GR/TODAY

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General Radio

Front cover:

A *Time/Data's 1923V system for vibration control*

B *Grason-Stadler's automatic system for life-science research*

C *Multi-station automatic network-testing system*

D *GR products for hearing conservation*

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The GR/TODAY is mailed without charge to engineers, scientists, technicians, educators, and others interested in electronics. Address all correspondence to Editor, GR/TODAY, General Radio Co., 300 Baker Avenue, Concord, Mass. 01742.

GR/TODAY

We are pleased to introduce the first issue of GR/TODAY. Through the pages of this new GR publication we plan to keep you informed of the many activities taking place within GR and its subsidiary companies and to report on events in which we have a mutual interest. News of new product introductions, unique product applications, show and seminar events, key personnel assignments, new company affiliations, and GR's international activities are typical subjects that will be covered by GR/TODAY.

The cover photographs illustrate the extent of the current scene at GR and thereby emphasize the significance of the name of this publication more than words could do. Today, GR is not one company but several companies; its expertise is not limited to 'black-box' instrumentation but extends to complex systems technology. GR has manufacturing plants on both coasts and in Europe and sells and services its products through a worldwide marketing network to customers on every continent and in many markets.

This, in brief, is GR today. We plan to keep you up to date on our activities through this new publication. We hope that what we report in GR/TODAY will interest you.

BUYING AN AUTOMATIC TEST SYSTEM: AN EXERCISE IN JUDGMENT

The following is condensed from the paper *Economic Analysis of Computer-Controlled Test Systems, or, Items the Supplier Failed to Mention*, presented at the 1972 IEEE INTERCON by Richard G. Rogers, Product Marketing Manager at GR.

There has recently been a considerable shift in the methods and equipment used to test electronic networks. Units under test have become more complex, while the human element of the test system has become more expensive. Either factor alone could cause a shift towards automatic testing; together, they have greatly accelerated the trend. For the majority of electronic manufacturers the question is no longer "Will we?" but "*How* will we automate our test systems?"

On the surface, the growth in the number of potential suppliers appears to be to the advantage of the customer, since he can now choose the best system from twenty potential suppliers rather than from one or two. The increased competition, however, is not necessarily all to the good; it adds another factor to the decision-making process of the buyer. The increased importance of a large-dollar order has led the suppliers to develop a new kind of direct marketing force: The traditional sales engineer has been augmented by a local product specialist, a factory-based marketing team (including both engineering and marketing talent), and a variety of company executives with their particular specialized knowledge.

The cause of this expanded marketing approach is the product itself. An automatic test system is more complex and more difficult to define than the test instruments that preceded it. In addition, there are more intangible factors involved in the purchasing decision; the specifications are becoming less important compared to such factors as delivery time, anticipated downtime, serviceability, etc. This paper discusses some considerations you, as a buyer, should weigh before reaching a decision on which automatic test system to purchase.

Your objective is to buy an automatic test system (probably minicomputerized) that will help you to continue producing reliable products, while at the same time reducing to a minimum your cost of testing those products. Consequently, the best automatic system will result in the maximum operational savings.

Once the operational savings have been determined, the economic superiority of one system vs another is easily determined by any of several accepted methods: Return on investment, payback period, or discounted cash flow. What, then, are the factors involved in operational savings? Some of them are known in advance by you, the customer:

- Number of units to be tested per time period.
- Number of different types of units.
- The average failure rate of each type.
- The loaded labor costs of the personnel currently doing the testing.
- The loaded labor costs of the personnel who will use the automatic system.

In addition, there are several important factors that you can determine only by combining your knowledge with information provided by the potential suppliers. It is in these areas that you should concentrate your effort to obtain information (facts, not promises) that will allow you to choose intelligently between suppliers. These factors may be grouped under some general headings:

- Preparation time
- Time to sort good from bad
- Troubleshooting time
- Maintenance

PREPARATION TIME

Preparation time is divided into two parts: (1) The generation of a debugged test program and, if necessary, the construction of a device adaptor or performance board; (2) the system set-up that occurs just prior to testing a specific device under test (DUT). The second operation includes inserting the device adaptor into the system and putting the proper test program into active core.

