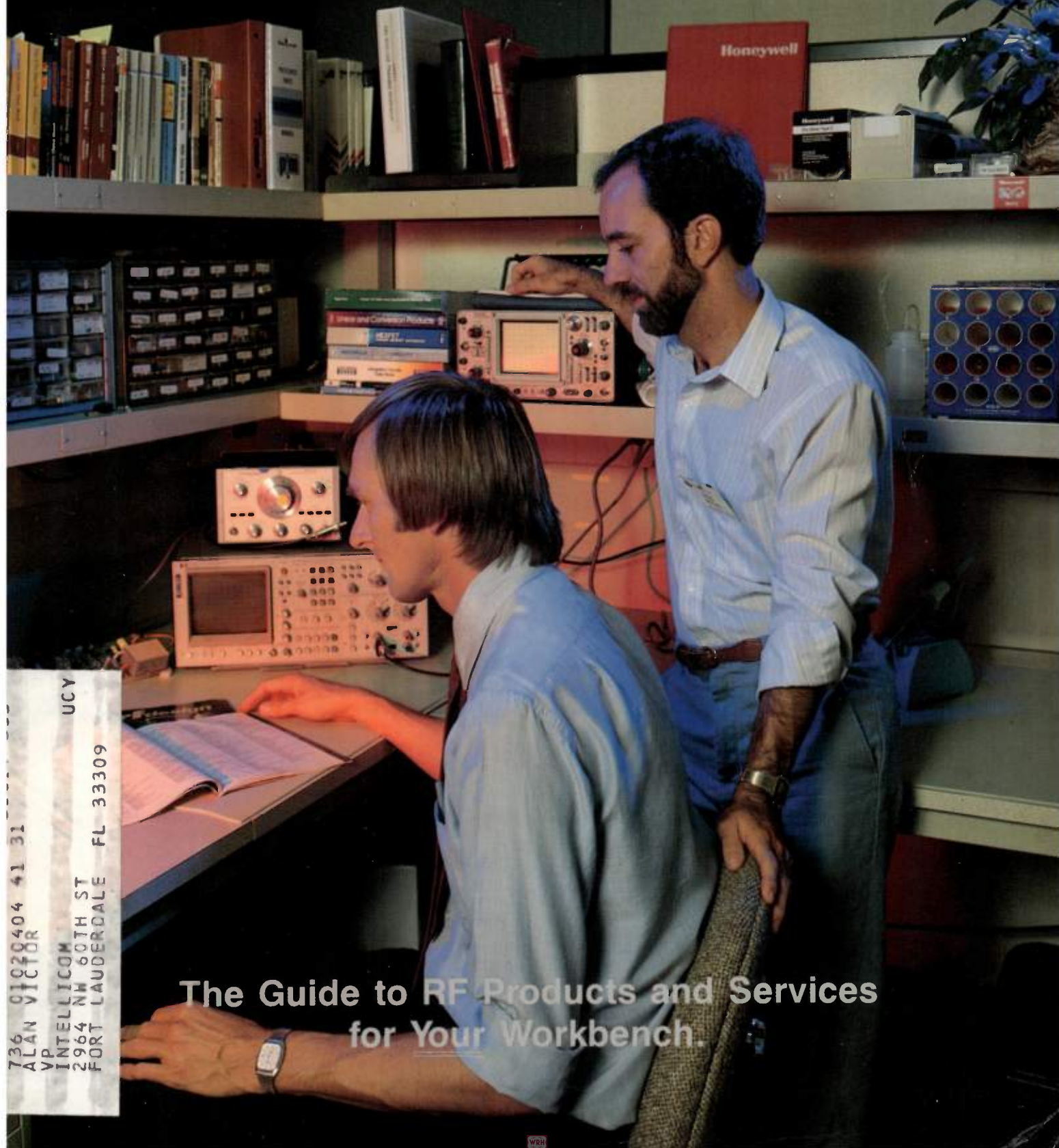


rf design

high frequency and analog engineering

1987 Directory Issue



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for Your Workbench.

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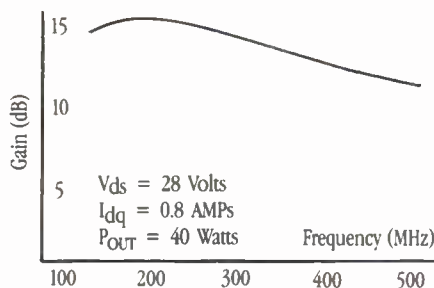
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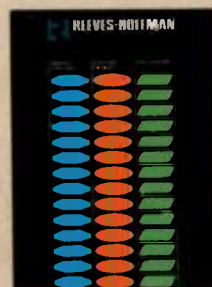


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INFO/CARD 2



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On the Cover

The two engineers looking over the *RF Design* Directory are Dave Cooper (seated) and Rick Rothe of Honeywell's Test Instruments Division (TID) in Littleton, Colorado. Dave is a principal design engineer working on data acquisition systems. His current project involves analog to digital conversion at MHz rates. Rick, also a principal design engineer, is a digital designer system with a 50 MHz clock. Like many digital engineers, he has found that new techniques are needed for clock rates that more closely resemble VHF signals than ON and OFF states.

TID makes high performance magnetic tape systems, imaging and graphic recorders, oscilloscope recorders, and data acquisition systems. These technologies represent areas where analog and that operate at RF-type speeds, requiring RF technicians in addition to more traditional engineering skills.

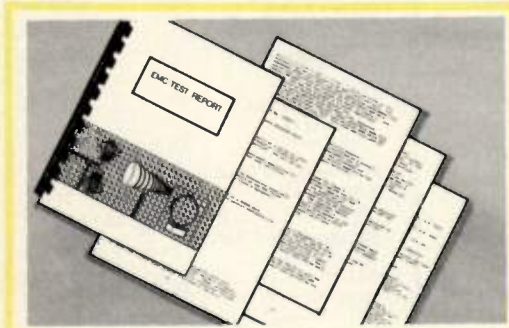
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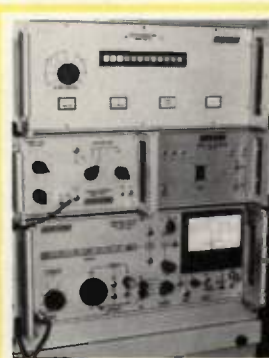
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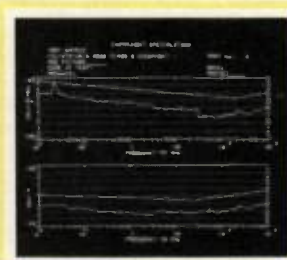
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The 1987 RF Design Directory Issue: More Listings, More Information



By Gary A. Breed
Editor

The entire content of this issue is essential information for RF engineers. For the fourth year, we have assembled a selective listing of products and services offered to the RF industry. Over 1200 companies were queried about their product lines, with the results compiled, sorted and listed in 174 specific categories. Approximately 1000 companies are included in the final listings.

A New 'Design Guide'

Besides product information, this issue offers engineers another reason to keep it nearby — reference material in a special "Design Guide" section. Consulting Editor Andy Przedpelski has assembled several items for quick reference on matching networks and other common functions. Peter Vizmuller contributed his list of "classic" RF references, something every engineer needs.

We want your help in developing future "Design Guide" entries! After looking over the material in this issue, you will certainly have suggestions for additional topics and references. Use the Comment Card in the back of this issue to submit your ideas. Next year, look for more handy engineering data.

Finding Your Way Around

The first section of the book contains the specific categories. Check the Table of Contents to find the exact category you are looking for. Under each heading is a list of companies who have identified themselves as suppliers of that particular type of product or service.

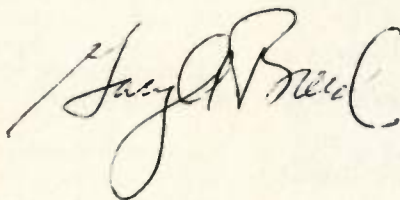
Once you have found a company name, you can find out their address and telephone number by looking in the alphabetical company listings toward the latter pages. The company listings are easy to spot by the black-striped margins that show as you thumb through the issue.

The "Design Guide" section lies between the product listings and the company listings. All three sections can be easily identified by the "headers" at the top of each page.

Comments and Caveats

With the cooperation of many companies, we have created the most complete listing possible. In addition to the hundreds of companies who eagerly respond to our questionnaire, we have listed another 100+ that we knew were appropriate for our Directory. Unfortunately, these firms didn't get our questionnaires back to us in time for publication. You won't find these companies' listings among the product categories, although we expect to track down all of them for future Directories.

Products, companies and engineering data are combined in one place for your convenience. Our greatest compliment will be finding dog-eared, well-worn copies of this Directory on top of RF engineers' desks.



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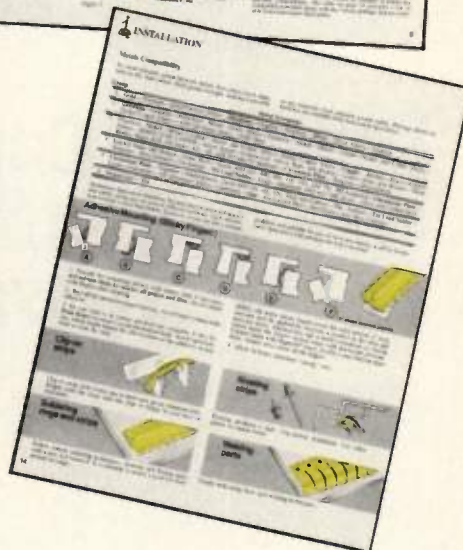
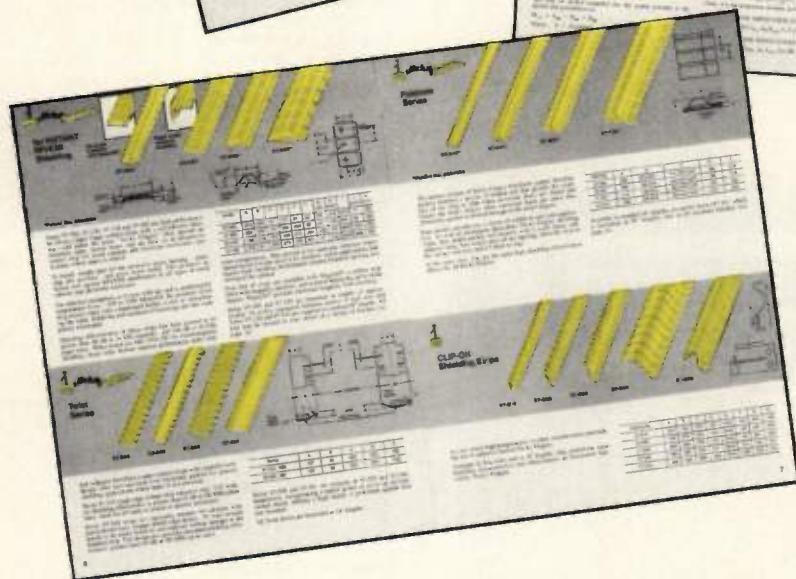
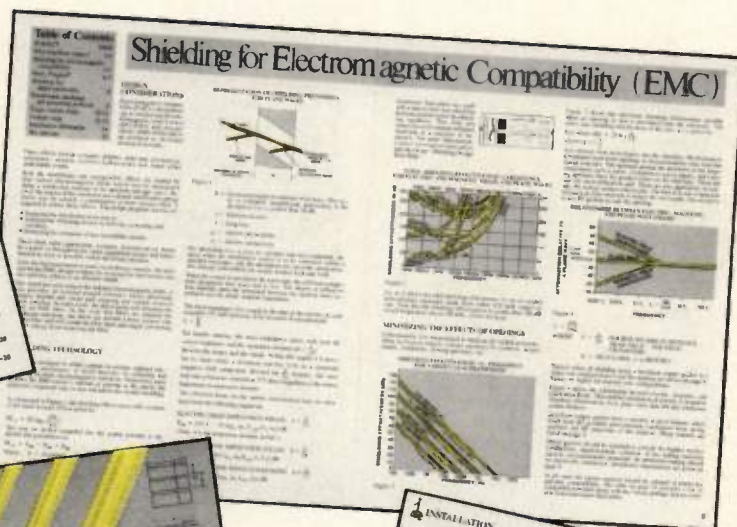
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- Available in leaded styles, body dimensions 0.415 in. (10.54mm) x 0.390 in. (9.91mm) x 0.170 in. (4.32mm) max.

ATC 175 ULTRA HIGH Q PORCELAIN CAPACITORS

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- Std. values per RETMA 5% table
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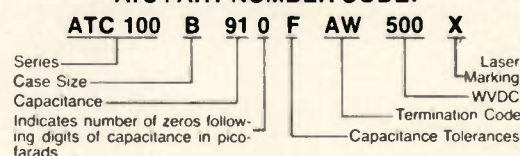
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		MIL-C-11272C	MIL-C-55681			Length (L)	Width (W)	Thickness (T)	Length (L)	Width (W)	Thickness (T)
100	CA	CY81 *	CDR118G	A Chip		.055 ± .010 (1.4 ± .25)		.055 (1.4) max.	 GOLD OVER NICKEL OVER SILVER (CA) Palladium Silver (C) 175 ONLY		
700		—	CDR118P								
100	CA	CY83 *	CDR138G	B Chip		.110 ± .015 (2.79 ± .38)		.100 (2.54) max.			
700		—	CDR138P								
175	C	—	—								
100	P	CY82	CDR128G	A Pellet		Same as chip plus twice solder build-up: solder build-up for size A is: .003 (.076) typ. Solder build-up for size B is: .005 (.127) typ.			 Pellets are solder-coated chips with a nickel barrier over the termination. Solder melting temp. is 372 F, 179°C.		
700		—	CDR128P								
100	P	CY84	CDR148G	B Pellet							
700		—	CDR148P								
175		—	—								
100	MS	CY85	CDR218G	B Microstrip		.120 (3.05) min.	.110 ± .015 (2.79 ± .38)	.100 (2.54) max.	.250 (6.35) min.	.093 ± .005 (2.36 ± .13)	.004 ± .001 (.102 ± .025)
700		—	CDR218P								
175		—	—								
100	AR	CY86	CDR228G	B Axial Ribbon		.150 (3.81) max.					
700		—	CDR228P								
100	RR	CY88	CDR248G	B Radial Ribbon							
700		—	CDR248P								
100	NAR	—	—	B Narrow Axial Ribbon		.120 (3.05) min.	.110 ± .015 (2.79 ± .38)	.100 (2.54) max.	.250 (6.35) min.	.050 ± .005 (1.27 ± .13)	.006 ± .003 (.15 ± .08)
700		—	—								
100	NMS	—	—	B Narrow Microstrip		.155 (3.94) max.					
700		—	—								
100	VNMS	—	—	B Vertical Narrow MS							
700		—	—								
100	RW	CY87	CDR238G	B Radial Wire		.120 (3.05) min.	.110 ± .015 (2.79 ± .38)	.100 (2.54) max.	.500 (12.7) min.	#26 AWG, .016 (.375) dia. nominal	
700		—	CDR238P								
100	AW	CY89	CDR258G	B Axial Wire		.165 (4.19) max.					
700		—	CDR258P								

* CY81 and CY83 are Palladium Silver-terminated Chips per MIL-C-11272 requirements.

* * VNMS improves the resonant frequency performance over that of the standard Microstrip. The first important resonance is approximately twice as high in frequency as with "flat" mounting (NMS). Note that in this configuration, the marking is now on a vertical surface. For details, contact factory.

- All dimensions are in inches except those in parentheses which are in millimeters.
- All leads are high purity silver and are attached with high temperature solder.
- Mechanical configurations for ATC 200 Series are the same as those for ATC 100 Series, except for VNMS which is not offered in the 200 Series.
- For 100E Mechanical Configurations, request complete ATC Product Catalog.
- LASER MARKED CAPACITORS with manufacturer's logo, capacity and tolerance code are available for any case size (including chips and pellets). To order, add suffix (X) to code.
- TAPE AND REEL PACKAGING for automated surface mounting available upon request.



