches. Also, one-port (i.e., two-terminal linear circuits).

**How large a network can MARTHA handle?** The maximum size depends on many factors, including how the network is defined, the exact topology, the number of sections that are used repeatedly, the number of frequencies used, and the workspace size. There are no arbitrary limits on network size, and networks of some sorts can have thousands of nodes and elements.

**What will MARTHA tell me about my circuit?** Using MARTHA, you can get any of several dozen steady-state response functions, including driving-point impedances, admittances, and reflection coefficient; two-port parameters such as impedance, admittance, and scattering matrices; VSWR, insertion gain, etc. These, or their real or imaginary parts, magnitude, or phase, can be printed, or plotted as a function of frequency or any circuit parameter. Any response can be plotted against any other response, and a wide variety of plot formats is available, including linear and logarithmic scales. More than one network can be analyzed at once, and both results plotted together (or, in fact, one plotted against another).

**Is MARTHA good for low-frequency circuits?** MARTHA is not inherently better at one frequency range than another, except perhaps in its repertoire of elements and response functions. MARTHA includes, besides R, L, and C, sixteen controlled sources; operational amplifiers; mutual inductance; three transistor models and the possibility of easily creating others; ideal transformers; several composite pi and tee structures; and a few exotic elements such as gyrators. Among the outputs that would be useful at lower frequencies are the two-port Z, Y, H, G, and ABCD matrices, all the usual driving-point parameters (input and output impedance and admittance), as well as various power gains or losses (transducer gain, insertion gain, available gain, etc.).

**Is MARTHA good for high-frequency circuits?** MARTHA has several microwave elements, including TEM transmission lines, waveguides, attenuators, and isolators. The lines and waveguides can be described in three different general ways—in terms of electrical properties (characteristic impedance, cutoff frequency, etc.); or in terms of physical dimensions (such as inner and outer radii of a coax line, or width and thickness of microstrip); or in terms of part numbers (e.g., the EIA waveguide classifications). The lines and guides can include dielectric loading, and the length can be specified either as so many meters long, or as so many degrees (or wavelengths) at some frequency. The responses of interest to microwave engineers include reflection coefficients, scattering and related matrices, and VSWR. Empirical data can be typed in and made a part of a network.

**All this in one program?** These features are available, now, in MARTHA and its library.

**What is this library you mentioned?** MARTHA is very versatile, and there is no logical end to the types of special-purpose programs which can be written. Included are special-purpose response functions, or special formats for the output, or unusual elements. So many have been written and debugged so far that they won't all fit together for lack of space, and besides not everyone would want all of them. They are available in a special MARTHA library and you can get whichever ones you want, on demand. The library is open-ended and can be expanded as time goes by. Look for specialized models and synthesis algorithms in the future.

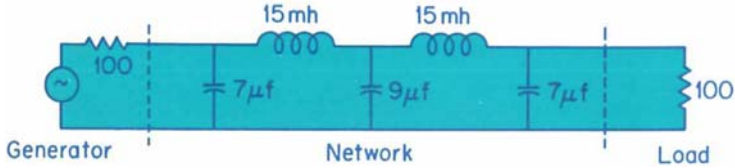
# 9E-6)WC(WS L .015)WC(WP C 7E-6)

**I don't know any programming. Can I still use MARTHA?** Yes. MARTHA is imbedded in a general-purpose programming language, APL, but is designed in such a way that the user does not need to program. If you can find the right keys on a typewriter, then you can use MARTHA.

**I know how to program already. Will that help me in using MARTHA?** Yes, but only for the more advanced applications. Because MARTHA is imbedded in APL, it is extremely versatile, and can itself be extended with relative ease. Perhaps you have some unusual devices, or a different form of output in mind, or wish to calculate with the results rather than simply print or plot them. You can write programs in APL to work with MARTHA to do any of these things.