First, consider the program; this can be a critical cost factor. There is an ever-growing list of test languages being offered by system suppliers, from the general-purpose type to the specific-use type (such as that used in the GR Logic-Circuit Analyzer). The more general the language, the more versatile it is, while the more specific the language, the easier it is to use.

The best way to determine if the particular language fits your need is to ask each supplier to write, in his language, test programs for some of your typical units. Thus, you can determine how easy (or difficult) it is to generate test programs for all your units.

Following the same reasoning, request a wired device adaptor or performance board. To avoid eliminating an otherwise potentially valuable supplier, limit this request to one of your simpler units to be tested. You can also ask to see programs and adaptors the supplier has produced for his own in-house use or for other customers.

The second part of preparation time involves system set-up prior to actual use. Each new type of device to be tested usually requires the insertion of a new adaptor to connect the DUT to the system and the placement of a new test program in core. Visit the supplier; ask him to demonstrate his system testing your device or a similar device.

As a prospective buyer, you should insist on the following:

1. Start at the beginning, not in the middle. Insist on a cold start with the device adaptor and test program in storage. How does the program get from paper tape into active core? How is the device adaptor connected to the system? How many device adaptors will you need – one universal adaptor, several for families of DUT's, or several hundred unique adaptors?

2. After a demonstration of system capability, ask the supplier to demonstrate how a program is prepared on the system. Can you edit and prepare programs on-line? Can you do it while the system is testing? Ask the supplier to prepare the first five to ten lines of the program he has already demonstrated. How easy is the process? Is a translator involved? How complex is the debugging procedure?

With this information, you can now make valid estimates of the time required for learning the test language, for test-program preparation and debugging time, and for system set-up time, plus an estimate of the number and complexity of interface units. All of these are key factors in calculating the operational savings of one system vs another.

One final point about test preparation: There is a trend, particularly in the logic-circuit-analyzer market, towards complete 'turn-key' operation. This means the system supplier contracts to do the whole job, including the provision of test programs and wired device adaptors for all your DUT's, which can be an attractive solution to many problems. The key factor to explore in detail is the interface between you and the supplier. Good test programs require a knowledge of the DUT as well as the system, but these two particular pieces of knowledge reside in different places. How does the supplier suggest handling this interface? Will he put a qualified test-system technician in your plant for a month? Does he feel he can obtain all the needed information by telephone? Who will write the basic test plan? You should strive to define clearly the responsibilities of both parties so that the debugging of 'finished' programs proceeds smoothly.

TIME TO SORT GOOD FROM BAD

Assuming that the system is to be used strictly for high-volume, production testing (with no intent to determine failure causes on-line), total testing time consists of three parts: Time to insert the DUT, time to test the DUT, and time to remove and sort the DUT. If insertion and removal times are long compared with the test time, then the system is

GR's Type 2240 Resistance Anodize Trim System trims 144 resistors at a time on a thin-film tantalum substrate.

A typical device adaptor used in network-testing systems.

clearly loafing while the operator works. If the volume justifies it, additional interfaces should be added (to provide test stations for additional operators) with minimum hardware expansion. Automatic handling should also be considered. If the reverse situation prevails, some minimal hardware could be added to provide more than one test station for the single operator. The point is, don't look at test time alone; it is the over-all system testing time, including handling (human or otherwise) that counts.

If the actual system test time is an important segment of the total testing time, you should insist on an additional piece of information from the potential supplier. Using the test program he prepared for your evaluation of his test language, ask him now to fill in the estimated test time for each step in the program. The total time for all steps is clearly the system testing time for your typical DUT. If the supplier's language manual is correctly written, it will contain typical test times for specific program steps and you can compare times between various suppliers. Caution: All suppliers wish to present their product in the best possible light; typical does not mean achievable in every case and may, in fact, mean achievable only under specific conditions.