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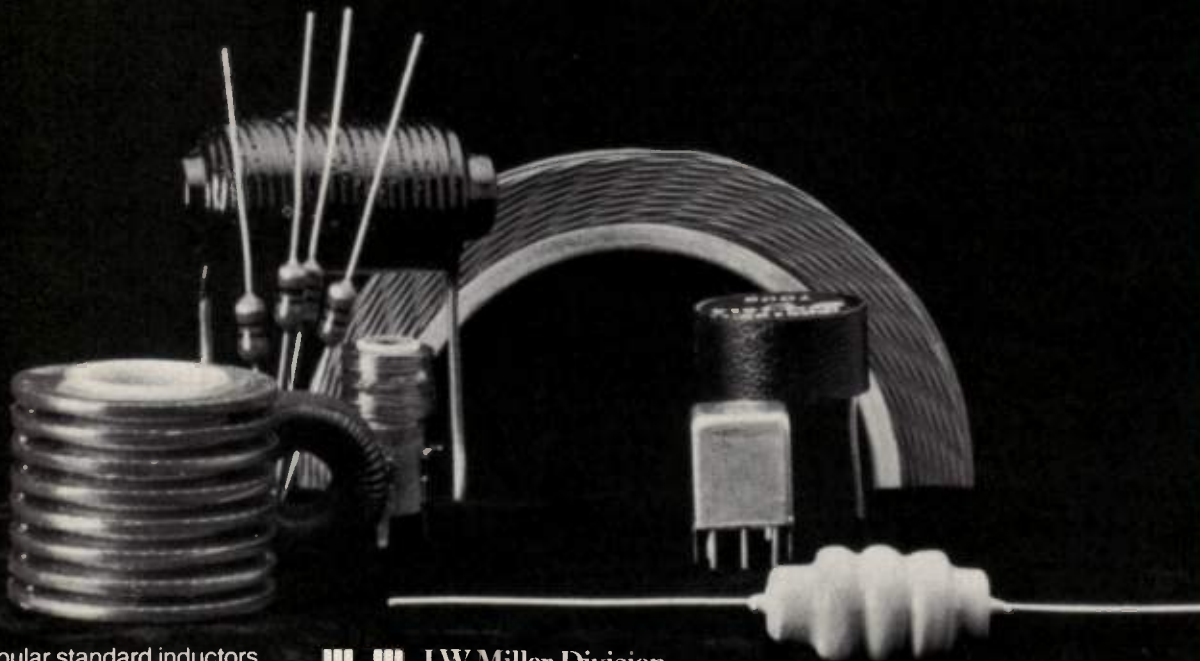
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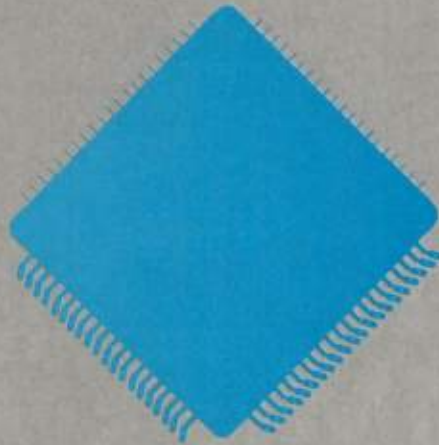
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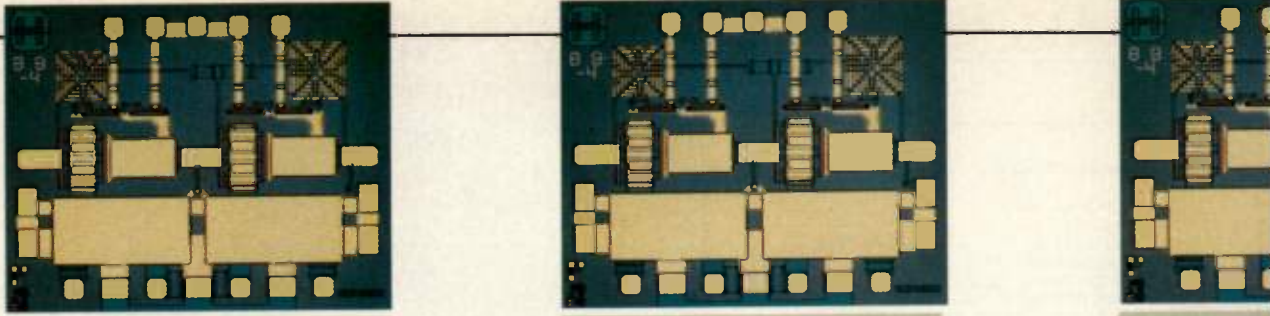
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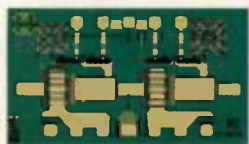


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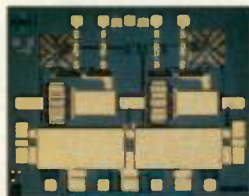
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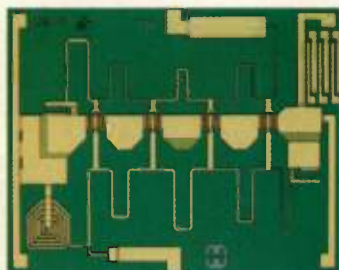
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HMR-10502 MMIC



HMR-10503 MMIC



HMM-11810 MMIC

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• 1-100 watts
• DC-26.5GHz
• Ideal for calibration and debugging



Flange Mount
• 2-500 watts
• External mounting replaces connectors
• Compact, easy to assemble



Stripline
• 1-3 watts
• Pin design mounts internally
• Small size, simple installation



Surface Mount
• Up to 150 watts
• DC-40GHz
• For microminiature packages
• Ideal for high frequency systems

ATTENUATORS



SMA Coax
• 0-30dB
• DC-18GHz
• 2-10 watts



Flange Mount
• 0-20dB
• DC-18GHz
• Interchangeable transition pins



Stripline
• 0-20dB
• Up to 3 watts
• Ideal for limited space



Surface Mount Chips
• 1-20dB
• DC-18GHz
• Many terminals, lead choices



Hi Power
• 125 watts
• DC-26GHz
• Up to 60dB

ATTENUATORS



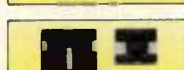
Switchable
• 1-15 dB
• Pre-tinned pads on Al₂O₃
• Surface mounting configurations
• Ideal for fast accurate circuit adjustment



Programmable
• 750MHz-8GHz
• Automatic compensation for signal strengths
• Various configurations available



Thin Film Chip
• 5dB to 20dB in 5dB steps
• DC-12GHz
• Unprecedented accuracy
• Low cost, small size



Hi Rel Chip
• 1-20 dB
• Full test documentation
• Low cost, small size



Miniature Chip
• 1-20dB
• DC-18GHz
• Many sizes, shapes, power ratings
• Stable, predictable performance

DC BLOCKS, SHORTS AND CAPACITORS



Stripline
• Pin and chip configurations for small packages
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• Fast, simple assembly



Coax
• SMA connector configuration for flexibility
• Replace standard connectors for cost, space savings
• Small size, light weight

DC BLOCKS, SHORTS, CAPACITORS AND RESISTORS



Flange Mount
• 1-18GHz
• 100V peak
• Ideal for systems where coax blocks can't be used



SMA
• 1-18GHz
• 100V peak
• Low VSWR



HIGH POWER RESISTORS
• 25-250 ohms
• DC-26GHz
• Up to 150 watts



ROD RESISTORS
• 10-500 ohms
• 125°C watts
• Al₂O₃ or BeO substrates



THICK OR THIN FILM RESISTORS
• 10-500 ohms
• 0.1-100 watts
• 100-380V
• Many different designs



CHIP RESISTORS
• 10-10K ohms
• 1/20-1 watt
• Chips or tabs
• Many standard sizes, custom configurations



PILL RESISTORS
• DC-12GHz
• 10-3 watts
• 10-250 ohms

EMC's interchangeable transition pin concept

The key to better electrical performance, lower costs and improved design flexibility

Interchangeable transition pins for MIC packages permit transitioning circuits to coax with attenuators, terminations, DC blocks or SMA connectors—even after the package has been sealed. Typical advantages of this system include:

- Increase package design options
- Replace/substitute components without disturbing package
- Assure mechanical integrity for improved electrical performance
- Simplify testing procedures
- Reduce inventory costs

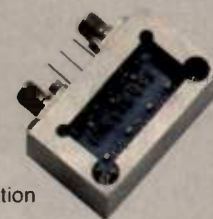


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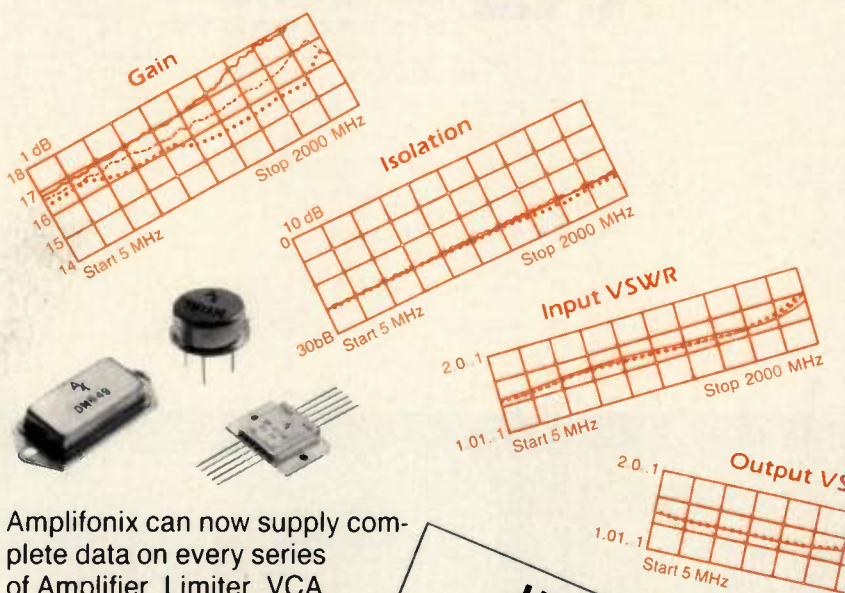
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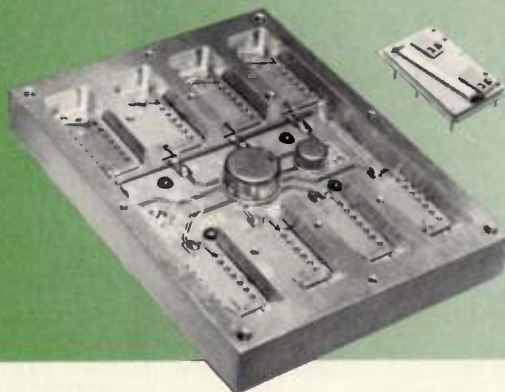
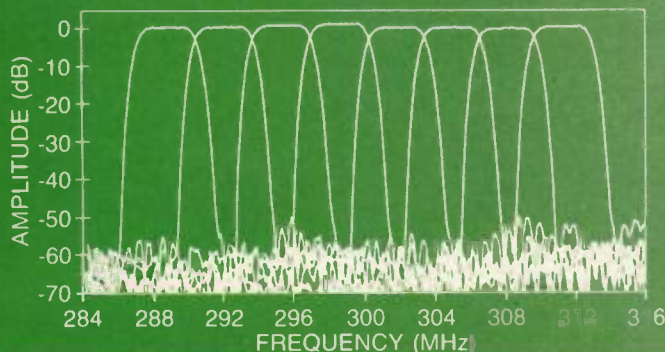
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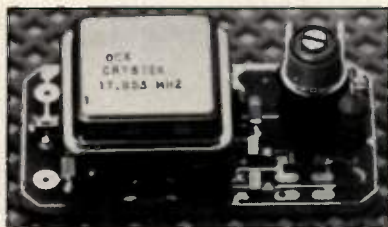
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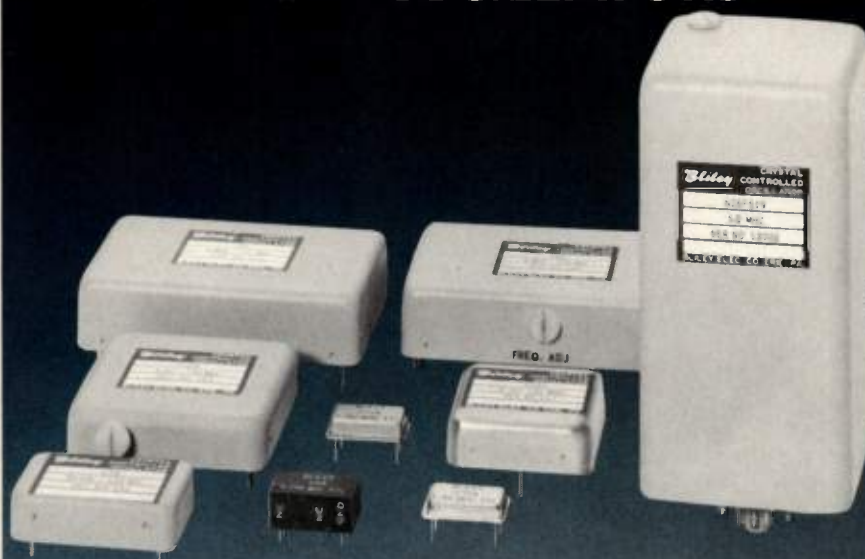
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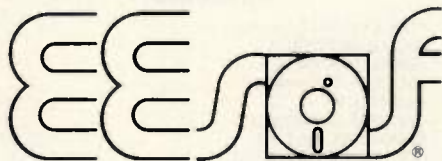
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50 watts minimum is a lot of rf power throughout a bandwidth of 1 to 1000 MHz. But that's what our new Model 50W1000 delivers for all your broadband test needs.

As your hunger for power plus bandwidth grows, this year and next, our all-solid-state "W" series

of 100-kHz-to-1000-MHz linear amplifiers should become more and more important in your plans. Today you may need only 1 watt (the little portable on the top of the pile), or 5, or 10—all with that fantastic bandwidth instantly available without tuning or bandswitching—the kind

of bandwidth that lets you sweep clean through with no pausing for adjustment.

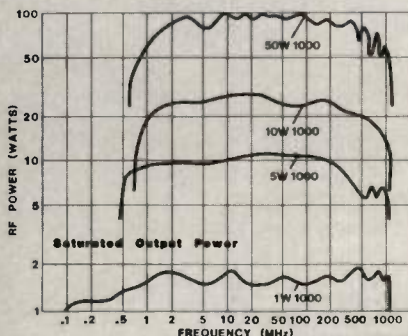
And next year?

But chances are good that next year you'll be moving up into higher-power work in the same bandwidth. Then you'll be glad you have a 50W, the *only* rf power amplifier in its power-to-bandwidth class. At that point, your smaller "W" series amplifiers can be freed for lower-power work around your lab.

What you can't see in the performance curves shown below is the unconditional *stability* of all Amplifier Research amplifiers—immunity to even the worst-case load mismatch or shorted or open cable with no fear of damage or system shutdown.

The "W" series is part of a complete line of amplifiers offering rf power up to 10,000 watts cw, for such diverse applications as plasma/fusion research, NMR, RFI susceptibility testing, and a host of other test situations that demand the very finest in broadband rf power.

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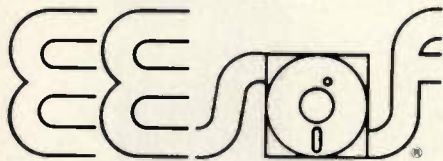
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102LC	2 W	25Hz-100MHz	33dB	100-140V	23dB	838.00
502LC	2 W	10KHz-525MHz	36dB	100-240V	18dB	1,395.00
505C	5 W	.5-550MHz	37dB	100-240V	25dB	1,495.00
110C	10 W	.1-60MHz	40dB	100-240V	16dB	1,190.00
210LC	10 W	8KHz-225MHz	40dB	100-240V	25dB	2,295.00
210C	10 W	.5-230MHz	40dB	100-240V	25dB	1,690.00
112C	25 W	1-120MHz	45dB	100-240V	25dB	1,595.00
125C	25 W	.1-50MHz	45dB	100-240V	25dB	1,495.00
225C	25 W	.5-200MHz	43dB	100-240V	23dB	2,450.00
150C	50 W	.15-50MHz	43dB	100-240V	23dB	2,339.00
150LCR	50 W	3KHz-12MHz	42dB	100-240V	30dB	2,690.00
115C	50 W	.5-100MHz	46dB	100-240V	23dB	2,995.00
250C	50 W	1-200MHz	40dB	100-240V	24dB	3,950.00
117CFR	100 W	100-160MHz	45dB	100-240V	35dB	3,495.00
155LCR	100 W	6KHz-10MHz	48dB	100-240V	25dB	3,250.00
161C	100 W	.5-90MHz	48dB	100-240V	23dB	3,995.00
162LP	100 W	50-200MHz	50dB	100-240V	23dB	4,995.00
600FC	100 W	200-500MHz	48dB	100-240V	20dB	6,650.00
118FC	125 W	225-400MHz	45dB	100-240V	22dB	4,880.00
121CA	200 W	.5-35MHz	50dB	100-240V	22dB	3,250.00
121CR	200 W	2-30MHz	50dB	100-240V	50dB	3,690.00
122C	200 W	10KHz-220MHz	50dB	208-380V	17dB	9,550.00
123CFR	200 W	80-160MHz	50dB	100-240V	35dB	5,850.00
126CR	200 W	225-400MHz	50dB	100-240V	22dB	7,500.00
127CR	200 W	400-500MHz	50dB	100-240V	50dB	8,500.00
163LP	250 W	10-100MHz	53dB	100-240V	23dB	4,900.00
163HP	250 W	80-200MHz	53dB	100-240V	23dB	5,900.00
* 164SP	250 W PULSE	400-500MHz	55dB	100-240V	25dB	6,990.00
* 164UP	300 W PULSE	200-400MHz	55dB	100-240V	25dB	6,990.00
130CF	400 W	80-160MHz	50dB	100-240V	30dB	8,990.00
131CF	400 W	225-400MHz	50dB	100-240V	23dB	18,500.00
128CF	500 W	2-30MHz	55dB	100-240V	16dB	7,250.00
128CR	500 W	2-30MHz	55dB	100-240V	50dB	8,990.00
134C	500 W	10KHz-220MHz	60dB	208-380V	17dB	17,990.00
134CM	500 W	1-200MHz	60dB	208-380V	17dB	17,100.00
* 164LP	500 W PULSE	10-86MHz	53dB	100-240V	23dB	6,990.00
* 164HP	500 W PULSE	80-180MHz	53dB	100-240V	23dB	7,990.00
* 166UP	600 W PULSE	200-400MHz	55dB	100-240V	25dB	8,990.00
135CF	1000 W PULSE	2-30MHz	60dB	208-240V	16dB	9,925.00
137C	1000 W	10KHz-220MHz	60dB	208-440V	17dB	24,990.00
137CM	1000 W	1-200MHz	60dB	208-440V	17dB	23,990.00
* 166LP	1000 W PULSE	10-86MHz	60dB	200-240V	23dB	8,990.00
* 166HP	1000 W PULSE	80-180MHz	60dB	200-240V	23dB	9,990.00
138CF	2000 W PULSE	2-30MHz	60dB	208-440V	16dB	12,990.00
* 167LP	2000 W PULSE	10-80MHz	60dB	200-240V	23dB	13,990.00
* 167HP	2000 W PULSE	80-175MHz	60dB	200-240V	23dB	16,600.00
* 168LP	4000 W PULSE	6-60MHz	60dB	208-440V	20dB	20,990.00

* with built-in blanking



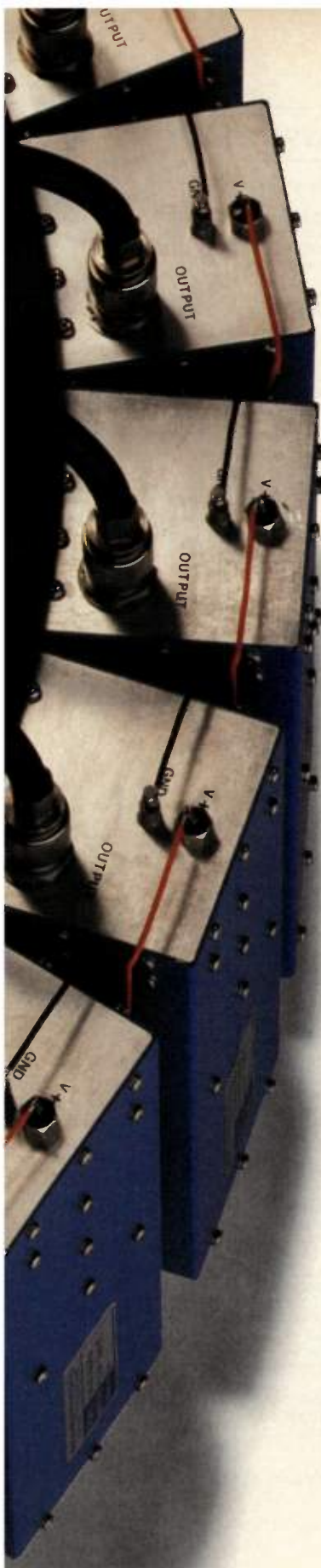
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Los Alamos Scientific Labs approached MMD several years ago with a very big need: The design and development of a high power pulsed UHF module with 1250W of output power, 40 db of gain, and the required storage capacitance—all contained within 120 cubic inches.