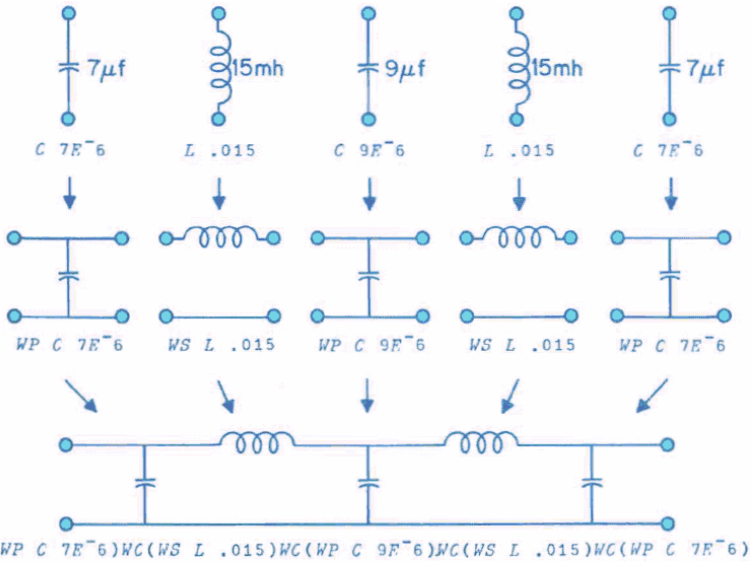
**Can my technician use MARTHA?** Yes, you don't have to be an engineer to use MARTHA. Networks are described in MARTHA in a manner similar to the way a technician would breadboard them. **MARTHA does analysis. Can it also do synthesis?** No, not in general. As you probably know, only a small fraction of practical design problems have been solved as a synthesis technique. If you want to use a synthesis algorithm that is not in the library, it is probably not difficult to program it, provided it is already known.

To analyze this network with –



is as simple as A–B–C ...

- A. Ask for your generator and load resistances  $Z_G$  and  $Z_L$ , and frequency sweep  $F$ .
- B. Build the network up from its elements –



- C. Command the output you want--for example the insertion gain expressed in dB, or magnitude and phase of the input impedance.

Here's how it looks:

```

A      ZG=100
      ZL=100
      F=200,400,600,800,1000,1200,1400,1600,1800,2000

[1]    ?N=NETWORK
[2]    N=(WP C 7E-6)WC(WS L .015)WC(WP C 9E-6)WC(WS L .015)WC(WP C 7E-6)
      ?
C      PRINT ZIN, MAG ZIN, DEG ZIN, DB IG OF NETWORK
    
```

YOU DO THIS

CIRCUIT ANALYSIS BY MARTHA. 71\*A 6/25/71 10:54

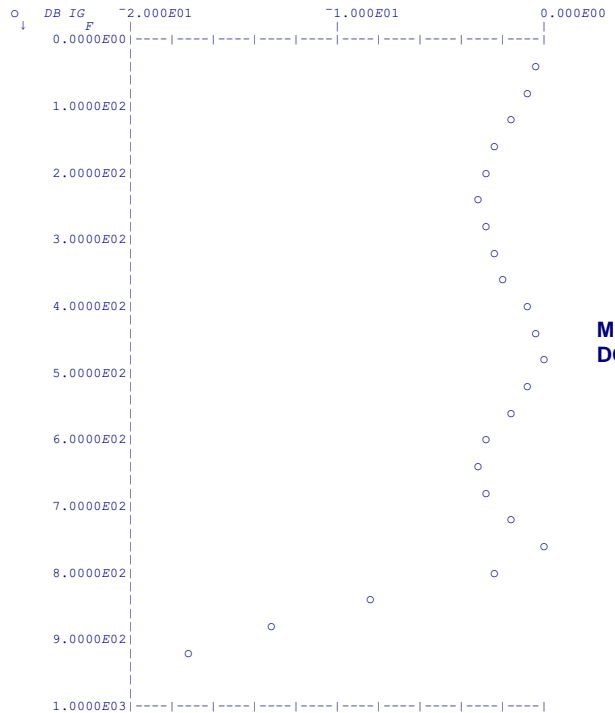
F	RE ZIN	IM ZIN	MAG ZIN	DEG ZIN	DB IG
2.0000E02	1.8783E01	-1.7671E01	2.5789E01	-4.3252E01	-2.8318E00
4.0000E02	4.0744E01	-2.5226E01	4.7921E01	3.1763E01	-9.8468E-01
6.0000E02	2.3609E01	-4.4737E01	5.0584E01	-6.2178E01	-2.6242E00
8.0000E02	4.3381E01	-1.0357E02	1.1229E02	-6.7273E01	-2.5598E00
1.0000E03	1.1247E-01	-3.3464E01	3.3465E01	-8.9807E01	-2.3939E01
1.2000E03	7.1485E-03	-2.3627E01	2.3627E01	-8.9983E01	-3.5674E01
1.4000E03	9.7871E-04	-1.8838E01	1.8838E01	-8.9997E01	-4.4224E01
1.6000E03	1.9874E-04	-1.5831E01	1.5831E01	-8.9999E01	-5.1104E01
1.8000E03	5.1841E-05	-1.3720E01	1.3720E01	-9.0000E01	-5.6914E01
2.0000E03	1.6133E-05	-1.2138E01	1.2138E01	-9.0000E01	-6.1966E01

MARTHA DOES THIS

```

F=40*123
PLOT DB IG OF NETWORK
    
```

CIRCUIT ANALYSIS BY MARTHA. 71\*A 6/25/71 10:55



MARTHA DOES THIS

**My job involves modeling. Can MARTHA devise models for me?**

MARTHA *can* provide a quick, convenient way of testing a proposed model, then you can modify it on the spot, test it again, etc. But the modeling job is still yours. Measured performance can be typed in and compared with the performance of the model.