Some of the foremost questions in your mind when assessing these test times should be:

- Did he allow for range-changing times or did he assume the measurement or stimulus module was on the proper range?
- Is the time longer at the range extremes, where you may be making many measurements?
- Did he allow for settling of his sources and does your DUT require additional settling time?
- Is the settling time of the scanner included?

Since your operational savings are directly related to the system throughput and this, in turn, is related to the testing time per DUT, you should strive for a clear understanding of the times involved in your system operation. If the situation is so complex that you are unsure, ask for guaranteed testing times for two or three units as part of the acceptance test.

TROUBLESHOOTING TIME

Most automatic test systems dealing with devices above the component level are intended not only to reject faulty products but to locate the fault and to provide either an error message for off-line repair or a system operation that will facilitate on-line repair. An ideal error message would read "Replace R5" or "Adjust L10", etc. The degree to which this fault location can be achieved depends on the complexity of the DUT, the effort put into writing the program, the number of points on the DUT that are accessible to the test system, and the diagnostic modes built into the system (loop on failure, branch, etc). In general, the cost of the system will rise sharply as you insist on fault isolation to a single component on increasingly complex DUT's.

If you expect that troubleshooting will occupy a major portion of the total system time, insist on a demonstration of system troubleshooting capability. Such a demonstration should include a diagnostic program written for one of your units (or one of the supplier's demonstration units) with you introducing the faults.

MAINTENANCE

So far, we have discussed buying aspects that can be reduced to numbers. Maintenance, however, defies mathematical analysis. You should reject out-of-hand MTBF figures on complex systems where the population may be small. The real questions are, "How often is the system likely to fail?" and, more important, "How long will it take to get the system back on-line?"

How often is the system likely to fail? There are some clear indicators available:

- Investigate the reputation of the manufacturer.
- Look inside and see how the system is constructed.
- Visit the supplier's plant and see his manufacturing and QC facilities.
- How many systems has the supplier made? System number 60 is likely to be more bug-free than system number six.

As for service, read the warranty (carefully!) and visit the supplier's closest service facility.

How long will it take to get the system back on-line? Downtime is not a function of the system and the supplier's service capability alone but also a function of the effort that you, the user, are willing to expend.

If you foresee an absolute need for 24-hour service, you should consider taking total control of the service function, with the supplier as back-up. The things you need to know are:

- What spare parts must you stock on location? How much will they cost? How will the stock be replenished?
- What sort of service training is offered? A 3-day cram session? Or can you send one or two people to the supplier's plant to assist in the final system checkout and really learn the system (in about a month)?
- Does the supplier take full responsibility for the complete system, including the various peripheral devices?
- How and where does he stock spare parts?

Finally, ask the man who owns one; look into similar systems the supplier has built for other customers.

'TIL DEATH DO YOU PART!

One final point on buying an automatic test system. Don't panic into a hasty buying decision. As one of our competitors recently suggested, you do not buy a system, you marry it! To carry the analogy further:

The supplier becomes your permanent in-law.

Most successful marriages are historically based on a courtship of reasonable duration, where both parties get to know each other quite well.

Divorces are very expensive.

DEVELOPMENT-IN-REVERSE LEADS TO STATE-OF-THE-ART INSTRUMENT

The original concept and the remarkably close final result of reverse development.

The 1933 indicates the current noise level in a machine shop, while the 1935 continuously records the changing level for exposure analysis according to OSHA requirements.

Most new instruments are born into this world through a 'routine' process of marketing decisions and breadboard models, followed by much testing and refinement. The mechanical-design and human-engineering factors usually just follow in the natural course of the instrument's development. In complete contradiction to this normal procedure, the new portable 1933 Precision Sound-Level Meter and Analyzer is an instance of the tail successfully wagging the dog!