MMD responded with an amplifier that delivered precisely that. Except our design occupied only 80 cubic inches.

Big thinking indeed. But that's only the beginning.

MMD then teamed with United Technology's Norden Division in support of the Strategic Defense Initiative. The challenge was to design a similar but higher power UHF pulse amplifier. A device with significant size and weight reduction and the highest possible efficiency.

A year later MMD had

developed an amplifier packing 2000W of pulsed UHF power, from a 2.4" x 2.25" x 0.45" package. An innovative design employing advanced circuit techniques that weighs in at an astounding 2.2 ounces.

This amplifier required the development of the world's most powerful, pulsed UHF transistor die which, in turn, was integrated into a truly revolutionary product. One that is perhaps two to three years ahead of present day technology.

So when it comes to your next big challenge, think of MMD. Call us at (415) 961-1473, or write to Microwave Modules and Devices Inc., 550 Ellis St., Mountain View, CA 94043, Telex 508 746.

We can design big ideas and, at the same time, engineer small solutions.



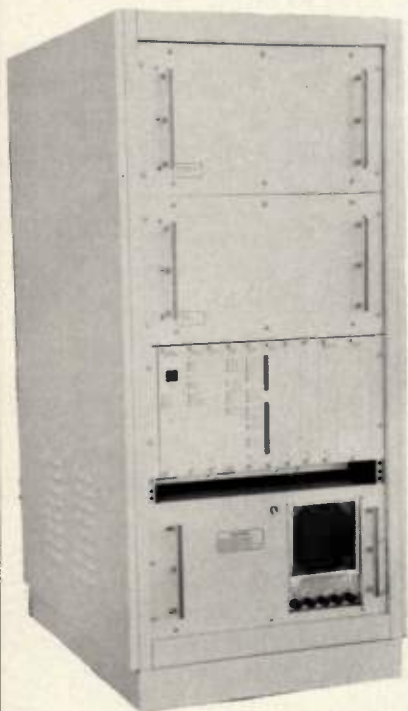
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Output: +3 to +13dBm: 50 ohm
Spurious Outputs: -75dB

Phase Noise: -75dBc (0-15KHz)
Freq. St'd: Oven, TCXO, Ext.
Interface: BCD par. or GPIB
Size: 19"W, 5 1/4"H, 18"D
Price: \$4,400.00*

Other Options:
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(or 0-99dB with GPIB)
nx10MHz output 20-140MHz
or any 10MHz line (20-140)

PTS 120

Range: 90-120MHz
Resolution: 0.1Hz-100KHz (opt.)
Switching: 5-20 μ s
Output: +3 to +10dBm: 50 ohm
Spurious Outputs: -75dBc

Phase Noise: -75dBc (0.5Hz-15KHz)
Freq. St'd: Oven, TCXO, Ext.
Interface: BCD par. or GPIB
Size: 19"W, 5 1/4"H, 18"D
Price: \$4,400.00*

Other Options:
Progr. Attenuator, 0-90dB
(or 0-99dB with GPIB)
nx10MHz output 20-140MHz
or any 10 MHz line (20-140)

PTS 160

Range: 0.1-160MHz
Resolution: 0.1Hz-100KHz (opt.)
Switching: 5-20 μ s
Output: +3 to +13dBm: 50 ohm
Spurious Outputs: -75dB

Phase Noise: -63dBc (0-15KHz)
Freq. St'd: Oven, TCXO, Ext.
Interface: BCD par. or GPIB
Size: 19"W, 5 1/4"H, 18"D
Price: \$5,600.00*

Other Options:
Progr. Attenuator, 0-90dB
(or 0-99dB with GPIB)
nx10MHz output 20-140MHz
or any 10 MHz line (20-140)

PTS 250

Range: 1-250MHz
Resolution: 0.1Hz-100KHz (opt.)
Switching: 5-20 μ s
Output: +3 to +13dBm: 50 ohm
Spurious Outputs: -70dB

Phase Noise: -63dBc (0-15KHz)
Freq. St'd: Oven, TCXO, Ext.
Interface: BCD par. or GPIB
Size: 19"W, 5 1/4"H, 18"D
Price: \$6,400.00*

Other Options:
Progr. Attenuator, 0-90dB
(or 0-99dB with GPIB)
nx10MHz output 20-140MHz
or any 10 MHz line (20-140)

PTS 500

Range: 1-500MHz
Resolution: 0.1Hz-100KHz (opt.)
Switching: 5-20 μ s
Output: +3 to +13dBm: 50 ohm
Spurious Outputs: -70dB

Phase Noise: -63dBc (0-15KHz)
Freq. St'd: Oven, TCXO, Ext.
Interface: BCD par. or GPIB
Size: 19"W, 5 1/4"H, 18"D
Price: \$7,500.00*

Other Options:
Progr. Attenuator, 0-90dB
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or any 10 MHz line (20-140)

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TEST EQUIPMENT CORP.
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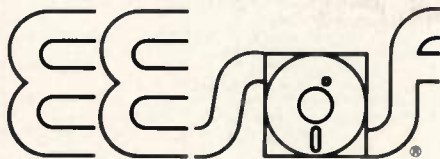
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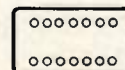
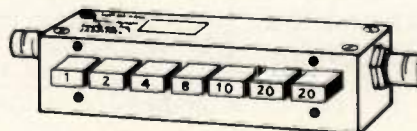
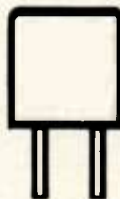
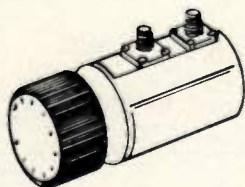
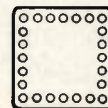
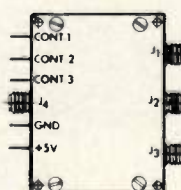
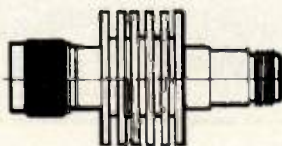
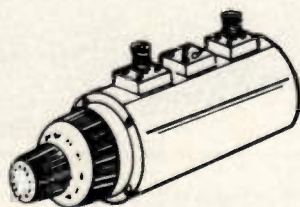
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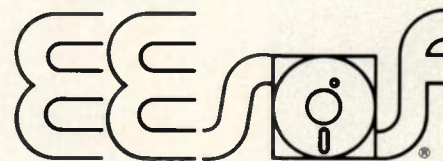
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INFO/CARD 36

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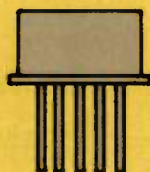
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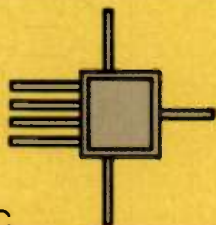
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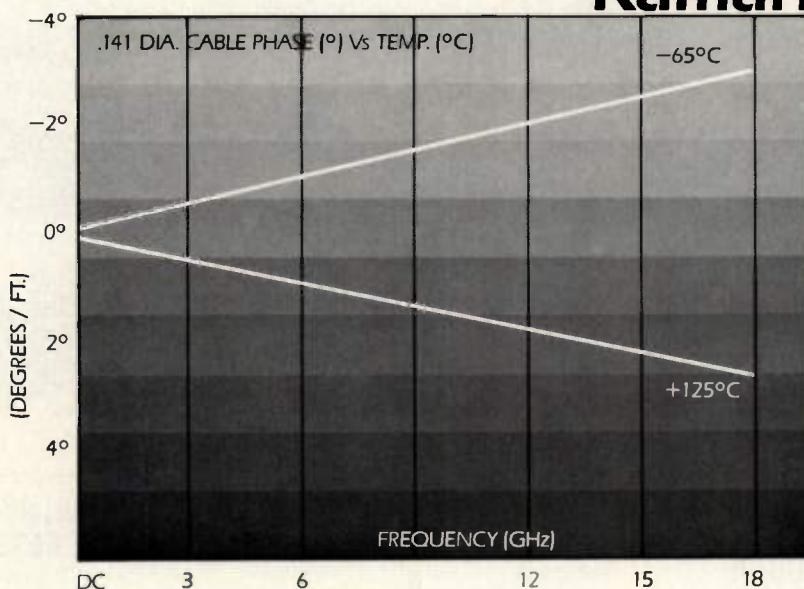
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Available with 2 - 12 sections, 2 - 30% bandwidth, 0.1dB Chebyshev design, and virtually any RF connector.

1/2-inch Diameter 3/4-inch Diameter 1-1/4-inch Diameter

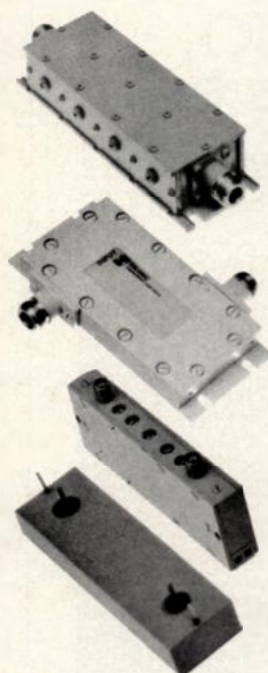
Low Pass

Series TLP	Series TLA	Series TLC
100-2,750MHz	50-1,500MHz	30-1,000MHz

Bandpass

Series TBP	Series TBA	Series TBC
100-2,400MHz	50-1,000MHz	30-900MHz

BANDPASS FILTERS



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Series TSF 30-400MHz, Helical Resonators, Slotted Aluminum Box
Series TCF 400-3,000MHz, Coaxial 1/4-Wavelength Resonators, Slotted Aluminum Box
Series TCC 500-2,500MHz, Coaxial 1/4-Wavelength Resonators, Bored Aluminum Block
Series TCA 1.0-3.0GHz, Coaxial 1/4-Wavelength Resonators, Bored Aluminum Block
Series TCG 2.0-6.0GHz, Coaxial 1/4-Wavelength Resonators, Bored Aluminum Block
Series TCH 6.0-12.0GHz TM010 Resonant Cavity, Bored Aluminum Block
Series TCB 1.0-2.4GHz, Coaxial 1/4-Wavelength Resonators, Adjustable Center Frequency, Bored Aluminum Block

Interdigital

Series TIF 1,000-9,000MHz, 3.0-30% Bandwidths, 4-17 Sections

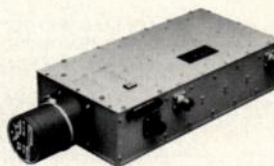
Miniature Combine

Series TSJ 1.4-10GHz, Miniature Size, Lightweight, Minimum Insertion Loss, High Rejection, Wide Stopband

Miniature LC or Thick Film

Series TSA 40-1,000MHz, PCB Applications
Series TSC 40-600MHz, Five Sections

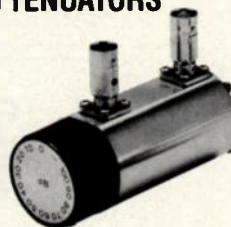
TUNABLE BANDPASS FILTER SYSTEMS



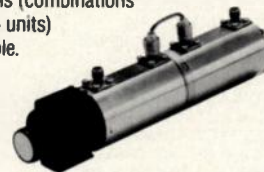
TCD Series, Iris-coupled, 0.05dB Chebyshev design, 3 or 5 sections. Self-contained μ P-Based Control for Interface with Digital System, RS-232, IEEE-488 and BCD Addressing, 32MHz-3GHz.

TCK Series μ P-Controlled Multi-Octave Systems for continuous tuning over as many as 6 octaves. Power Supplies and Band-switching included.

SUBMINIATURE & MINIATURE ROTARY STEP ATTENUATORS



Available in 9 models with ranges from 1-100dB, 500MHz-2GHz. Tandem-mounted versions (combinations of step units) available.



BENCH-TYPE ROTARY STEP ATTENUATORS



Discrete instruments for electronics lab, production, testing or QA. 0.1, 1 and 10dB steps, 500MHz-2GHz, 3% accuracy.

COMPUTER-CONTROLLED ATTENUATORS



Model 8300 DC-4GHz, 3 or 4 sections in series which can be selected in any order for attenuation changes from 0dB to max. attenuation value. Relay solenoid drive circuitry self-contained.

VSWR SYSTEMS & ACCESSORIES

- VSWR Detectors
- Terminations & Mismatches
- Coaxial Switches
- RF Detectors



WAVEGUIDE FILTERS



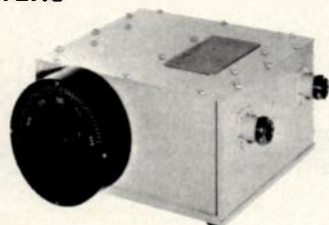
Bandpass

TWGBP 2-26GHz, Copper Brass Invar Construction

Band Reject

TWGBR 2-26GHz, Copper Brass Invar Construction

MANUAL BANDPASS & BAND REJECT FILTERS



Iris-coupled, 0.05dB Chebyshev design, Frequency-Reading Dials, Full Octave Coverage 48MHz-4GHz Range, Individually Calibrated, Vernier Tuning, 3 or 5 sections.

TTA Series 3% & 5%, 20W Max. Input Power

TTF Series 5%, 50W Max. Input Power

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MINIATURE FREQUENCY AGILE (HOPPING) FILTER



SPECIFICATIONS

Tuning Range	225-400 MHz
Insertion Loss	3.5 dB to 5.5 dB
0.5 dB Bandwidth	8 MHz Minimum
VSWR	1.8:1 Maximum
35 dB Bandwidth	±25 MHz Maximum
60 dB Bandwidth	±70 MHz Maximum
Power Handling	10 Watts Avg., 40 Watts Peak
Voltage Requirements	+5 VDC 1 Amp 100 VDC 40 mAmp



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TELEDYNE MICROWAVE
TELEWAVE INC.
TELONIC BERKELEY, INC.
TEMEX ELECTRONICS INC.
TEXSCAN
TEXSCAN INSTRUMENTS
TIL-TEK LTD.
TOKO AMERICA, INC.
TRANSCO PRODUCTS, INC.
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WAVECOM
WAVETEK RF PRODUCTS, INC.
WAVETEK SAN DIEGO, INC.