**My job is circuit design. Can MARTHA do my design for me?**

MARTHA *can* predict the performance of a proposed design, and allow you to modify it immediately and try again. The desired performance can be stored in the form of an empirical function, and MARTHA can compare this with your design. A sweep with respect to a circuit parameter is often helpful, and MARTHA can do this with ease. But the circuit design is, and will remain, yours.

**Is MARTHA expensive to use?** Considering the cost of an engineer's time it saves, MARTHA will probably pay for itself every single time it is used. Computer simulation is usually cheaper than breadboarding, provided the programs already exist and are debugged, and are user-oriented and easy to use (like MARTHA), and provided the models used are good enough.

**How can I use MARTHA?** To use MARTHA, you need three things.

1. A user's manual. 2. A circuit to be analyzed. 3. Access to a time-sharing computer service that carries MARTHA. The manual you can buy at a bookstore, or directly from the MIT Press. The circuit problem you supply yourself. Contact your local time-sharing company that offers APL to see whether or not they carry MARTHA. If not, they can get it from APL General.

**I have some devices that do not correspond to any circuit with common lumped or distributed elements. One is an IMPATT diode, and another is an antenna radiation resistance. I know the formulas all right. Can I use MARTHA?**

Yes, provided you are able to program the formulas in APL. Provision is made in MARTHA for as many user-defined elements as you require.

**I am a college teacher. Should I have my students use MARTHA?**

Whether your students should use MARTHA depends on what you expect of them. MARTHA analyzes circuits, so it would not be appropriate for elementary circuit-theory courses if the whole point is to get the student to learn to do the analysis. MARTHA might be useful for a student to check his own work, or for preparation of demonstration material. At more advanced levels, the emphasis shifts from analysis techniques, to design or an interpretation of the results of analysis. Here MARTHA is better suited, since the student can quickly have the entire tedious analysis done for him, and can then concentrate on the results. But probably a more important use of MARTHA is for student projects. The student may want to do a project extending the capabilities of MARTHA in some way.

**Check these features:**

- Choose your own names for elements, networks, etc.
- Lumped passive elements—R, L, C, mutual inductance, transformers.
- Active elements—operational amplifier, three transistor models.
- Distributed elements—TEM line, microstrip, coax; waveguide.
- Other elements—isolator, attenuator, tee's, pi's, gyrator, NIC's, controlled sources.
- Describe distributed elements using electrical parameters, physical dimensions, or stock numbers.
- Numerical functions of frequency (FOF's).
- Use FOF's to define elements or networks, or as output.
- Use any arithmetic expression for element values.
- As many user-defined elements as you need.
- Build and maintain your own collection of elements, models, and networks.
- Define a model once; use it many times in the same or different networks.
- Define as many networks as you wish; wire them together when needed.
- No arbitrary limit on number of nodes.
- Simple impedance scaling.
- Save networks, results, and models indefinitely.
- Analyze more than one network at once.
- Over 70 real and complex response functions.
- Sweep frequency and/or any circuit parameter.
- Print, plot, or store results.
- Many plotting formats.
- Plot responses against frequency.
- Plot responses against parameters being swept.
- Plot responses against each other.
- Plot responses of one network against responses of another.
- Easy simulation of temperature changes, component tracking, etc.
- As many user-defined procedures as you need.
- Change topology or element values under program control.
- An open-ended library of programs to work with MARTHA.

For copies of MARTHA User's Manual, please write to MIT Press, 28 Carleton St., Cambridge, Mass. 02142. \$6.95 each. Information on how to obtain or access MARTHA is available from M.I.T. Account, APL General, Box 5245, Trenton, N.J., 08638, or call (609) 883-2092.

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You can use MARTHA in your own office or home, using your own telephone. There are many terminals to choose from. Shown is a Date! 30 portable terminal and acoustic coupler (Photograph courtesy of University Computing Company).