The design of the more visible portions of the GR 1933 was begun in the fall of 1968. This was long before the world was capable of supplying the required internal components in a configuration compatible with the size limitations imposed by the package design of the 1933. Initially ignoring the electro-mechanical conditions that usually determine the final design, GR developed the 1933 in terms of the task the operator would perform, the conditions under which he would function, and the level of technical sophistication that could reasonably be expected from the operator. Only then, with this inside-out design completed, did marketing and electrical design considerations enter into the development of a useful and desirable product.

With the user's point of view in mind, we established the following design criteria:

- The 1933 must be a small, lightweight device that could be held in one hand along with a clipboard or notebook, with the other hand free to make adjustments or to record data.
- The 1933 should not require any mental arithmetic (such as range multiplying).
- Confusing choices between amplifier attenuators should be eliminated.
- While all controls and connections should be included to make it a true laboratory instrument, the primary controls that make the 1933 a simple-to-use field instrument should be separated from the others.

Once the package design was completed, the entire 1933 concept was submitted to GR's Development Committee. Because of the rapid advances being made by our Microcircuit Facility in the Bolton, Massachusetts plant, the Committee confidently endorsed further development of the 1933. With imaginative design techniques, the latest in microcircuit technology, plus GR's equally new electret microphones, the 1933 is now on the market. Instead of lagging three to five years behind the development of the necessary microcircuits (and microphones), the portable and compact 1933 Precision Sound-Level Meter and Analyzer is available today!

To enhance the usefulness of the 1933, two companion instruments are also available. The 1935 Cassette Data Recorder is a two-channel, two-track magnetic tape recorder that records the noise signal on one channel and the setting of the 1933 range control on the other; voice notes can also be recorded by breaking into the range code. The 1940 Power Supply and Charger allows either the 1933 or 1935 to operate from an ac line. The 1940 is supplied with rechargeable cells to replace the ordinary cells supplied with the analyzer and recorder.

SUMMER 1972– IT'S BROWNOUT SEASON AGAIN!

A slightly low line voltage in the midst of a summer's heat wave probably won't endanger our species, but the same is not necessarily true for complex electronic systems. Under the strain of reduced line voltage, computers may drop bits or lose an entire memory, or a thermo-electric process, such as plastic molding, may lose an entire day's output. Many systems can tolerate low voltage for a time (although some will shut down entirely), but for how long a time? What happens when an environmental control system is in borderline operation and the ambient temperature rises significantly? The point is, summer (and its attendant peak power drain) returns on schedule each year; your equipment should be prepared for brownouts.

The electric companies try to maintain a limited reserve margin against unforeseen peaks of power usage by the general public. The prime enemy of this reserve is the hot summer day when people and systems alike try to 'keep their cool.' Brownouts occur because the reserve margin is not sufficient to satisfy this demand; the utilities are forced to lower their line voltage and, on occasion, may have to enforce a brief, but total, blackout.

Since survival is often more critical for machines than is comfort for people, let's forget about air conditioners and talk about line-voltage regulators for industry. An automatic line-voltage regulator (like GR's 1591 Variac® automatic voltage regulator) does exactly what its name implies; it automatically maintains the line voltage at a predetermined value selected by the user. In selecting a regulator, consider the following factors.

Power Requirements and Expected Overload Not only must your regulator handle the usual current, voltage, frequency, and power factor of the load, but it must be able to deal with on-off surge currents. Note, also, that operation at a slightly lower line voltage, so long as the voltage is within equipment specifications, can actually be beneficial to your equipment. Operating at the low end of the input-voltage range results in cooler operation, increased reliability, and longer equipment life; this certainly makes a regulator a worthwhile investment for year-round use.

Accuracy Accuracy (such as the ±0.2% specified for the 1591) is the ability of the regulator to establish its output at a predetermined level under conditions ranging from no load to full load, even with a fluctuating line voltage.

Speed of Response This is the time required for the regulator to restore its output to the preset value when the input level changes. (The correction time for the 1591 is 6 cycles + 1.5 cycles/V for 115-V models.)

Distortion Unlike many others, Variac regulators add no distortion to the waveform and, therefore, are useful with devices that respond to the peak, average, or rms value of the line voltage.