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ACCUTEST INSTRUMENTS INC.
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AIRTRON CORP.
ALPHA COMPONENTS, INC.
AMERICAN ELECTRONIC LABS, INC.
ANGHEL LABORATORIES, INC.
APOLLO MICROWAVES LTD.
APPLIED RESEARCH INC.
APPLIED SPECIALTIES, INC.
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CALIFORNIA AMPLIFIER, INC.
CAPTOR CORP.
CIR-QTEL, INC.
COAXIAL DYNAMICS, INC.
COM DEV
COMAD COMMUNICATIONS LTD.
COMARK COMMUNICATIONS, INC., A THOMSON-CSF CO.
COMSTRON CORP.
CTS CORP.
DADEN ASSOCIATES, INC.
DAJEM TECHNOLOGY CO.
DATEL, INC.
DAYTON-GRANGER, INC.
DECIBEL PRODUCTS, INC.
DELTA MICROWAVE INC.
DIELECTRIC COMMUNICATIONS
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EATON CORP. MICROWAVE PRODUCTS DIV.
EATON CORP., COMPONENT & SEMICONDUCTOR
EG & G CIRTECH
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EQUITABLE/RENTELCO CORP.
ESC ELECTRONICS CORP.
FILTRON CO. INC.
GAMMA-F CORP.
GENERAL SERVICES ENGINEERING, INC.
GENISCO TECHNOLOGY CORP.
HUBER & SUHNER INC.
HUGHES AIRCRAFT CO.
JACK HUSNEY & ASSOCIATES
JOSEPH ELECTRONICS INC.
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KW ENGINEERING
LECTROMAGNETICS, INC.
LECTRONIC RESEARCH LABS
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MICRO COMMUNICATIONS, INC.
MICROLAB/FXR
MICROPHASE
MICROSONICS INC.
MICROWAVE FILTER CO., INC.
MICROWAVE TECHNIQUES
MINI CIRCUITS
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PASCALL ELECTRONICS LTD.
PICO PRODUCTS, INC.

PICONICS
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RF PRODUCTS, INC.
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SOLITRON DEVICES, INC.
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TELONIC BERKELEY, INC.
TEMEX ELECTRONICS INC.
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TEXSCAN INSTRUMENTS
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TIME MICROWAVE
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TUCKER ELECTRONICS
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VIEWSONICS
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WAVETEK RF PRODUCTS, INC.
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APPLIED SPECIALTIES, INC.
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CAPCON, INC.
CAPTOR CORP.
CENTRE ENGINEERING, INC.
CIR-QTEL, INC.
COAXIAL DYNAMICS, INC.
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COMARK COMMUNICATIONS, INC., A THOMSON-CSF CO.
COMSTRON CORP.
CTS CORP.
DADEN ASSOCIATES, INC.
DAJEM TECHNOLOGY CO.
DATEL, INC.
DAYTON-GRANGER, INC.
DECIBEL PRODUCTS, INC.
DELTA MICROWAVE INC.
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EAGLE
EASTERN MICROWAVE CORP.
EATON CORP. MICROWAVE PRODUCTS DIV.
EATON CORP., COMPONENT & SEMICONDUCTOR
EG & G CIRTECH
ELECTRO RENT CORPORATION
EQUITABLE/RENTELCO CORP.
ESC ELECTRONICS CORP.
FILTRON CO. INC.
GENERAL SERVICES ENGINEERING, INC.
GENISCO TECHNOLOGY CORP.
HEWLETT-PACKARD CO.
HOPKINS ENGINEERING CO.
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JACK HUSNEY & ASSOCIATES
JMK, INC.
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MICRO COMMUNICATIONS, INC.
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MICROPHASE
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MINI CIRCUITS
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PENSTOCK INC.
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TELEWAVE INC.
TELONIC BERKELEY, INC.
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TEST EQUIPMENT CORP.
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TIL-TEK LTD.
TIME AND FREQUENCY LTD.
TIME MICROWAVE
TOKO AMERICA, INC.
TONY CHAPMAN ELECTRONICS LTD.
TRANSCO PRODUCTS, INC.
TTE, INC.
TUCKER ELECTRONICS
UNITED TRANSFORMER CORP.,
SUB. OF OPT INDUSTRIES
VIEWSONICS
WAVECOM
WAVETEK RF PRODUCTS, INC.
WAVETEK SAN DIEGO, INC.
WESTERN MICROWAVE INC.
WI-COMM ELECTRONICS INC.
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BANDPASS

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COAXIAL DYNAMICS, INC.
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COMARK COMMUNICATIONS, INC., A THOMSON-CSF CO.
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DATEL, INC.
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DECIBEL PRODUCTS, INC.
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 M/A-COM LAND MOBILE COMMUNICATIONS
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 MICRO COMMUNICATIONS, INC.
 MICROLAB/FXR
 MICROPHASE
 MICROSONICS INC.
 MICROWAVE FILTER CO., INC.
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 OXLEY INC.
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 RF PRODUCTS, INC.
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 WAVETEK SAN DIEGO, INC.
 WESTERN MICROWAVE INC.
 WIDE BAND ENGINEERING CO. INC.

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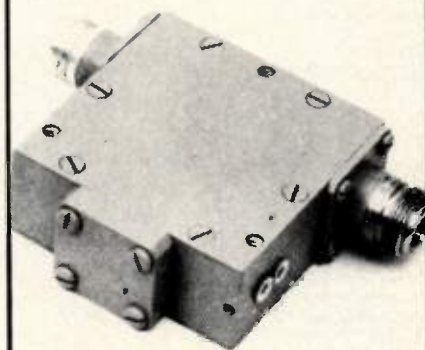
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 APPLIED SPECIALTIES, INC.
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 OXLEY INC.
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 PIEZO TECHNOLOGY, INC.
 REACTEL, INC.
 REMEC
 RLC ELECTRONICS, INC.
 SALISBURY ENGINEERING INC.
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 WAVETEK SAN DIEGO, INC.
 WESTERN MICROWAVE INC.
 XETRON CORP.

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 AIRTRON CORP.
 ALPHA INDUSTRIES, INC.
 ANTENNA SPECIALISTS CO., THE
 APOLLO MICROWAVES LTD.
 APPLIED SPECIALTIES, INC.
 CASTLE MICROWAVE
 COM DEV
 DAJEM TECHNOLOGY CO.
 DECIBEL PRODUCTS, INC.
 EATON CORP. MICROWAVE PRODUCTS DIV.
 EATON CORP., COMPONENT & SEMICONDUCTOR
 ELECTRO RENT CORPORATION
 HARRIS CORP. FARINON COMPONENTS OPERATION
 HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
 INNOWAVE (AND VIRTECH)
 JOSEPH ELECTRONICS INC.
 ELECTRONIC RESEARCH LABS
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 M/A-COM LAND MOBILE COMMUNICATIONS
 MARLOW ELECTRONICS LTD.
 MAURY MICROWAVE CORP.
 MERRIMAC INDUSTRIES, INC.
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PENSTOCK INC.
PREMIER MICROWAVE CORP.
RAYTHEON CO., MPTD
SEAELECTRO
SHOKAI FAR EAST LTD.
SIERRA MICROWAVE TECHNOLOGY
SINCLAIR RADIO LABS INC.
SOLITRON DEVICES, INC.
SYSTRON DONNER CORP., MICROWAVE DIV.
TELEDYNE MICROWAVE
TELEWAVE INC.
TEST EQUIPMENT CORP.
TONY CHAPMAN ELECTRONICS LTD.
TRAK MICROWAVE CORP.
TRW MICROWAVE
TUCKER ELECTRONICS
UTE MICROWAVE, INC.
VIRTECH
WAVELINE INC.
WESTERN MICROWAVE INC.

LOADS

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ACRIAN, INC.
ADAMS-RUSSELL ELECTRONICS CO., INC.
AEROWAVE INC.
AIRTRON CORP.
ALAN INDUSTRIES, INC.
ANTENNA SPECIALISTS CO., THE
APOLLO MICROWAVES LTD.
APPLIED SPECIALTIES, INC.
AVIEL ELECTRONICS
BIRD ELECTRONIC CORP.
COAXIAL DYNAMICS, INC.
COMAD COMMUNICATIONS LTD.
CORE-TRONICS DIV. KRYSTINEL CORP.
DECIBEL PRODUCTS, INC.
DIELECTRIC COMMUNICATIONS
DYMA ENGINEERING
EASTERN MICROWAVE CORP.
ELCOM SYSTEMS INC.
ELECTRO IMPULSE LABORATORY, INC.
ELECTRO RENT CORPORATION
EMC TECHNOLOGY, INC.
EMERSON & CUMING INC., A GRACE CO.
EQUITABLE/RENTELCO CORP.
HUBER & SUHNER INC.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
JOSEPH ELECTRONICS INC.
LECTRONIC RESEARCH LABS
M/A-COM LAND MOBILE COMMUNICATIONS
M/A-COM OMNI SPECTRA, INC.
MARLOW ELECTRONICS LTD.
MICON, INC./MICROWAVE CONTROL CO. DIV.
MICROLAB/FXR
MICRONETICS INC.
MICROWAVE DEVICES, INC.
MIDISCO
MIDWEST MICROWAVE INC.
NARDA MICROWAVE CORP.
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POLYMER DESIGN
RADIALL, INC.
RAYTHEON CO., MPTD
RCD COMPONENTS INC.
RESIN SYSTEMS CORP.
RFDC INC.
RLC ELECTRONICS, INC.
SINCLAIR RADIO LABS INC.
SOLITRON DEVICES, INC.
SOLITRON/MICROWAVE
TELEWAVE INC.
TELONIC BERKELEY, INC.
TEST EQUIPMENT CORP.
TEXSCAN INSTRUMENTS
TONY CHAPMAN ELECTRONICS LTD.
TROMPETER ELECTRONICS
UNION CARBIDE
WAVECOM
WAVELINE INC.
WEINSCHTEL ENGINEERING

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ACCUTEST INSTRUMENTS INC.
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AMERICAN ELECTRONIC LABS, INC.
AMERICAN MICROWAVE CORP.
ANDREW CORP.
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APOLLO MICROWAVES LTD.
APPLIED RESEARCH INC.
APPLIED SPECIALTIES, INC.
COM DEV
COMMUNITRONICS
DECIBEL PRODUCTS, INC.
DIELECTRIC COMMUNICATIONS
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ELECTRO RENT CORPORATION
ELECTROWAVE PRODUCTS, INC.
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LOCUS INC.
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M/A-COM LAND MOBILE COMMUNICATIONS
M/A-COM OMNI SPECTRA, INC.
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OLEKTRON CORP.
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RF PRODUCTS, INC.
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TELE-TECH CORP.
TELEWAVE INC.
TIL-TEK LTD.
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WIDE BAND ENGINEERING CO. INC.
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APPLIED SPECIALTIES, INC.
AVNET/CHANNEL MASTER DIV.
AYDIN VECTOR DIV.
CARDION ELECTRONICS
COM DEV
COMMUNITRONICS
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EASTERN MICROWAVE CORP.
EATON CORP. MICROWAVE PRODUCTS DIV.
EATON CORP., COMPONENT & SEMICONDUCTOR
ELECTRO RENT CORPORATION
EON INSTRUMENTATION, INC.
EQUITABLE/RENTELCO CORP.
GAMMA-F CORP.
HUBER & SUHNER INC.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
JOSLYN DEFENSE SYSTEMS, INC.
K & L MICROWAVE, INC.

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MICROLAB/FXR
MICROPHASE
MICROWAVE FILTER CO., INC.
MICROWAVE SYSTEMS INC.
MICROWAVE TECHNIQUES
MITEC ELECTRONICS
MU-DEL ELECTRONICS, INC.
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RACOM CORP.
REMEC
RF PRODUCTS, INC.
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SIERRA MICROWAVE TECHNOLOGY
SILICONIX, INC.
SOLITRON DEVICES, INC.
SYSTRON DONNER CORP., MICROWAVE DIV.
TELEDYNE MICROWAVE
TELONIC BERKELEY, INC.
TIME MICROWAVE
TOKO AMERICA, INC.
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VIEWSONICS
WAVECOM
WAVELINE INC.
WESTERN MICROWAVE INC.
WIDE BAND ENGINEERING CO. INC.
XETRON CORP.

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ANGHEL LABORATORIES, INC.
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ELECTROWAVE PRODUCTS, INC.
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HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
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M/A-COM OMNI SPECTRA, INC.
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PULSAR MICROWAVE CORP.
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REMEC
RHG ELECTRONICS LABORATORY
ROBINSON LABS
SAGE LABORATORIES, INC.
SANDERS, MICROWAVE DIV. ECB

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TEST EQUIPMENT CORP.
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WERLATONE, INC.

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APPLIED SPECIALTIES, INC.
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AVTECH ELECTROSYSTEMS LTD.
BARTH ELECTRONICS, INC.
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DECIBEL PRODUCTS, INC.
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LOCUS INC.
LORCH ELECTRONICS CORP.
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M/A-COM OMNI SPECTRA, INC.
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MICON, INC./MICROWAVE CONTROL CO. DIV.
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MAGNECRAFT ELECTRIC CO.
MATRIX SYSTEMS CORP.

See
Matrix Systems
Ad on
Coaxial Switching

Page 119

INFO/CARD 42

HIGH POWER COMBINERS



2-WAY 600 WATTS
MODEL D1994

4-WAY 600 WATTS
MODEL D1995

4-WAY 1500 WATTS
MODEL D1996

SPECIFICATIONS
above models

Freq. Range	20-90 MHz
Insertion Loss	0.3 dB max.
Isolation	20 dB min.
VSWR	1.3:1 max.

HIGH POWER COUPLERS

DUAL DIRECTIONAL
COUPLER
MODEL C1997

Freq. Range	20-90 MHz
Coupling	40 dB
Directivity	20 dB min.
Power (watts)	1500

See Gold Book and Microwave/RF
Handbook, for additional products.



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- Choice of body finishes

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- Float mounts, closed-entry hoods available

7000 Series:

- Microminiature size
- Rugged and reliable
- Snap-on mating

75 ohm Connectors:

- Screw-on or snap-on
- Similar to SMB and SMC

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- For .141 semi-rigid
- One-step assembly
- VSWR<1.20:1 to 18 GHz.

Cable Terminations:

- Bulkhead and PCB mount

Adapters:

- Within and between series

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Hermetic Seals:

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- Standard and custom

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SOLID STATE

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KIDDE INC.
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MATRIX SYSTEMS CORP.

See Matrix Systems Ad on Coaxial Switching

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INFO/CARD 45

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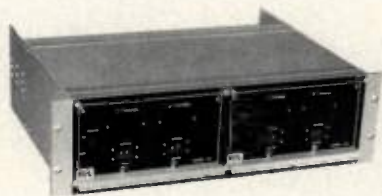
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Model 100 Switch Matrix



is featured as a 2×16 switch matrix. Designed to provide both manual and computer control, this network is ideally suited for general purpose switching and actuation of external devices from DC to 50 MHz. Mounted on the back panel is the switch module. The module contains the relay type switches arranged as a 50 ohm impedance system. Each channel can switch up to 1 amp at 28 VDC.



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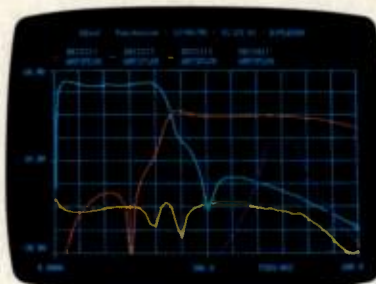
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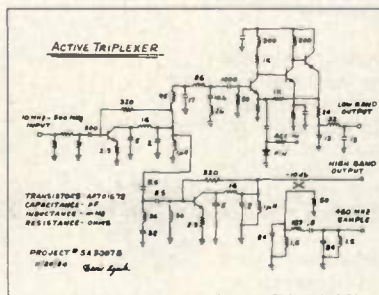


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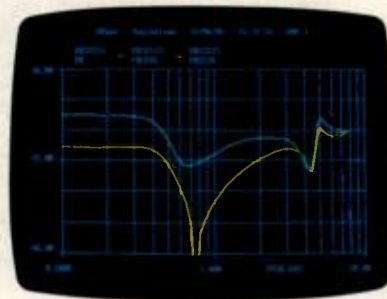
- A Touchstone analysis of an active triplexer circuit with sampled output.
- B Insertion loss and return loss of crystal filter analyzed over its narrow pass band.
- C Schematic diagram of the active triplexer analyzed above.
- D A log axis can be used for displaying very broad frequency ranges. This feed back amplifier operates over nearly a decade bandwidth.



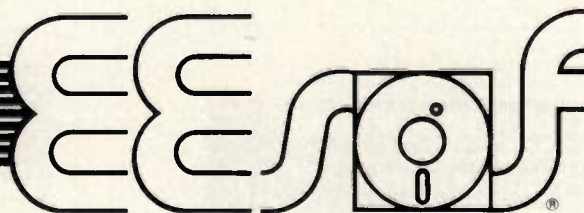
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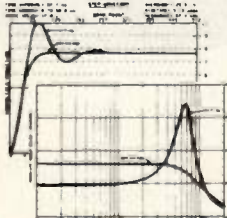
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INFO/CARD 49

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LIBERTY LABORATORIES
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NORAND EMC TEST LAB
RADIOMETRICS CORP.
TECHNOLOGY SERVICES CORP.
XETRON CORP.

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DESIGN AUTOMATION, INC.
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EI INTL, INC.
ELECTRO RENT CORPORATION
G & H TECHNOLOGY INC.
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INTERLEAVE, INC.
INTUSOFT
JENSEN TRANSFORMERS, INC.
MADE IT ASSOCIATES, INC.
RF ENGINEERING
SOF CAD ELECTRONICS, INC.
STAR MICROWAVE
TEST EQUIPMENT CORP.
WEBB LABORATORIES
XETRON CORP.

PC BOARD DESIGN

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COMPACT SOFTWARE, INC.
DAJEM TECHNOLOGY CO.
EESOF, INC.
INTERFERENCE CONTROL TECHNOLOGIES, INC.
INTERLEAVE, INC.
LPKF PACIFIC
PROTO CIRCUITS
SIGNATURE DESIGNS
XETRON CORP.

