

GR/TODAY

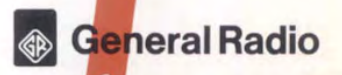
VOLUME 2 • NUMBER 3 • AUTUMN/1973 • A PUBLICATION OF GENERAL RADIO

GR 1062 —
a new achievement in
frequency synthesizers . . .

GR 1062 Frequency Synthesizer • General Radio


GR 1062 Frequency Synthesizer • General Radio

GR 1062 Frequency Synthesizer • General Radio



IET LABS, INC in the GenRad tradition
534 Main Street, Westbury, NY 11590

www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988



New 500-MHz synthesizer packs more performance into less space - at less cost!

Picture a 500-MHz frequency synthesizer with phase noise at least 60 dB down and 100-microsecond switching speed — all in 5¼ inches of rack space. That's the new GR 1062 — an achievement at any price, but all the more remarkable at its base price of only \$8700.

The GR 1062 Frequency Synthesizer provides output frequencies from 10 kHz to 500 MHz with exceptional spectral purity for any synthesizer application. Both frequency and amplitude are remotely programmable with rapid settling time. Worst-case frequency error is less than 100 Hz after 100 microseconds. Non-harmonic spurs are down more than 80 dB below the signal, and harmonics are down more than 26 dB. The leveled output is continuously adjustable from -7 to +13 dBm into 50 ohms. The standard 10-kHz resolution

(5 digits) is expandable to 0.1 Hz (10 digits) in one-digit increments.

In the basic model of the GR 1062 Frequency Synthesizer, the digital programming of the frequencies is controlled remotely through back-panel connections, using standard 8-4-2-1 BCD signals. A local-control front panel is available for manual selection of the frequencies.

Through the use of microwave microelectronic circuitry, the GR 1062 is more compact than other 500-MHz frequency synthesizers. This is an important consideration where space is at a premium, particularly in search systems and digitally-swept instrumentation. The rack model of the GR 1062 measures only 19" wide x 5-1/4" high x 22-3/8" deep, and weighs only 55 lbs.

The excellent reproducibility of microwave microcircuits enables frequencies over 2 GHz to be processed reliably and economically. A unique waveguide-below-cutoff packaging technique permits more than 90-dB attenuation in the stop-band response of critical bandpass filters.

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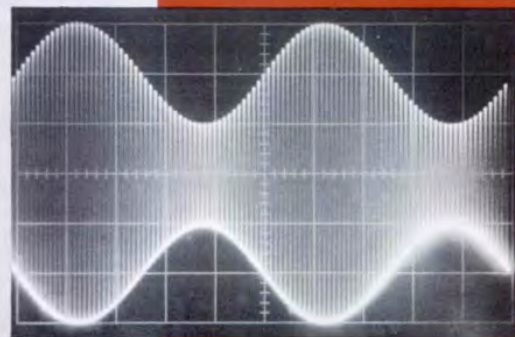
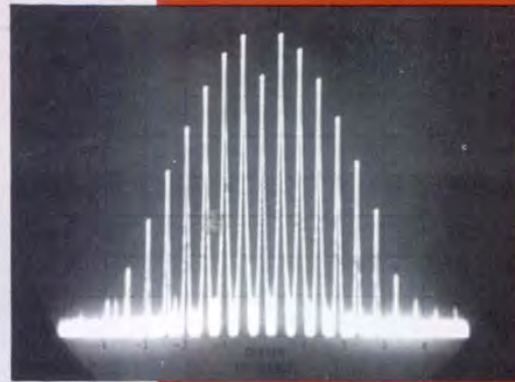


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The high spectral purity and stability of the 1062 make it the ideal source to up-convert or multiply into microwave frequency bands. The low residual phase-noise — typically -65 dB — is enhanced by using a novel drift-cancelled loop operating at microwave frequencies, with no high synthesis factors required.

The 100-microsecond switching speed of the GR 1062 permits real-time dynamic displays of *more* measured data in *shorter* time spans. One hundred points in a digitally swept system can be scanned in 50 milliseconds, with 400 microseconds of dwell-time allowed for each measurement.

To expand the 1062's capability in wide-dynamic-range measurement applications, a GR 1062-P1 Tracking Synthesizer will soon be available as an accessory to generate frequencies that are 80 kHz offset from, and coherent with, the synthesizer output. This permits down-converting the variable output of a device under test to 80 kHz. Suitable narrow-band predetection filtering is easily achieved at this low frequency.

The GR 1062 and its companion tracking synthesizer are used with the GR 1710 RF Network Analyzer to evaluate transmission and reflection properties of rf devices and systems over a 115-dB dynamic range. With precision frequencies under digital control, measurements of magnitude and phase

are accurate and repeatable. And, as evidence of the low synthesizer phase-noise, a high-resolution group-delay measurement capability exists.

A significant feature of the GR 1062 Frequency Synthesizer is its built-in sweep-search capability. Any decade up to 1 MHz can be electrically converted into a continuously adjustable decade to extend the resolution two decades beyond its step-digit resolution.