Regulation Range For nominal changes in line voltage, your regulator will maintain its output at the desired level (with a certain maximum load current). For excessive voltage changes, however, you may still be able to regulate output voltage, but with some loss of load current. (The 115-V models

of the 1591 can adjust their output ±15 V for inputs from 100 to 130 V.)

Wiring Depending on the wiring configuration of your system, you may require more than one regulator. These wiring set-ups include single phase, 4-wire wye, 3-wire closed delta, or 3-wire open delta. Any capable sales engineer can help you work out your exact requirements.

Other requirements that you should consider are the ambient operating temperature of the regulator, its overall efficiency and, sometimes, weight restrictions (such as those imposed by airborne systems). Do not, however, try to regulate the whole world – stick to critical equipment. Whatever your needs, any GR office will help you select the right regulator for your requirement; for your own edification, use the reply card to get a free copy of *Voltage Regulators*, the catalog for all Variac automatic voltage regulators.

NEW STROBES FIT THE APPLICATION AND THE POCKETBOOK!

In contrast to the familiar GR 1531-AB Strobotac® electronic stroboscope, a general-purpose tachometric and motion-analysis tool, GR's three new low-cost strobes are intended primarily for the observation of machine motions and high-speed processes. Although uncalibrated, each model has a stable oscillator to control the flash rate from 180 to 3800 rpm and can visually stop motion in excess of 3800 rpm by flashing at a submultiple of the target rep rate. With their focused bright light, these new strobes are ideal for use by original equipment manufacturers or as service-department tools.

1542-B Perfect for general-purpose inspection and for teaching the principles of stroboscopy. Because of its increased light output (many times that of the original 1542), the 1542-B will clearly demonstrate motion phenomena under almost all light conditions.

1543 With greater light output than the 1542-B, the 1543 is especially useful in the physics lab to demonstrate dramatically the principles of the laws of motion. The 1543 can be synchronized to the line frequency (or its submultiples) to assure an accurate knowledge of the flash rate when examples of acceleration and velocity are photographed with Polaroid* cameras.

1544 Useful for mechanical engineers in both school and industry. In addition to performing all the 1543 functions, the 1544 can also be triggered by reflective tape from the subject (via photoelectric pickoff) to provide sharp, fixed-position images even when the motion varies in speed. The 1544 also has a delay control that permits the image to be phased through an entire cycle of the subject machine's operation.

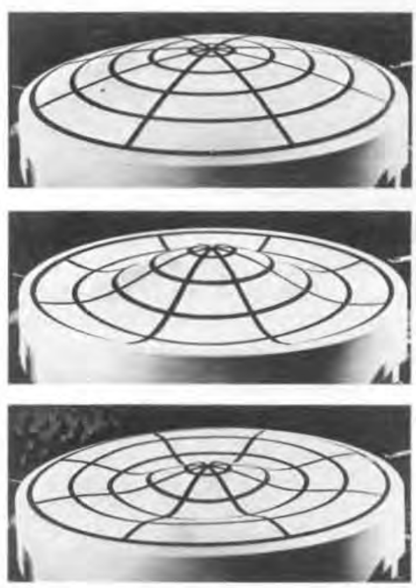
*Registered trademark of the Polaroid Corporation.

An unretouched photograph showing one beater blade whirling under normal lighting conditions while the second blade is visually stopped by stroboscopic light, although the liquid continues to churn beneath it!