CIRCUIT OPTIMIZATION

ANALOP ENGINEERING
APPLIED I
CALREP
CIRCUIT BUSTERS, INC.
COMPACT SOFTWARE, INC.
DAJEM TECHNOLOGY CO.
DESIGN AUTOMATION, INC.
E.E. PUBLIC DOMAIN LIBRARY
EESOF, INC.
EI INTL, INC.

ELECTRO RENT CORPORATION
G & H TECHNOLOGY INC.
HARRIS MICROWAVE SEMICONDUCTOR
HAYWARD ELECTRONIC SYSTEMS, INC.
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INTUSOFT
JENSEN TRANSFORMERS, INC.
MADE IT ASSOCIATES, INC.
MICROWAVE SOFTWARE
RF ENGINEERING
SOF CAD ELECTRONICS, INC.
SPEFCO SOFTWARE
SUNCREST SOFTWARE
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APPLIED SPECIALTIES, INC.
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EESOF, INC.
HEWLETT-PACKARD CO.
INTERLEAVE, INC.
INTUSOFT
NORTH HILLS ELECTRONICS, INC.
SIGNATURE DESIGNS
WEINSCHTEL ENGINEERING

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CALREP
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COMPAC DEVELOPMENT CORP.
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CTS CORP.
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SKYDYNE
STRONGBOX
TELEMETRY TECHNOLOGIES, INC.
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DABURN ELECTRONICS & CABLE CORP.
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MORGAN MATROC, UNILATOR DIV.
MYKROY/MYCALEX CERAMICS
NTK TECHNICAL CERAMICS
OAKBURY COMPONENTS
PIEZO ELECTRIC PRODUCTS INC.
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TECHNICAL COMPONENTS INC.
VERNITRON CORP., PIEZO ELECTRIC DIV.

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MICRO CIRCUITS CO., INC.
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TAFI INC.

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HYBRIDS INTERNATIONAL, THICK FILM DIV.
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CRYSTAL TECHNOLOGY INC.
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HI-Q CRYSTALS
HYBRID INTL - THICK FILM DIV.
MATEC CORP./VALPEY - FISHER CORP.
MIDLAND ROSS/NEL UNIT
PIEZO TECHNOLOGY, INC.
REEVES - HOFFMAN
SOLITRON DEVICES, INC.

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BUDWIG MFG. CO.
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Taconic TLY-5	RT/duroid [®] 5880	DiClad [™] 880
Dielectric Constant		
2.2 ± .02	2.2 ± .02	2.17 ± .04
Thickness in Inches		
.0035 ± .00025	N/A	N/A
.005 ± .0005*	.005 ± .0005	N/A
.010 ± .0007*	.010 ± .0007	.010 ± .001
.020 ± .001	.020 ± .001	.020 ± .002
.031 ± .001	.031 ± .001	.030 ± .002

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DIELECTRICS
DIVISION

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EXPORT DEPARTMENT, P.O. BOX 1896, NEW HAVEN CT 06508

(203) 288-1638

TELEX: 963487

FAX: (203) 287-8099

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INFO/CARD 50



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VIEWSONICS
VITRO SERVICES CORP.

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JOSEPH ELECTRONICS INC.
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PNEUMAFIL CORP.
VIEWSONICS

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PALOMAR ENGINEERS
POLYMER CORP.
POLYMER DESIGN
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SIEMENS COMPONENTS INC., SPECIAL PRODUCTS DIV.
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MOUSER ELECTRONICS
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SUMITOMO ELEC.
TECH ETCH, INC.
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GE CERAMICS
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INJECTORALL ELECTRONICS
JOSEPH ELECTRONICS INC.
M.M. NEWMAN CORP.
POLYMER CORP.
TACONIC PLASTICS, LTD.

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CALREP
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E/M CORP.
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ELGIN ELECTRONICS
ENGLEHARD PREC. MICROWAVE CIRC.
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KEMTRON CIRCUITS & ELECTRONICS CORP.
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MOUSER ELECTRONICS
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PROTO CIRCUITS
REL LABS, INC.
SOLADYNE DIV. OF ROGERS CORP.
TEMEX ELECTRONICS INC.
WORLD BUSINESS CORP.

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GIGABIT LOGIC INC.
GILTRON INC.
INJECTORALL ELECTRONICS
JETTRON PRODUCTS, INC.
JOSEPH ELECTRONICS INC.
MOUSER ELECTRONICS
ONEIDA ELECTRONIC MFG CO. INC.
PROTO CIRCUITS

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M/A-COM OMNI SPECTRA, INC.
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MOTOROLA SEMICONDUCTORS
MURATA ERIE

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POLYFLON CO.
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ROGERS CORPORATION
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ESCO ASSOC.
GILTRON INC.
HENRY MANN INC.
HEXACON ELECTRIC CO.
JOSEPH ELECTRONICS INC.
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UTICA TOOL CO.

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AMPLIFIER RESEARCH
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EAGLE MAGNETIC CO. INC.
EG&G PRINCETON/ELECTROCHEMICAL INSTR
ELECTRO RENT
ENI POWER SYSTEMS
EPSCO, INC.-RF DIV.
EQUITABLE/RENTALCO CORP.
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HEWLETT-PACKARD CO.
HOPKINS ENGINEERING CO.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
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KROHN-HITE CORP.
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MICROWAVE SOLUTIONS INC.
MILCOM INTL
MILLIVAC INSTRUMENTS, INC.
PG. ELECTRONICS LTD.
RF POWER LABS INC.
ROSS ENGINEERING CORP.
RUBYTRON INSTRUMENTS
SIGNAL ONE
SYSTRON DONNER CORP., MICROWAVE DIV.
TE SYSTEMS
TEST EQUIPMENT CORP.
TEXSCAN INSTRUMENTS
TUCKER ELECTRONICS
U.S. INSTRUMENT RENTALS
VIEWSONICS
WI-COMM ELECTRONICS INC.
WIDE BAND ENGINEERING CO. INC.

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HEWLETT-PACKARD CO.
HOPKINS ENGINEERING CO.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
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SCIENTIFIC ATLANTA
SYSTRON DONNER CORP., MICROWAVE DIV.
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DATUM INC.
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MICROWAVE SYSTEMS INC.
MICROWAVE TECHNIQUES
RACAL-DANA INSTRUMENTS, INC.
RUTHERFORD RESEARCH
SPECTRACOM CORP.
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TUCKER ELECTRONICS
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WENZEL ASSOCIATES, INC.
WIDE BAND ENGINEERING CO. INC.

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HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.

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KDI ELECTRONICS
ELECTRONIC RESEARCH LABS
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RAYTHEON CO., MPTD
RESIN SYSTEMS CORP.
SYSTRON DONNER CORP., MICROWAVE DIV.
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SENCORE INC.
TEST EQUIPMENT CORP.
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ELECTRO RENT
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ELECTRO RENT
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IFR SYSTEMS INC.
JOSEPH ELECTRONICS INC.
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ELECTRONIC RESEARCH LABS
MARCONI INSTRUMENTS INC.
RACAL-DANA INSTRUMENTS, INC.
ROHDE & SCHWARZ-POLARAD, INC.
TEST EQUIPMENT CORP.
TEXSCAN INSTRUMENTS
U.S. INSTRUMENT RENTALS
WEINSCHEL ENGINEERING

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DAMON CORP/ELECTRONICS DIV.
DRANETZ TECHNOLOGIES, INC.
ELECTRO RENT
EQUITABLE/RENTTELCO CORP.
GENSTAR RENTAL ELECTRONICS, INC.
HARRIS CORP/GSSD/PRD INSTRUMENTS
HEWLETT-PACKARD CO.
HOPKINS ENGINEERING CO.
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TUCKER ELECTRONICS
U.S. INSTRUMENT RENTALS
WAVETEK MICROWAVE, INC.
WAVETEK RF PRODUCTS, INC.
WILTRON CO.

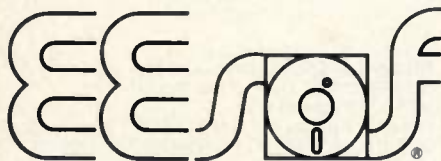
NOISE FIGURE METERS

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ANRITSU
CONTINENTAL RESOURCES, INC.
DAMON CORP./ELECTRONICS DIV.
ELECTRO RENT
EQUITABLE/RENTELCO CORP.
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HEWLETT-PACKARD CO.
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LEASEAMETRIC, INC.
LECTRONIC RESEARCH LABS
MICRONETICS INC.
RUBYTRON INSTRUMENTS
TEST EQUIPMENT CORP.
TUCKER ELECTRONICS
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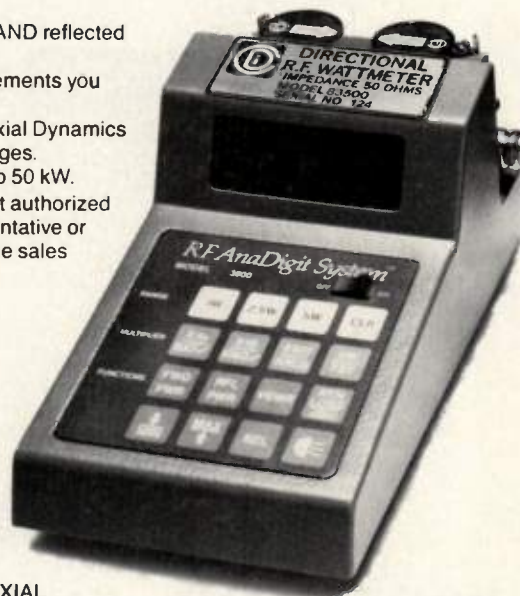
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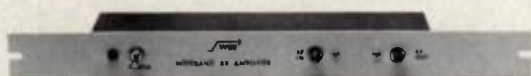
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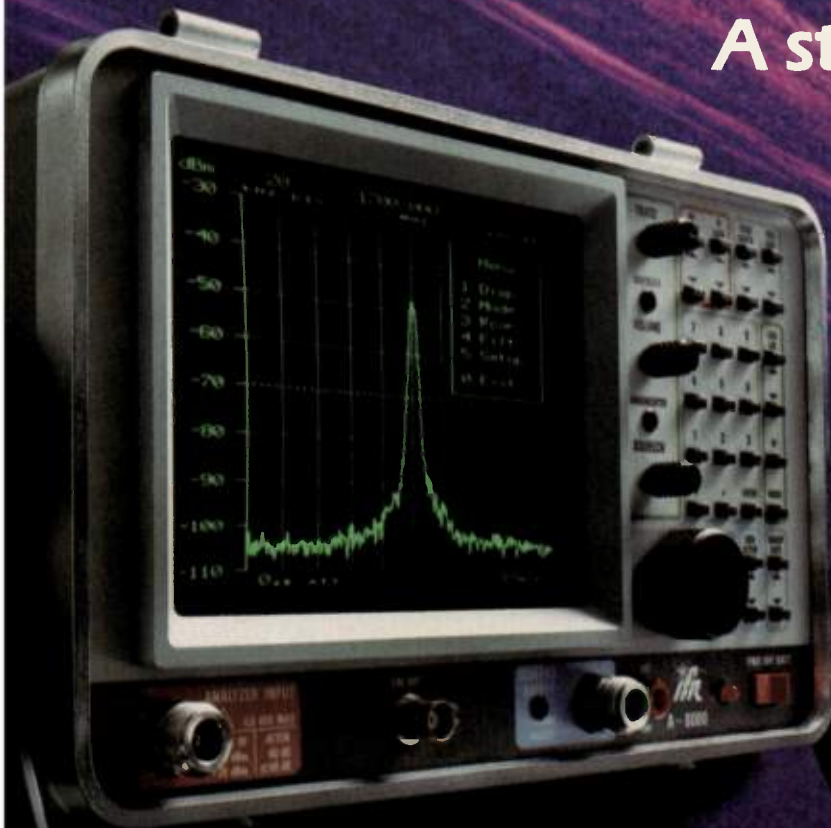
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The new A-8000, quite simply put, is our response to industry's demand for a higher frequency, yet still economical, Spectrum Analyzer.

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A-8000 and A-7550 Features — All Standard:

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- 300 Hz resolution bandwidth
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- IF gain in 1 dB steps
- Line, bar, average, compare and peak hold display modes
- 300 Hz and 30 kHz video filters
- 106 to 266 VAC operation without switching
- 12 to 30 VDC operation

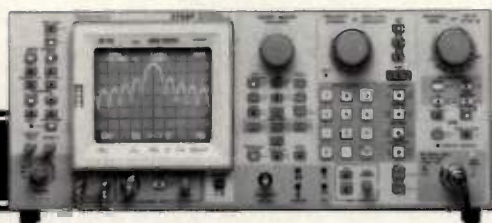
- *Optional Features Include:**
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 - Internal tracking generator with 1 dB step attenuator
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 - 75Ω adapter
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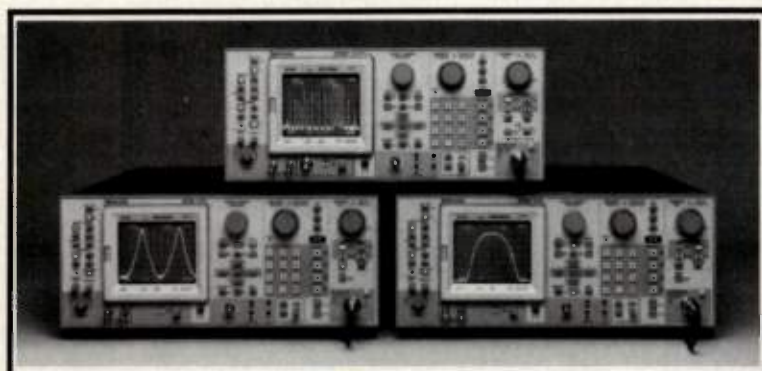
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2756P Laboratory Spectrum Analyzer



494AP Portable Spectrum Analyzer



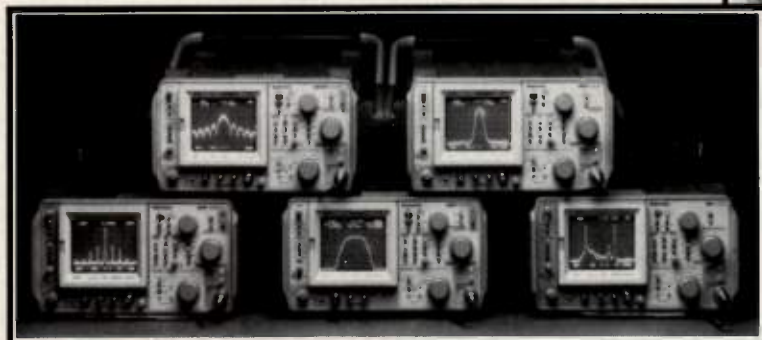
2750 Series Laboratory Spectrum Analyzers



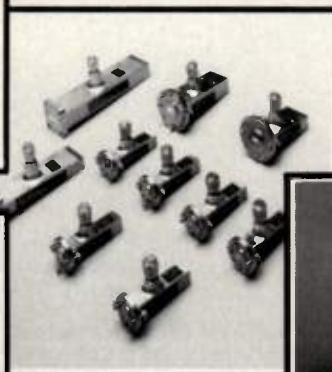
7000 Series Plug-in Spectrum Analyzers



2710 Low-Cost Portable Spectrum Analyzer



490 Series Portable Spectrum Analyzers



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SOFTWARE SUMMARY

Communication Products			
Application	Function/Product	Language	Runs on/with
Spectrum Analysis RF Microwave Millimeter-wave	S26RF00—General RF Application Software Package • Measurements • Waveform Operation • Filter Tests • Utilities • Signal Search • Remote Access	Tek 4041 BASIC HP BASIC 3.0 IBM Advanced BASIC 2.1	490P Series, 2750P Series, Spectrum Analyzers/ Tek 4041, HP9826, 9836 IBM PC Compatible
EMI Testing	S26EM00—EMI Prequalification Software FCC/VDE Conducted and Radiated MIL-STD-461B/462 Conducted and Radiated	IBM Compiled BASIC 2.0	490P Series and 2750P Spectrum Analyzers with IBM PC Compatible
Remote Site Monitoring	S26 RM00 Host/Operator's Package S26 RM01 Remote Site Package Monitor/Control Multiple Spectrum Analyzers	IBM BASIC	490P and 2750P Series Spectrum Analyzers

2750 SERIES LABORATORY SPECTRUM ANALYZERS

Model	Frequency Range	Resolution Range	Average Noise Level (Minimum BW)	Amplitude Measurement Range	GPB Capability	Tracking Generator	Frequency Accuracy
2753P New	100 Hz to 1.8 GHz	3 MHz to 10 Hz	-130 dBm	+30 to -130 dBm	Full	TR 503	$\pm[(2\% \text{ Span or Res BW}) + (F \times 10^{-9}) + 15 \text{ Hz}]$ Where: F = Center or Marker Freq
2754	50 kHz to 21 GHz	1 MHz to 1 kHz	-115 dBm	+30 to -115 dBm	Direct Plot	TR 503	$\pm[(20\% \text{ Span/Div or Res BW}) + (\text{Center or Marker Freq}) \times 10^{-5}] \text{ Hz}$
2754P	50 kHz to 21 GHz	1 MHz to 1 kHz	-115 dBm	+30 to -115 dBm	Full	TR 503	
2755	50 kHz to 325 GHz	1 MHz to 100 Hz	-125 dBm	+30 to -125 dBm	Direct Plot	TR 503	$[(20\% \text{ Span/Div or Res BW}) + (\text{Center or Marker Freq}) \times 10^{-5}] \text{ Hz}$
2755P	50 kHz to 325 GHz	1 MHz to 100 Hz	-125 dBm	+30 to -125 dBm	Full	TR 503	
2756P New	10 kHz to 325 GHz	3 MHz to 10 Hz	-134 dBm	+30 to -134 dBm	Full	TR 503	$\pm[(2\% \text{ Span or Res BW}) + (\text{Center or Marker Freq.} \times 10^{-9}) + (2N + 25 \text{ Hz})]$