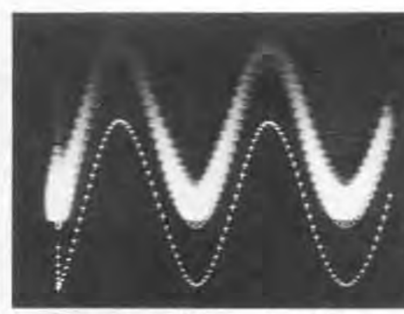
A

B

C



Overtones *A flexible diaphragm is set in motion by a loudspeaker mounted underneath:* **A,** *first by a frequency at which the diaphragm is resonant;* **B,** *second by twice that frequency which produces the first overtones; and* **C,** *lastly by three times the original frequency which produces the second overtone. Photos courtesy of Project Physics.*



Harmonic oscillation. *A weight, suspended from a spring attached to a movable beam, is set in motion vertically. At the same time, the beam is moved horizontally past the camera. The result is a sinusoidal harmonic oscillation.*

Three new low-priced strobes; select the one that fits your need.

SHIRT-POCKET NOISE-EXPOSURE MEASUREMENTS

In the pocket, out of the way, but on the job for hearing conservation.

Retrieving noise-exposure data from the 1944 Monitor with the 1944 Indicator.

The logical way to measure an employee's exposure to workday noise is to have the measuring device travel with him, 'hearing' exactly the same noise levels he hears. GR's new 1944 Noise-Exposure Monitor makes the first step toward compliance with OSHA just that easy!

The 1944 weighs less than 8 ounces, clips into a shirt pocket, detects the noise with its built-in microphone, and accumulates the day's total noise exposure based on the criteria of the Occupational Safety and Health Act (U.S. Public Law 91-596). Powered for about 300 hours by a single 9-V battery, the 1944's operation is tamper-proof because of the lack of displays or visible controls. Even the on-off switch, controlled by the supervisor of the noise-measurement program, is concealed.

Retrieval and interpretation of the accumulated data are equally simple. At the end of the day, plug the monitor into the companion 1944 Noise-Exposure Indicator and press a button. The cumulative noise exposure is displayed by a light-emitting-diode readout. The displayed number indicates the percentage of noise exposure experienced by the employee. 100% is the maximum permissible exposure in accordance with OSHA; all the calculations are performed by the 1944. A separate lamp on the indicator tells if the 115-dBA impact level has been exceeded during the day.

The 1944 has one more important feature — a built-in calibrator that provides rapid acoustic calibration verification at the start and end of each measurement period.

Complete information on industrial hearing conservation, including data on the 1944 Noise-Exposure Monitor and Indicator, is available on request.

ALL NEW HANDBOOK OF NOISE MEASUREMENT

The seventh edition of the *Handbook of Noise Measurement* — expanded, updated, and hard-bound — will be available at the end of July. GR's growth into a multi-company organization really pays off for the reader of this new, broadly illustrated edition since completely new chapters on real-time signal analysis and audiometry have been contributed by Time/Data and Grason-Stadler, respectively. Other new information includes a discussion of U.S. noise legislation and complete data on GR's latest sound- and vibration-measuring instruments and systems.

The new *Handbook* will be an invaluable textbook addition to any technical library as a useful and authoritative reference for engineers and management alike. Copies are available for $7.50 (U.S. price) from our main office at 300 Baker Avenue, Concord, Massachusetts 01742.

SEMINAR NOTES

NOISE CONTROL FOR ENGINEERS

The Institute on Noise Control Engineering will be presenting its fifth and sixth seminars in a series of courses dealing with factory, environmental, and product noise problems. These week-long presentations will include demonstrations of many GR sound- and vibration-measuring instruments and will cover the following topics:

- Noise: Its measurement and its troublesome effects
- Characteristics of noise generated by equipment commonly encountered in industry and the community
- Methods for evaluation of noise problems
- Noise reduction at the source, along transmission paths, and at the receiver
- Case histories of noise abatement in industry

The seminars will be conducted in White Haven, Pennsylvania on August 6-11, 1972 and in Clearwater, Florida on February 11-16, 1973. Complete details on the curriculum, accommodations, and tuition of these and other forthcoming INCE seminars can be obtained by writing to the Institute on Noise Control Engineering, P.O. Box 3164, Bethlehem, Pa. 18017.

NEW PROFESSIONAL ORGANIZATION SPONSORS NOISE-CONTROL CONFERENCE

INTER-NOISE 72, an International Conference on Noise-Control Engineering, will be held at the Shoreham Hotel in Washington, D.C. on October 4-6 of this year. The Institute of Noise Control Engineering, established as a professional engineering society in 1971, will sponsor the conference in cooperation with the Acoustical Society of America, the Department of Transportation, and other U.S. Federal agencies.

INTER-NOISE 72 will provide an opportunity for those interested in advancing noise control and noise-control engineering to gather together for discussion, consultation, and the exchange of technical information. The program will include panel discussions, workshops, technical papers, tutorial sessions on the principles of noise control, and an exhibition of instrumentation, products, and materials available for noise and vibration reduction. The registration fee (approximately $45.00) will cover the cost of a luncheon, a formal dinner, and a book of preprints of the papers presented at the conference.

Complete information on INTER-NOISE 72 is available from Professor Malcolm J. Crocker, Ray W. Herrick Laboratory, School of Mechanical Engineering, Purdue University, Lafayette, Indiana 47907.

* * * *

The Institute of Noise Control Engineering was founded as a non-profit membership organization dedicated to the control of environmental noise. Among the goals of INCE are . . . to be sensitive to the needs and responsibilities of the noise-control engineer, . . . to promote the recognition of noise-control engineering as a technical profession, . . . to cooperate with and furnish advice to governmental bodies on measures that will advance the public interest, . . . to stimulate the development of suitable curricula in noise-control engineering at educational institutions, . . . to encourage the establishment of national institutes in other countries, . . . to provide channels of information for the effective exchange of information.

Information concerning membership requirements can be obtained from Warren R. Kundert, INCE Board of Directors, General Radio Company, 300 Baker Avenue, Concord, Massachusetts 01742.

NOISE AND VIBRATION CONTROL IN BUILDINGS AND MANUFACTURING PLANTS

Bolt Beranek and Newman Inc., consultants in the control of noise and vibration, are offering two series of seminars, co-sponsored by GR, for mechanical engineers, plant engineers, architects, builders, and manufacturers.

The first of the series, covering noise and vibration control of mechanical and electrical equipment in buildings, consists of three-day seminars emphasizing practical acoustics and architectural and engineering noise control. The topics covered will include an introduction to acoustics, noise criteria, noise and vibration control for mechanical and electrical equipment, noise control for ducted ventilation systems, and representative examples of data forms for the evaluation and solution of many indoor and outdoor equipment noise problems. This first series will be conducted at the following locations:

Vancouver, B.C.	Aug 29-31
Detroit, MI	Sept 13-15
Kansas City, MO	Sept 27-29
Atlanta, GA	Oct 11-13
Washington, DC	Oct 25-27
Boston, MA	Nov 8-10

The second group of seminars, also three days in length, will discuss noise in manufacturing plants and will cover basic acoustics, noise criteria, plant-noise measurements, and factory- and plant-noise problems. This series will occur at:

Vancouver, B.C.	Sept 6-8
Detroit, MI	Sept 18-20
Kansas City, MO	Oct 2-4
Atlanta, GA	Oct 16-18
Washington, DC	Oct 30-Nov 1
Boston, MA	Nov 13-15

Lecturer at both seminars will be Mr. Laymon N. Miller, a Principal Consultant of BBN.

These courses, now in their fourth year, have been attended by more than 1200 people in over 30 U.S. and Canadian cities. Registration information for either (or both) of the current seminars can be obtained from Bolt Beranek and Newman Inc., 50 Moulton St., Cambridge, Mass. 02138.

B.J. Sargent

I.G. Easton

GR ON STAGE AND IN THE WINGS AT 1972 CPEM

R.A. Soderman

J.K. Skilling

C.G. Gorss

R.A. Benson

This year's Conference on Precision Electromagnetic Measurements (June 26-29 in Boulder, Colorado) includes GR contributions in every facet. Robert A. Soderman, Manager of Engineering Staff at GR's Bolton, Mass. plant, is chairman of the Conference. Ivan G. Easton, Senior Vice President, is acting as representative of the IEEE, one of the Conference's sponsors. In more direct view, GR engineers are presenting two papers that are abstracted below. Reprints of the complete papers will be available in late fall.