490 SERIES PORTABLE SPECTRUM ANALYZERS

492A	50 kHz to 325 GHz	1 MHz to 100 Hz	-125 dBm	+30 to -125 dBm	Direct Plot	TR 503	$\pm[(20\% \text{ Span/Div or Res BW}) + (\text{Center or Marker Freq}) \times 10^{-5}] \text{ Hz}$
492AP	50 kHz to 325 GHz	1 MHz to 100 Hz	-125 dBm	+30 to -125 dBm	Full	TR 503	
494A New	10 kHz to 325 GHz	3 MHz to 10 Hz	-134 dBm	+30 to -134 dBm	Direct Plot	TR 503	$\pm[(2\% \text{ Span or Res BW}) + (\text{Center or Marker Freq} \times 10^{-9}) + (2N + 25 \text{ Hz})]$
494AP New	10 kHz to 325 GHz	3 MHz to 10 Hz	-134 dBm	+30 to -134 dBm	Full	TR 503	
495	100 Hz to 1.8 GHz	3 MHz to 10 Hz	-130 dBm	+30 to -130 dBm	Direct Plot	TR 503	$\pm[(2\% \text{ Span or Res BW}) + (F \times \text{Ref}) + 15 \text{ Hz}]$ Where: F = Center or Marker Freq Ref = 10^{-5} Standard 10^{-9} Option 05
495P	100 Hz to 1.8 GHz	3 MHz to 10 Hz	-130 dBm	+30 to -130 dBm	Full	TR 503	
496	1 kHz to 1.8 GHz	1 MHz to 30 Hz	-126 dBm	+30 to -126 dBm		TR 503	$\pm(5 \text{ MHz} + 2\% \text{ Span})$

2710 LOW-COST SPECTRUM ANALYZER

2710	10 kHz to 1.8 GHz	3 kHz to 5 MHz	-129 dBm w/built in pre amp	+20 to -129 dBm	To be announced	To be announced	CF x $10^{-5} \pm 5 \text{ kHz}$ CF x $10^{-5} \pm 10 \text{ Hz}$ (Option 02)
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7000 SERIES PLUG-IN SPECTRUM ANALYZERS

7L5 with L3	10 Hz to 5 MHz	10 Hz to 30 kHz	-148 dBV	+8 to -148 dBV	Semiautomatic with 7854	Option 25	$\pm(5 \text{ Hz} + 2 \times 10^{-6} \text{ Dot Freq})$
7L12	100 kHz to 1.8 GHz	300 Hz to 3 MHz	-115 dBm	+30 to -115 dBm	Semiautomatic with 7854	TR 502	$\pm(8 \text{ MHz} + 1\% \text{ of Dial})$
7L12 Option 39	100 kHz to 2.5 GHz	300 Hz to 3 MHz	-115 dBm	+30 to -115 dBm	Semiautomatic with 7854	TR 502 (to 1.8 GHz)	$\pm(8 \text{ MHz} + 1\% \text{ of Dial})$
7L14	10 kHz to 1.8 GHz	30 Hz to 3 MHz	-130 dBm	+30 to -130 dBm	Semiautomatic with 7854	TR 502	$\pm(5 \text{ MHz} + 2\% \text{ Span})$
7L14 Option 39	1 kHz to 2.5 GHz	30 Hz to 3 MHz	-130 dBm	+30 to -130 dBm	Semiautomatic with 7854	TR 502 (to 1.8 GHz)	$\pm(5 \text{ MHz} + 2\% \text{ Span})$

Contact your nearest Tektronix sales office (listed in major city directories) for more information. Or call 1-800-TEK-SPEC for descriptive literature. (In Oregon, (503) 235-7315). Tektronix, Inc., P.O. Box 15149, Portland, OR 97215. In Europe: Tektronix Europe B.V., P.O. Box 827, 1180 AV Amstelveen, The Netherlands.

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COILCRAFT

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HOPKINS ENGINEERING CO.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
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LECTRONIC RESEARCH LABS
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MAURY MICROWAVE CORP.
MEGARATE TEST PRODUCTS
MICROWAVE TECHNIQUES
MOTOROLA SEMICONDUCTORS
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PHOTO TRANSFER INDUSTRIES
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TUCKER ELECTRONICS

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DAMON CORP/ELECTRONICS DIV.
DRANETZ TECHNOLOGIES, INC.
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ELECTRO RENT
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HAMEG INC.
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MARCONI INSTRUMENTS INC.
PANASONIC INDUSTRIAL CO.
RUBYTRON INSTRUMENTS
SOLTEC CORP.
TEST EQUIPMENT CORP.
TUCKER ELECTRONICS
U.S. INSTRUMENT RENTALS

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E³ ENGINEERS INC.
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IRT CORP.
LIBERTY LABORATORIES
MICRO COMMUNICATIONS, INC.
MICROWAVE SPECIALTY CORP.
MM - WAVE TECHNOLOGY INC.
NORAND EMC TEST LAB
RADIOMETRICS CORP.
RADIOMETRICS MIDWEST CORP.
SOUTHWEST RESEARCH INSTITUTE

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CTS CORP./KNIGHTS DIV.
E³ ENGINEERS INC.
E/M CORP.

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GENERAL SERVICES ENGINEERING, INC.
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HYBRID INTL - THICK FILM DIV.
HYBRID-TEK, INC.
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MICROWAVE SOLUTIONS INC.
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N. AMERICAN PHILIPS, SMD TECH.
NORCOMM CORP.
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RCD COMPONENTS INC.
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REPCO INC.
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MICROWAVE SOFTWARE APPLICATIONS, INC.
MICROWAVE SOLUTIONS INC.
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NELCO
NORAND EMC TEST LAB
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RADIOMETRICS MIDWEST CORP.
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MICROWAVE SOLUTIONS INC.
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SOLITRON DEVICES, INC.
TEKTRON MICRO ELECTRONICS INC.
TELEDYNE MICROELECTRONICS
TOKO AMERICA, INC.
TRW RF DEVICES

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ANALOG DEVICES, INC.
ANALOG SOLUTIONS
AYDIN VECTOR DIV.
DATEL, INC.
ENGLEHARD INDS
EPITRONICS CORP.
GENERAL ELECTRIC MW SUBSYSTEMS
GIGABIT LOGIC INC.
HYPRES INC.
ITT DEFENSE
LINEAR TECHNOLOGY INC.
MICROWAVE SEMICONDUCTOR CORP.
NEC ELECTRONICS, INC.
PACIFIC MONOLITHICS
PHOTO TRANSFER INDUSTRIES
REL LABS, INC.
RF MONOLITHICS INC.
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SOLITRON DEVICES, INC.
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TOKO AMERICA, INC.
TRIQUINT SEMICONDUCTOR INC.

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CARNEL LABS CORP.
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COMSEARCH APPLIED TECHNOLOGY
CONTINENTAL TESTING LABORATORIES
CURTIS INDUSTRIES
DETROIT TESTING LABORATORY, INC.
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NORAND EMC TEST LAB
R & B ENTERPRISES
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RADIOMETRICS CORP.
RADIOMETRICS MIDWEST CORP.
RETLIF, INC. TESTING LABORATORIES
RUTHERFORD RESEARCH
SANDERS, A LOCKHEED CO.
SMITH ELECTRONICS, INC.
SOLITRON DEVICES, INC.
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TEXAS SPECTRUM ELECTRONICS INC.
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UNDERWRITERS LABORATORIES INC.

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ELECTRO RENT CORPORATION
EQUITABLE/RENTALCO CORP.
EXPERIMENTAL PHYSICS CORP.
GILTRON INC.
HUGHES AIRCRAFT CO. MICROWAVE PRODUCTS DIV.
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MICROWAVE DEVICES, INC.
RADIOMETRICS CORP.
RADIOMETRICS MIDWEST CORP.
RUBYTRON INSTRUMENTS
SAGE ENTERPRISES INC.
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TUCKER ELECTRONICS
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RUBYTRON INSTRUMENTS
TEST EQUIPMENT CORP.
TUCKER ELECTRONICS
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E/M CORP.
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EPSILON LAMBDA ELECTRONICS CORP.
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GROUP J INC.
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SOLITRON DEVICES, INC.
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TEXSCAN INSTRUMENTS

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OPTICAL COATING LABS (OCL)
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IDEAS, INC.
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MADE IT ASSOCIATES, INC.
MCH ASSOCIATES
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MICROWAVE SOFTWARE
MICROWAVE SOFTWARE APPLICATIONS, INC.
NORAND EMC TEST LAB
RADIOMETRICS CORP.
SIGNAL ONE
SIGNATURE DESIGNS

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POLYMER DESIGN
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ANECHOIC/EMI SYSTEMS
TDK CORP. OF AMERICA

AC LINE FILTERS

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CORCOM, INC.
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EEE ELECTRONICS, INC.
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RFI CORP.
RTE AEROVOX
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VIEWSONICS

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ESPEC CORP.
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RANTEC DIV., EMERSON ELECTRIC CO.
ANECHOIC/EMI SYSTEMS
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CARROLL COATINGS CO., INC.
CHOMERICS, INC.
E/M CORP.
EVAPORATED COATINGS, INC.
G.C. ELECTRONICS CO.
INSTRUMENT SPECIALTIES CO., INC.
LEBOW CO.
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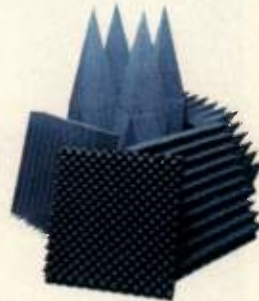
AEMI's transmission tunnel allows measurement of dielectric parameters in the 2 to 18 GHz range.

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SPIRA MFG CORP.

SRS INDUSTRIES
TDK CORP. OF AMERICA
TECH ETCH, INC.
TECKNIT A TWP CO.

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TRI-MAG INC.

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CALREP
COMPAC DEVELOPMENT CORP.
COMSEARCH APPLIED TECHNOLOGY
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EAGLE MAGNETIC CO INC.
ELECTRONIC CONSTRUCTION
ENCLOSURE CORP.
EQUIPTO ELECTRONICS CORP.
HOFFMAN ENGINEERING CO.
INTERNATIONAL STEEL CO./LINDSAY STRUCTURES
JOE QUIN MFG. CORP.
LINDGREN R.F. ENCLOSURES INC.
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MCDONALD ASSOCIATES
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ANECHOIC/EMI SYSTEMS
SIEMENS COMPONENTS INC., SPECIAL PRODUCTS DIV.

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CHOMERICS, INC.
CORE-TRONICS DIV. KRYSTINEL CORP.
EAGLE MAGNETIC CO INC.
MAGNETIC RADIATION LABORATORIES, INC.
MAGNETIC SHIELD DIV., PERFECTION MICA CO.
MAGNETICS, DIV. OF SPANG & CO.
NOVAMET SPECIALTY PRODUCTS CORP.
RF COMPONENTS
SIEMENS COMPONENTS INC., SPECIAL PRODUCTS DIV.
STACKPOLE CORP.
TAFE INC.
ZIPPERTUBING CO., THE

FOIL

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AVL INDUSTRIES, INC.
CALMONT ENGINEERING AND ELECTRONICS CORP.
CHOMERICS, INC.
EAGLE MAGNETIC CO INC.
MAGNETIC RADIATION LABORATORIES, INC.
MAGNETIC SHIELD DIV., PERFECTION MICA CO.
MAGNETICS, DIV. OF SPANG & CO.
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ZIPPERTUBING CO., THE

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L-Section Conjugate Bilateral Match of Complex Impedances

The L-section provides a conjugate bilateral match between a complex source and load. It is the simplest discrete-component matching section, providing satisfactory results at frequencies where parasitic reactances and couplings are negligible. Bandwidth is usually large, providing that input and output impedances are comparable. Good results are also obtained for large impedance differences, but bandwidth decreases.

$$X_a = -\frac{R_i^2 + X_i^2}{QR_i + X_i}$$

$$X_b = QR_o - X_o$$

$$Q = \pm \sqrt{\frac{R_i[1 + (X_i/R_i)^2]}{R_o} - 1}$$

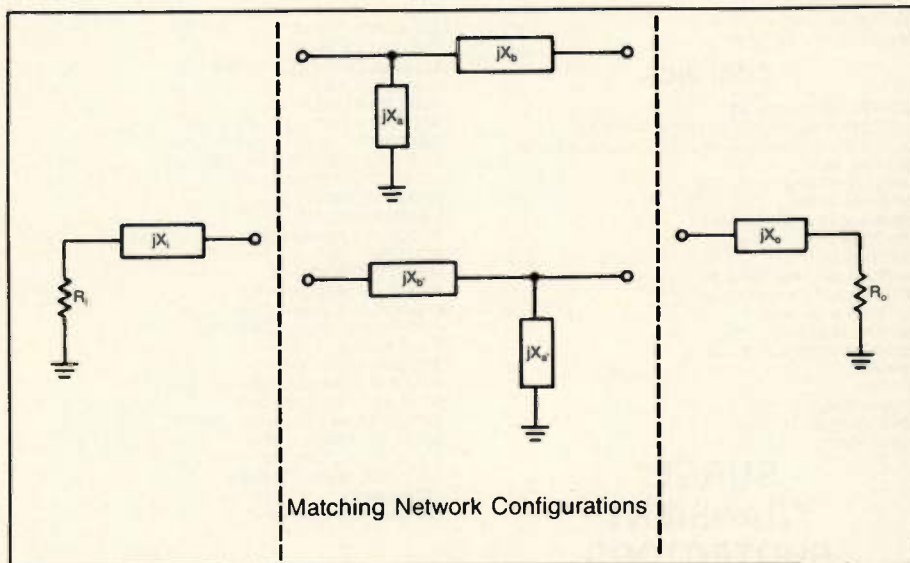
$$X_a = -\frac{R_o^2 + X_o^2}{QR_o + X_o}$$

$$X_b = Q'R_iX_i$$

$$Q' = \pm \sqrt{\frac{R_o[1 + (X_o/R_o)^2]}{R_i} - 1}$$

Examples

At least two possible solutions will exist ("lowpass" and "highpass" configurations). In some cases, all four configurations can be obtained. Ideal components



are assumed, which is valid since circuit Q is usually low.

1. Circuit values:

$$\begin{aligned} R_i &= 4.13 \\ X_i &= -13.76 \\ R_o &= 2.00 \\ X_o &= 6.00 \end{aligned}$$

Possible Solutions:

$$\begin{aligned} X_a &= -31.91 & X_b &= 3.80 \\ X_a &= 6.07 & X_b &= -15.80 \\ X_a' &= -4.03 & X_b' &= 21.86 \\ X_a' &= -19.24 & X_b' &= 5.66 \end{aligned}$$

2. Circuit values:

$$\begin{aligned} R_i &= 2.0 \\ X_i &= 2.0 \\ R_o &= 4.13 \\ X_o &= -13.76 \end{aligned}$$

Possible Solutions:

$$\begin{aligned} X_a &= -31.91 & X_b &= 7.80 \\ X_a' &= 6.07 & X_b' &= -11.80 \end{aligned}$$

Reference

A. Przedpelski, "Simplify Conjugate Bilateral Matching," *Electronic Design* 5, March 1, 1978, p.54

```

10 REM CALCULATES "L" MATCHING CIRCUIT
10 REM CALCULATES "L" MATCHING CIRCUIT
20 PROGRAM NO. 508 - "LMATCH"
22 REF: ELECTRONIC DESIGN 5, MARCH 1, 1978, p. 54
30 A. PRZEDPELSKI - 8 FEB 1978
32 A.R.F. PRODUCTS, INC.
34 2559 75TH STREET
36 BOULDER, CO 80301
40 I=0 @ Z=1
50 DISP "Ro=?";Ro
60 GOSUB 410
70 Ro=X
80 DISP "Xo=?";Xo
90 GOSUB 410
100 Xo=X
110 DISP "Ri=?";Ri
120 GOSUB 410
130 Ri=X
140 DISP "Xi=?";Xi
150 GOSUB 410
160 Xi=X
170 PRINT TAB (12); "CIRCUIT VALUES"
180 PRINT
190 PRINT USING 280 ; "Ri=", Ri, "Ro=", Ro
200 PRINT USING 280 ; "Xi=", Xi, "Xo=", Xo
210 PRINT @ PRINT
220 K=Ri/Ro*(1+(Xi/Ri)^2)-1
230 IF K<= 0 THEN GOTO 540
240 Q=SQR (K)
250 GOSUB 470

```

```

260 Q=-Q @ Z=Z+1
270 GOSUB 470
280 IMAGE 3X, 3A, 4D, 2D, 12X, 3A, 4D, 2D
290 Ri1=Ro @ Ro0=Ri
300 Ro=Ro0 @ Ri=Ri1
310 Xi1=Xo @ Xo=Xi
320 Xo=Xo0 @ Xi=Xi1
330 K=Ri/Ro*(1+(Xi1/Ri)^2)-1
340 IF K<= 0 THEN GOTO 540
350 Q=SQR (K)
360 Z=Z+1 @ Q=-Q
370 GOSUB 470
380 Q=-Q @ Z=Z+1
390 GOSUB 470
400 GOTO 40
410 I=I+1
420 DISP TAB (10); "INSERT NEW VALUE"
430 DISP TAB (10); "OR '0' TO RETAIN"
440 INPUT X
450 IF X THEN RETURN
460 ON I GOTO 80, 110, 140, 220
470 Xa=-((Ri^2+Xi^2)/(Q*Ri+Xi))
480 Xb=Q*Ro-Xo
490 PRINT TAB (12); "CIRCUIT"; Z
500 PRINT
510 PRINT USING 280 ; "Xa=", Xa, "Xb=", Xb
520 PRINT @ PRINT
530 RETURN
540 PRINT TAB (7); "N O SOLUTION"
550 END

```

BASIC program listing for computation of L-section matching network.