The Folded Ramp: A New Technique for Computer-Controlled Time-Interval Measurement.

by R.A. Benson, B.J. Sargent, and J.K. Skilling

This paper describes the folded-ramp circuit, a computer-controlled device for measurements of time intervals from a few nanoseconds to a few seconds. The unique features of this circuit are single-range operation, binary-output format, measurement-error detection, and an output-register size that is set by dynamic range rather than by accuracy or resolution. The circuit generates a ramp-type waveform that reverses slope at 0 V and at a predetermined peak voltage; control of the ramp slope makes each leg of the 'folded ramp' 100 ns in duration. The measured time interval is described by the number of slope reversals plus the amplitude difference between the voltages at the termination of the measurement and at the last reversal.

A Precision System for RF Network Analysis

by Charles G. Gorss

. . . in which is described a new and precise general-purpose network analyzer – the GR 1710 – for making swept measurements of network parameters from 0.4 to 500 MHz. This paper discusses the ways in which the individual system components influence the accuracy of the system as a whole, with emphasis on the choices and trade-offs that were made, during development, to achieve a compatible set of components; the principles involved are applicable to the design of any modern network-analyzer system. The interaction of the characteristics of the various components is considered, and the resulting effects upon design requirements – sometimes severe, sometimes trivial – are covered. In the course of the discussion it is shown that component performance cannot be independently evaluated until the component's interaction with other system elements is demonstrated.

PRECISION RF NETWORK ANALYZER

The 1710 is the newest, most complete rf network analyzer for the measurement of transmission characteristics from 400 kHz to 500 MHz. The system features 3-decade sweep range, 115-dB dynamic range (80 dB displayed on the CRT), 0.005-dB resolution, two measurement channels for comparison of magnitude, phase, and group delay to a third (reference) channel, and 50- or 75-Ω measuring circuits.

Convenience and versatility to the user are evidenced by the direct-reading display of group delay and absolute level on the unknown, a built-in variable-width marker, pushbutton S-parameters, a multiple-parameter display (including polar coordinates), narrow- or wide-band measurement capability, complete programmability, and the availability of accessories to tailor the system to the requirement.

Anyone dealing with the commercial, military, or aerospace aspects of rf networks in the fields of communications, transportation, materials and component evaluation, and lab standards will want the full story on the 1710 RF Network Analyzer.

VARIAC CATALOG AND APPLICATION HANDBOOK... 40 YEARS OF VOLTAGE-CONTROL KNOW-HOW!

A complete handbook on GR's Variac® adjustable autotransformers is available. This illustrated guide includes such topics as 'How to Select a Variac,' 'Applications,' and 'Get More Out of Your Variac,' in addition to complete general specifications, specifications by application, and specifications by model series. The *Variac Catalog and Applications Handbook* is a handy reference for anyone who deals with the problems of ac-voltage control or of any other parameters that derive from ac voltage.

GR TO EXHIBIT IN JAPAN

GR's instruments and systems will be demonstrated at two important Japanese shows in the next several months. At the Japan Electronics Show (Sept. 21-27), Midoriya Electric Company, GR's Far-East instrument distributor of long standing, will exhibit several of GR's current test equipment: The 1710 RF Network Analyzer, the 1683 Automatic RLC Bridge, the 1684 DZM, the 1921 Real-Time Analyzer, the 1933 Precision Sound-Level Meter and Analyzer, the 1935 Cassette Data Recorder, the 1944 Noise Exposure Monitor, and perhaps some other brand-new developments.

GR's INTERNEPCON/JAPAN space will feature examples of our fully and semi-automatic systems capability. In this show, to be held in early 1973, GR will be represented by Tokyo Electron Laboratories, our new systems distributor in the Orient.

Both these shows will be well worth the time investment to anyone with current or anticipated testing problems.

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