Minimum Q T-Section Conjugate Bilateral Match of Complex Impedances

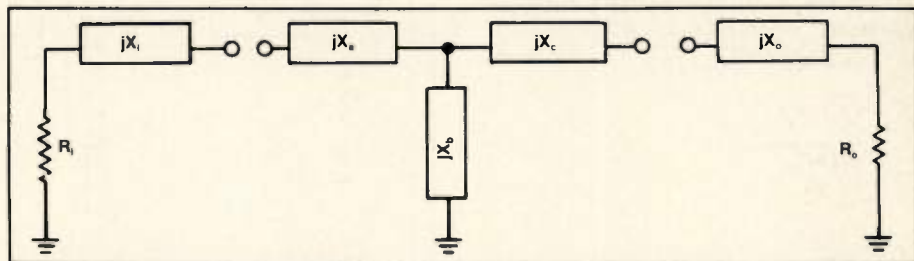
The circuit shown here is the T version of the three element matching circuit. The related design equations are shown below. While the circuit seems similar to the PI version, the frequency is different. Note that two solutions exist.

$$Q = \pm \sqrt{\frac{R_i}{R_o} - 1}$$

$$X_a = -X_i$$

$$X_o = \frac{R_i}{Q}$$

$$X_c = -(X_o + QR_o)$$



The T version matching circuit.

Examples

1. Circuit Values
 $R_i = 2.00$ $R_o = 4.13$
 $X_i = 6.00$ $X_o = -13.76$

2. Circuit Values
 $R_i = 4.13$ $R_o = 2.00$
 $X_i = -13.76$ $X_o = 6.00$

Reference

1. A. Przedpelski, "Simplify Conjugate Bilateral Matching," *Electronic Design* 5, March 1, 1978, p. 54.

```

10 REM CALCULATES MINIMUM Q T MATCHING CIRCUIT
20 PROGRAM NO. 510 - "LDQT"
22 REF: ELECTRONIC DESIGN 5, MARCH 1, 1978, p. 54
24 "SIMPLIFY CONJUGATE BILATERAL MATCHING"
30 A. PRZEDPELSKI - 9 FEB 1983
32 A.R.F. PRODUCTS, INC.
34 2559 75TH STREET
36 BOULDER, CO 80301
40 I=0 @ Z=0
50 DISP "Ro=?";Ro
60 GOSUB 310
70 Ro=X
80 DISP "Xo=?";Xo
90 GOSUB 310
100 Xo=X
110 DISP "Ri=?";Ri
120 GOSUB 310
130 Ri=X
140 DISP "Xi=?";Xi
150 GOSUB 310
160 Xi=X
170 PRINT TAB (12); "CIRCUIT VALUES"
180 PRINT
190 PRINT USING 280 ; "Ri=", Ri, "Ro=", Ro
200 PRINT USING 280 ; "Xi=", Xi, "Xo=", Xo
210 PRINT @ PRINT
220 R=0
230 IF Ri<Ro THEN GOSUB 470
240 Q=SQR (Ri/Ro-1)
250 GOSUB 370
260 Q=-Q @ Z=Z+1
270 GOSUB 370
280 IMAGE 3X, 3A, 4D.2D, 12X, 3A, 4D.2D
290 IF R=-1 THEN GOSUB 480
300 GOTO 40
310 I=I+1
320 DISP TAB (10); "INSERT NEW VALUE"
330 DISP TAB (10); "OR '0' TO RETAIN"
340 INPUT X
350 IF X THEN RETURN
360 ON I GOTO 30, 110, 140, 230
370 Xa=-Xi
380 Xb=Ri/Q
390 Xc=-(Xo+Ro*Q)
400 IF R=-1 THEN GOSUB 510
410 PRINT TAB (20); "CIRCUIT"; Z
420 PRINT
430 PRINT USING 440 ; "Xa=", Xa, "Xb=", Xb, "Xc=", Xc
440 IMAGE 3X, 3A, 4D.2D, 7X, 3A, 4D.2D, 7X, 3A, 4D.2D
450 PRINT @ PRINT
460 RETURN
470 R=-1
480 Ri=Ri @ Ro=Ro @ Xi=Xi @ Xo=Xo
490 Ro=Ri @ Ri=Ro @ Xo=Xi @ Xi=Xo
500 RETURN
510 Xaa=Xa @ Xcc=Xc
520 Xc=Xaa @ Xa=Xcc
530 RETURN
540 END

```

The minimum Q T-matching circuit values can be obtained with this program.

Minimum Q PI Conjugate Bilateral Match of Complex Impedances

This matching circuit is similar to the L-section but uses one additional reactive component. This is a minimum Q design. The frequency response can be obtained by using the program on *Response of a Four-Element Reactive Network*.

$$A = X_i^2 + R_i^2$$

$$B = X_o^2 + R_o^2$$

$$Q = \pm \sqrt{\frac{AR_o}{BR_i} + 1}$$

$$X_o = -\frac{A}{X_i + QR_i}$$

$$X_o = \frac{QB}{R_o}$$

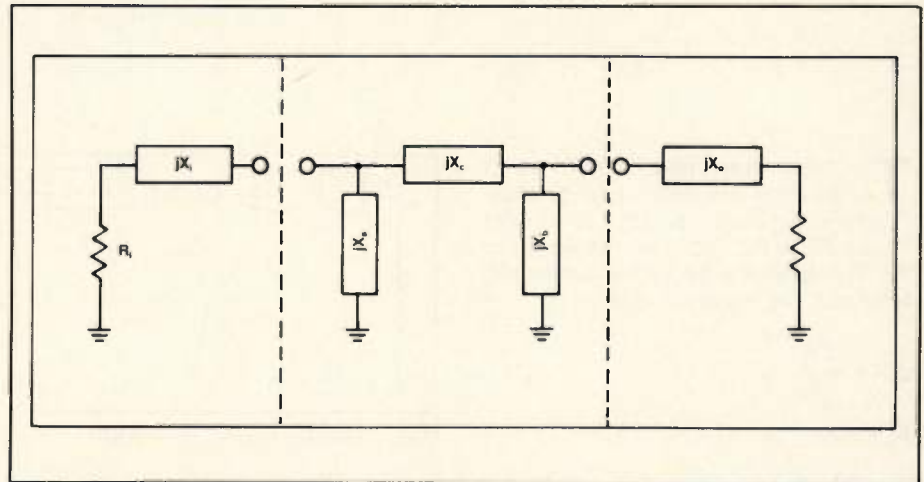
$$X_c = -\frac{B}{X_o}$$

Examples

The circuit values below were entered into the program and the results are shown.

1. Circuit Values

$R_i = 4.13$ $R_o = 2.00$
 $X_i = -14.76$ $X_o = 6.00$



Matching network configurations.

Circuit 1

$X_i = 25.67$ $X_o = 27.16$ $X_c = -6.67$

Circuit 2

$X_i = 11.53$ $X_o = -27.16$ $X_c = -6.67$

Circuit 1

$X_i = -6.67$ $X_o = 27.16$ $X_c = 25.67$

Circuit 2

$X_i = -6.67$ $X_o = -27.16$ $X_c = 11.53$

References

1. A. Przedpelski, "Simplify Conjugate Bilateral Matching," *Electronic Design* 5, March 1, 1978, p. 54.

```

10 REM CALCULATES MINIMUM Q PI MATCHING CIRCUIT
20 PROGRAM NO. 509 - "LOOPPI"
22 REF: ELECTRONIC DESIGN 5, MARCH 1, 1978, p. 54
24 "SIMPLIFY CONJUGATE BILATERAL MATCHING"
30 A. PRZEDPELSKI - 8 FEB 1983
32 A.R.F. PRODUCTS, INC.
34 2559 75TH STREET
36 BOULDER, CO 80301
40 I=0 @ Z=1
50 DISP "Ro=?";Ro
60 GOSUB 340
70 Ro=X
80 DISP "Xo=?";Xo
90 GOSUB 340
100 Xo=X
110 DISP "Ri=?";Ri
120 GOSUB 340
130 Ri=X
140 DISP "Xi=?";Xi
150 GOSUB 340
160 Xi=X
170 PRINT TAB (12);"CIRCUIT VALUES"
180 PRINT
190 PRINT USING 310 ; "Ri=",Ri,"Ro=",Ro
200 PRINT USING 310 ; "Xi=",Xi,"Xo=",Xo
210 PRINT @ PRINT
220 R=0
230 IF Ro*(Xi^2+Ri^2)<Ri*(Xo^2+Ro^2) THEN GOSUB 500
240 A=Xi^2+Ri^2
250 B=Xo^2+Ro^2
260 K=A*Ro/(B*Ri)-1
270 Q=SQR (K)
280 GOSUB 400
290 Q=-Q @ Z=Z+1
300 GOSUB 400
310 IMAGE 3X,3A,4D.2D,12X,3A,4D.2D
320 IF R=-1 THEN GOSUB 510
330 GOTO 40
340 I=I+1
350 DISP TAB (10);"INSERT NEW VALUE"
360 DISP TAB (10);"OR '0' TO RETAIN"
370 INPUT X
380 IF X THEN RETURN
390 ON I GOTO 80,110,140,230
400 Xa=-(A/(Xi+Q*Ri))
410 Xb=Q*B/Ro
420 Xc=-(B/Xo)
430 IF R=-1 THEN GOSUB 540
440 PRINT TAB (20);"CIRCUIT";Z
450 PRINT
460 PRINT USING 470 ; "Xa=",Xa,"Xb=",Xb,"Xc=",Xc
470 IMAGE 3X,3A,4D.2D,7X,3A,4D.2D,7X,3A,4D.2D
480 PRINT @ PRINT
490 RETURN
500 R=-1
510 Rii=Ri @ Roo=Ro @ Xii=Xi @ Xoo=Xo
520 Ro=Rii @ Ri=Roo @ Xo=Xii @ Xi=Xoo
530 RETURN
540 Xaa=Xa @ Xcc=Xc
550 Xc=Xaa @ Xa=Xcc
560 RETURN
570 END

```

This program calculates minimum Q PI matching circuits.

Matching Low Pass Filter With a Trap

This is a modified m-derived lowpass filter. A PI lowpass filter can be made to provide very high attenuation at a frequency above the passband while providing impedance transfer. This circuit is useful as a transmitter output filter to attenuate harmonics.

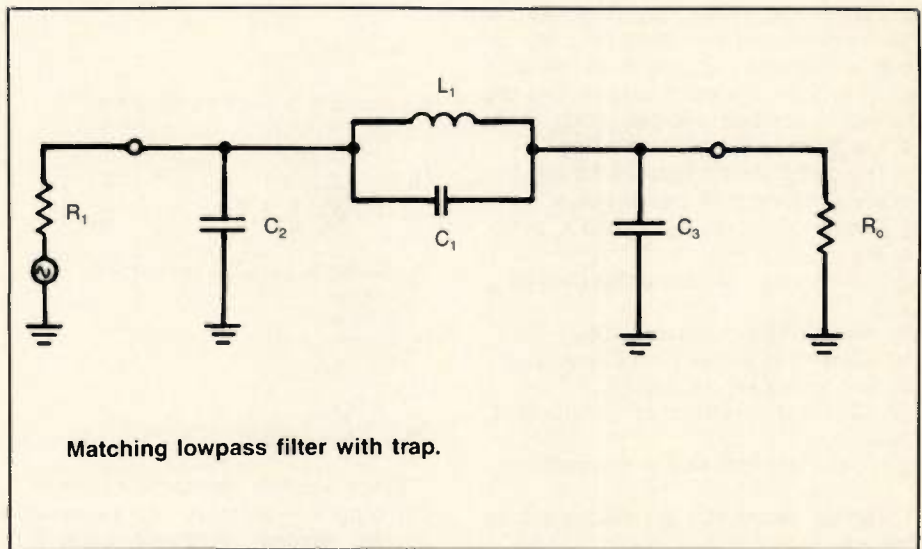
$$C_1 = \frac{F_o (1 + Q^2)}{2\pi R_i (F_a^2 - F_o^2) [Q + \sqrt{\frac{R_o}{R_i} (1 + Q^2) - 1}]}$$

$$L_1 = \frac{1}{2(\pi F_a)^2 C_1}$$

$$C_2 = \frac{Q}{(2\pi F_o R_i)}$$

$$C_3 = \frac{\sqrt{\frac{R_o}{R_i} (1 + Q^2) - 1}}{2\pi F_o R_o}$$

The inputs are F_o (cut-off frequency), F_a (trap frequency), R_i (source resistance), R_o (load resistance), and Q (a semi arbitrary value). Choose a value of Q that is larger than Q_{min} and configure the filter



such that $R_i > R_o$. The filter is bidirectional. Check the response and change Q if necessary.

Example

Circuit Characteristics
 $R_i = 150.00$ $F_o = 5.00E+006$
 $R_o = 50.0$ $F_a = 1.00E+007$

Calculated Circuit Values

$Q_{min} = 1.41$
 $Q = 1.50$
 L_1 (henry) = $1.97E-006$

C_1 (farads) = $1.29E-010$
 C_2 (farads) = $3.18E-010$
 C_3 (farads) = $1.84E-010$

```

10 REM CALCULATION OF LOWPASS TRAP COMPONENTS - #503
20 REM      A. PRZEDPELSKI - 5 FEB 1983
30 REM      A.R.F. PRODUCTS, INC.
40 REM      BOULDER, CO
50 REM ***** ENTER DATA *****
60 DISP "Ri (OHMS)=";
70 INPUT Ri
80 DISP "Ro (OHMS)="; ! NOTE: Ro<Ri
90 INPUT Ro
100 DISP "Fo (Hz)="; ! CUT-OFF FREQUENCY
110 INPUT Fo
120 DISP "Fa (Hz)="; ! FREQUENCY OF HIGH ATTENUATION
130 INPUT Fa
140 Qmin=SQR (Ri/Ro-1)
150 DISP "Qmin=";Qmin
160 DISP "Q="; " (Q must be larger than Qmin)"
170 INPUT Q
180 C1=Fo*(1+Q^2)/(2*PI *Ri*(Fa^2-Fo^2)*(Q+SQR (Ro/Ri*(1+Q^2)-1)))
190 L1=1/((2*PI *Fa)^2*C1)
200 C2=Q/(2*PI *Fo*Ri)
210 C3=SQR (Ro/Ri*(1+Q^2)-1)/(2*PI *Fo*Ro)
220 PRINT TAB (10); "CIRCUIT CHARACTERISTICS"
230 PRINT
240 PRINT USING 350 ; "Ri=",Ri,"Fo=",Fo
250 PRINT USING 350 ; "Ro=",Ro,"Fa=",Fa
260 PRINT
270 PRINT
280 PRINT TAB (10); "CALCULATED CIRCUIT VALUES"
290 PRINT
300 PRINT USING 330 ; "Qmin=",Qmin,"C1 (FARADS)=",C1
310 PRINT USING 330 ; "Q=",Q,"C2 (FARADS)=",C2
320 PRINT USING 340 ; "L1 (HENRY)=",L1,"C3 (FARADS)=",C3
330 IMAGE 3X,5A,3D.DD,15X,12A,MD.DDE
340 IMAGE 3X,11A,MD.DDE,5X,12A,MD.DDE
350 IMAGE 3X,3A,4D.D,12X,4A,D.DDE
360 END

```

This program performs calculations for lowpass trap components.

Response of a Four-Element Reactive Network

The frequency response of L, PI and T matching networks, as well as other four-element networks of suitable configuration, can be calculated. The program shown does not consider step up or down due to impedance ratio. First, the reflection coefficient is calculated followed by the loss caused by mismatch. Since ideal components are assumed, parasitic reactances at high frequencies may cause errors. Also since these circuits have low Q values, the resistive losses in the components have been neglected. At each normalized frequency, F/F_0 , the circuit is stepwise reduced (from the load side) to a simple configuration and the reflection coefficient is calculated. From it, the mismatch loss is obtained.

The calculation sequence for the frequency response is shown below.

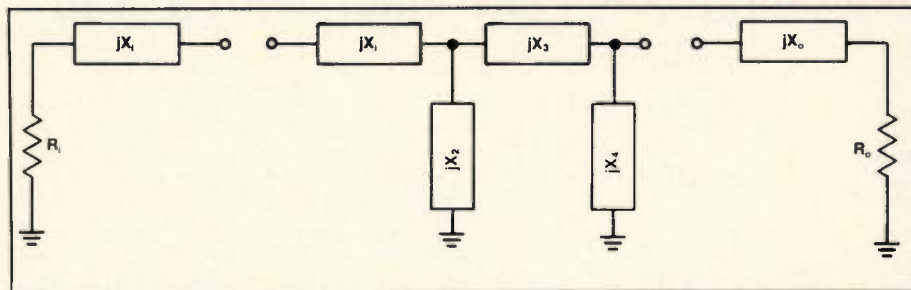
- Convert X_1 , X_0 , X_1 , X_2 , X_3 and X_4 at frequency F.
- Convert $R_0 + jX_0$ to parallel form $[R_{op}, X_{op}]$.
- Add parallel reactances (X_9)
- Convert to series form $[R_{10} + jX_{10}]$
- Add series reactances $[X_{11}]$
- Calculate reflection coefficient, gamma.
- Calculate loss due to mismatch.

The equations that are utilized are as follows:

- Addition of parallel reactances

$$X = \frac{1}{\frac{1}{X_1} + \frac{1}{X_2}}$$

- Transmitted power
Incident power = $1 - \Gamma^2$



- Addition of series reactances

$$jX = jX_1 + jX_2$$

- Parallel to series conversion

$$R_s = \frac{R_p}{\left(\frac{R_p}{X_p}\right)^2 + 1} \quad X_s = \frac{X_p}{\left(\frac{X_p}{R_p}\right)^2 + 1}$$

- Series to parallel conversion.

$$R_p = \frac{X_s^2}{R_s} + R_s$$

$$X_p = \frac{R_s^2}{X_s} + X_s$$

When a series element is not used in the program, enter 0. For an unused parallel element reactance, enter IE5. When reactances are capacitive, a minus (-) sign should be used.

Examples

- Circuit Values

$$R_1 = 2.00 \quad X_1 = 6.00 \\ X_2 = 14.00 \quad X_3 = -65.62$$

$$R_0 = 4.13 \quad X_0 = -13.76 \\ X_3 = -14.83 \quad X_4 = 100000.00$$

F/F ₀ Ratio	Response, dB
.25	-25.42
.50	-17.53
.75	-9.74
1.00	-.00
1.25	-7.80
2.00	-17.56
10.00	-34.62

- Circuit Values

$$R_1 = 2.00 \quad X_1 = 6.00 \\ X_2 = 0.00 \quad X_3 = 100000.00$$

$$R_0 = 4.13 \quad X_0 = -13.76 \\ X_3 = 3.80 \quad X_4 = -31.91$$

F/F ₀ Ratio	Response, dB
.25	-19.12
.50	-11.44
.75	-4.71
1.00	-.00
1.25	-3.38
2.00	-11.57
10.00	-30.17

References

- A. Przedpelski, "Eliminate Bandwidth Calculation Drudgery with a Universal Calculator Program," *Electronic Design* 21, October 11, 1979, p. 154.

```

10 REM FREQUENCY RESPONSE OF A FOUR ELEMENT REACTIVE NETWORK
20 PROGRAM NO. 513 "LPITRESP"
21 REF: ELECTRONIC DESIGN 21, OCTOBER 11, 1979, p. 154
22 "ELIMINATE BANDWIDTH CALCULATION DRUDGERY WITH
23 A UNIVERSAL CALCULATOR PROGRAM"
24 A. PRZEDPELSKI 15 FEB 1983
25 A.R.F. PRODUCTS, INC.
26 2559 75TH STREET
27 BOULDER, CO 80301
28
29 PAGESIZE 24
30 DISP "R0=";R0
31 DISP "X0=";X0
32 DISP "R1=";R1
33 DISP "X1=";X1
34 DISP "X2=";X2
35 DISP "X3=";X3
36 DISP "X4=";X4
37 DISP TAB (6);"CHANGE ANY VALUES BY OVERPRINTING AND 'END LINE'"
38 DISP TAB (6);"USE (-) FOR CAPACITIVE REACTANCE, ALL REACTANCES AT F0"
39 DISP TAB (6);"CONTJ TO PROCEED" @ PAUSE
40 CLEAR
41 PRINT TAB (12);"CIRCUIT VALUES" @ PRINT
42 PRINT USING 200 : "R1=",R1,"X1=",X1,"R0=",R0,"X0=",X0
43 PRINT USING 200 : "X1=",X1,"X2=",X2,"X3=",X3,"X4=",X4
44 IMAGE 3A,6D,2D,5X,3A,6D,2D,5X,3A,6D,2D,5X,3A,6D,2D
45 PRINT @ PRINT
46
47 PRINT USING "3X,12A,7X,12A" : "F/F0 RATIO", "RESPONSE, DB"
48 PRINT
49 DISP "FREQUENCY RATIO=?" @ INPUT FR
50 X0C=X0*FR @ IF X0<0 THEN X0C=X0/FR
51 R0P=X0C^2/R0+R0 @ X0P=R0^2/X0C+X0C
52 X4C=X4*FR @ IF X4<0 THEN X4C=X4/FR
53 X5=1/(1/X0P+1/X4C)
54 R6=R0P/(1+R0P^2/X5^2)
55 X6=X5*R0P^2/(X5^2+R0P^2)
56 X3C=X3*FR @ IF X3<0 THEN X3C=X3/FR
57 X7=X6+X3C
58 RB=X7^2/R6+R6
59 X0=X0C^2/X7+X7
60 X2C=X2*FR @ IF X2<0 THEN X2C=X2/FR
61 X9=1/(1/X2C+1/X8)
62 R10=RB/(1+RB^2/X9^2)
63 X10=X9*RB^2/(X9^2+RB^2)
64 X1C=X1*FR @ IF X1<0 THEN X1C=X1/FR
65 X1C=X1*FR @ IF X1<0 THEN X1C=X1/FR
66 X11=X1C+X10+X1C
67 G=SOR ((R10-R1)^2+X11^2)/SOR ((R10+R1)^2+X11^2)
68 GAIN=10*LG (1-G^2)
69 PRINT USING "6X,3D,2D,14X,4D,2D." : FR,GAIN
70 DISP TAB (10);"ENTER NEW FREQUENCY"
71 DISP TAB (10);"OR 0 TO CHANGE VALUES"
72 INPUT FR @ IF FR THEN 250 ELSE 50
73 END

```

This BASIC program calculates the response of a four-element reactive network.

Integrator Slew Rate

Complex active integrators are used in PLL circuits as lowpass filters after phase/frequency comparators. Their response to an input step function is of interest in evaluating the PLL switching times.

The response equation for second and third order integrators are shown below.

Second Order

$$V_o = -V \left[\frac{t}{T_1} + \frac{T_2}{T_1} \right]$$

Third Order

$$V_o = -V \left[\frac{t}{T_1} + \left[\frac{T_2}{T_1} (1 - e^{-t/T_3}) \right] \right]$$

where $T_1 = R_1 \cdot C_1$

$T_2 = R_2 \cdot C_1$

$T_3 = R_2 \cdot C_2$

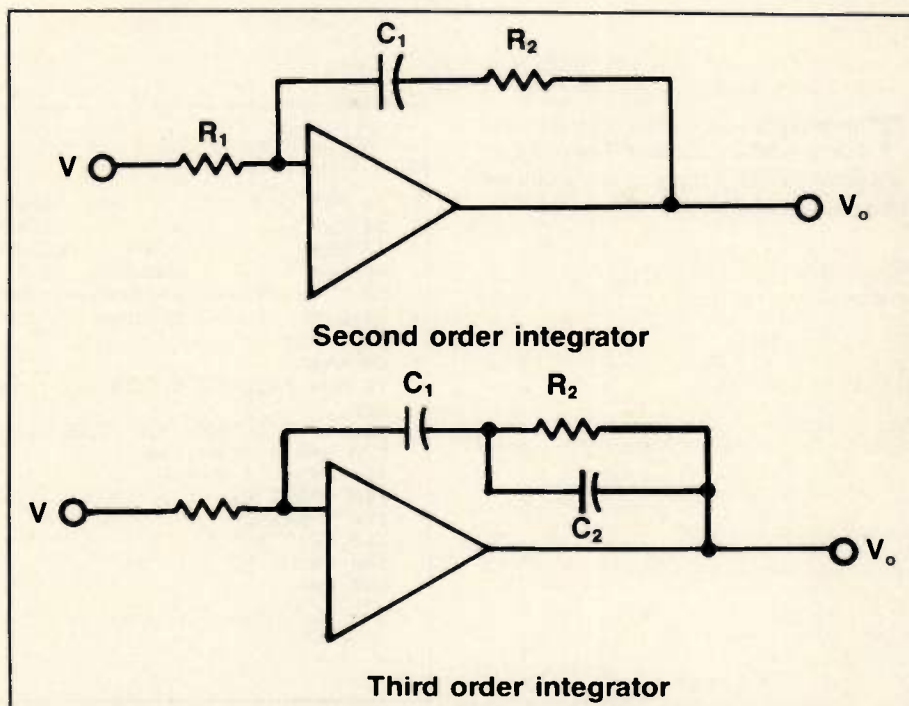
V_o = output voltage

V = input step voltage

t = time after V is applied

Reference

1. A. Przedpelski, "PLL Primer — Part IV."



```

10 REM SECOND ORDER PLL INTEGRATOR SLEW RATE - #564A
20 REM      A. PRZEDPELSKI      -      24 APRIL 1987
30 REM      A.R.F. PRODUCTS, INC.
40 REM      BOULDER, CO
50 ! ***** INPUTS - INSERT VALUES HERE *****
60 T1=.0728 ! R1*C1
70 T2=.00181 ! R2*C1
80 V=5 ! INPUT STEP VOLTAGE
90 ! ~~~~~ CALCULATION AND DISPLAY ~~~~~
100 PRINT "TIME","OUTPUT VOLTAGE"
110 FOR T=0 TO .01 STEP .001 ! TIME IN SECONDS
120 Vo=V*(T/T1+T2/T1)
130 PRINT T,V0
140 NEXT T
150 END

```

Program for calculating second order PLL integrator slew rate.

```

10 REM THIRD ORDER PLL INTEGRATOR SLEW RATE - #564B
20 REM      A. PRZEDPELSKI      -      24 APRIL 1987
30 REM      A.R.F. PRODUCTS, INC.
40 REM      BOULDER, CO
50 ! ***** INPUTS - INSERT VALUES HERE *****
60 T1=.0728 ! R1*C1
70 T2=.00181 ! R2*C1
80 T3=.0000139 ! R2*C2
90 V=5 ! INPUT STEP VOLTAGE
100 ! ~~~~~ CALCULATION AND DISPLAY ~~~~~
110 PRINT "TIME","OUTPUT VOLTAGE"
120 FOR T=0 TO .01 STEP .001 ! TIME IN SECONDS
130 Vo=V*(T/T1+T2/T1*(1-EXP(-(T/T3))))
140 PRINT T,V0
150 NEXT T
160 END

```

This basic listing performs third order PLL integrator slew rate calculations.

Decimal to Binary Conversion

This program converts a decimal number to a binary number. The program will show 16 bits. If fewer or more bits are required, change value of I in line 90.

Example

00000101000011101 2589

```
10 REM CONVERTS DECIMAL NUMBER TO BINARY - #572
20 REM      A. PRZEDPELSKI - 29 MAY 1987
30 REM      A.R.F. PRODUCTS, INC.
40 REM      BOULDER, CO.
50 ! *****
60 DISP "ENTER DECIMAL NUMBER";
70 INPUT N
80 X=N
90 FOR I=16 TO 0 STEP -1 ! CHANGE I, IF REQUIRED
100 Z=N/2^I
110 IF Z<1 THEN 120 ELSE 130
120 A=0 @ GOTO 140
130 N=N-2^I @ A=1
140 PRINT A;
150 ! X=X-Z
160 NEXT I
170 PRINT "      ";X
180 END
```

Decimal to binary conversions are possible with this program.

Binary to Decimal Conversion

This program converts a binary number to a decimal number. Enter the binary number starting with the least significant bit (LSB).

Example

BIT 1 1
Decimal Number 1
BIT 2 0
Decimal Number 1
BIT 3 0
Decimal Number 1
BIT 4 1
Decimal Number 9
BIT 5 1
Decimal Number 25

```
10 REM BINARY TO DECIMAL CONVERSION - 571
20 REM      A. PRZEDPELSKI - 5 JUNE 1987
30 REM      A.R.F. PRODUCTS, INC.
40 REM      BOULDER, CO
50 ! *****
60 Y=0 @ X=0 @ I=0
70 DISP "ENTER NEXT LSB";
80 INPUT N
90 PRINT "BIT";I+1;N
100 IF N=1 THEN X=2^I @ GOTO 120
110 X=0
120 Y=Y+X
130 PRINT "DECIMAL NUMBER";Y
140 I=I+1 @ GOTO 70
150 END
```

This listing performs binary to decimal conversions.

Classic References for RF Design Engineers

References are arranged alphabetically by subject. The following is a list of topics covered:

- Amplifiers
- Antennas
- CATV
- Communication
- Detectors
- Filters
- Microstrip and Striplines
- Mixers
- Oscillators
- PIN Diodes
- Radar
- Reference Handbooks
- Synthesizers

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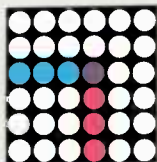
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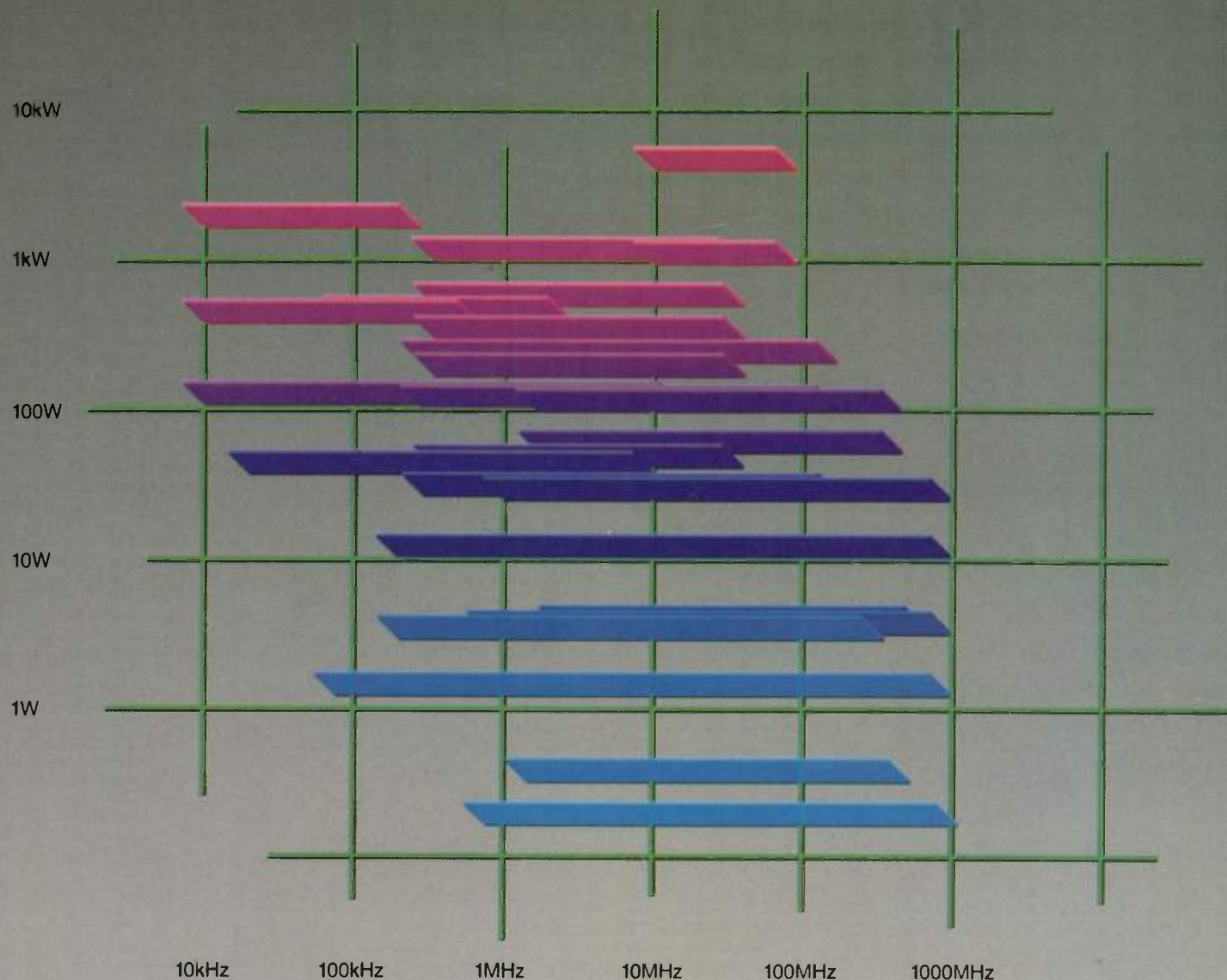
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All solid state. Unconditionally stable. Compact. Tremendously versatile. Whatever your need for RF Power, ENI offers you a choice of Class A power amplifiers unsurpassed in quality. Our wide line spans a frequency spectrum from 10kHz to 1GHz with power outputs that range from 300 milliwatts to over 4000 watts.

These units can be driven by virtually any signal source. They're completely broadband and untuned, amplifying inputs of AM, FM, TV, SSB, and pulse modulations with minimum distortion. Their unconditional stability and fail-safe design make them impervious to severe mismatch conditions, and capable of delivering rated power to any load impedance from an open to a closed circuit.

The design excellence of ENI amplifiers is symbolized by the perfect geometry of the design elements we use with our logo. For our latest catalog, please contact us at any of the offices listed below.



The advanced design line of RF power amplifiers

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