This sweep-search feature gives the GR 1062 the convenience of a signal generator for critical resonance or bandpass studies. It also enables sweep-frequency measurements to be performed via control of an external sawtooth waveform. Amplitude modulation and phase modulation capabilities are also built in and controlled from external signals.

Applications for the GR 1062, in addition to test and measurement, include NMR studies, satellite communications systems, and CHIRP radar. The GR 1062 synthesizer can detect very precise Doppler shifts, and may be used to excite a radar antenna with a ramp of very closely spaced frequencies with continuous phase.

The first of the new GR 1062 Frequency Synthesizers are being used in quality monitoring and control of communication systems aboard several U.S. Navy vessels.

New paper describes GR 1062 Frequency Synthesizer

A new technical paper describing the operation and versatile performance of the GR 1062 Frequency Synthesizer is now available. Titled "A 500-MHz Low-Noise General-Purpose Frequency Synthesizer," the paper was presented at the Frequency Control Symposium held in June, 1973. The paper was authored jointly by William F. Byers, Kingsley W. Craft, and George H. Lohrer of General Radio's High Frequency Equipment group. Copies of the paper may be requested via the attached reply card.

New article cites key specs in selecting a synthesizer

Key specifications to consider when selecting a frequency synthesizer are the subject of a recent *Electronic Design* article titled "Hung Up On Synthesizer Specs?" Copies of the article, written by Robert L. Moynihan, GR Assistant Product Marketing Manager for High Frequency Equipment, are available via the attached reply card.

AUTUMN/1973

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From GR's Grason-Stadler - a better way to diagnose middle-ear problems

A common type of hearing impairment is a conductive loss resulting from a malfunction in the middle ear. The middle ear comprises the eardrum or tympanic membrane and, connected to it, the chain of ossicular levers (popularly called the hammer, anvil, and stirrup) that convey sound vibrations from the eardrum to the inner ear where they are converted into electrical impulses for the brain.

The key to diagnosing a middle-ear malfunction lies in the eardrum itself. For the acoustic characteristics of the eardrum mirror the physical condition of the middle-ear mechanism.

The eardrum uses only a portion of the sound energy it receives and rejects the remainder. Many of the pathologies that can impair the middle-ear mechanism — otosclerosis, effusion, blocked eustachian tubes, inoperative ossicular levers, etc. — will also induce a *distinctive change* in the proportion and mode of the eardrum's use and rejection of sound energy. Thus, measurement of these eardrum characteristics can help the audiologist or otologist identify the cause of the middle-ear malfunction.

Unfortunately, this has been easier said than done. For although the first acoustic measurements of the eardrum were made over 30 years ago, the technique is just emerging from its infancy. This has been due largely to the fact that, until now, most commercially available instruments were either insufficiently precise or awkward to use.

This situation has now been rectified by a unique development of Grason-Stadler, a GR company serving

the audiological community. The new Grason-Stadler 1720 Otoadmittance Meter is specially designed for faster, more accurate and convenient measurements of eardrum acoustic characteristics essential to diagnosis of middle-ear malfunctions.

A stumbling block in past efforts to design suitable instrumentation has been the difficulty in measuring the acoustic impedance of just the eardrum alone, without involving the ear canal as well. Since the contribution of the ear-canal cavity to acoustic measurements varies widely and lacks clinical significance, it must be excluded to obtain the true impedance of the eardrum.

One method of cancelling out the influence of the ear canal is to determine its impedance separately and then subtract the canal-only figure from the combined canal/eardrum impedance figure. This is done by immobilizing the eardrum temporarily — stiffening it by positive or negative air pressure — so that an impedance measurement will reflect just the ear canal. Unfortunately, the subtraction process is formidable since the canal and eardrum impedances are complex and in parallel.

This eardrum-stiffening approach is basically the same one used in the new Grason-Stadler 1720 Otoadmittance Meter to obtain separate acoustic data for the canal and the eardrum. But that's where the resemblance ends, for the tedious computations have been eliminated by a simple yet significant innovation.

Although impedance components in parallel are quite difficult to add and subtract, their reciprocal *admittance*

components in parallel are very easy to work with. Hence, as its name indicates, the Grason-Stadler 1720 Otoadmittance Meter measures the components of admittance — conductance and susceptance — instead of impedance.

The 1720 enables the otologist to control the eardrum-stiffening pressure precisely while he measures the conductance (G) and susceptance (B) of the eardrum at both 220 Hz and 660 Hz. Tests at 660 Hz may reveal pathologies not evident at 220 Hz, and the 1720 is the only electroacoustic instrument now available with provision for testing at this higher frequency as well as at 220 Hz.

Measurements, in millimhos, are indicated immediately on two panel meters, and are continuously readable for any pressure condition. No nulling manipulations are required. With an optional plotter, curves generated for conductance and susceptance at 220 Hz and 660 Hz can be recorded on a chart to create a graphic representation called a tympanogram.

Each of the various pathologies that can impair the function of the middle-ear mechanism will produce a characteristic tympanogram that can be interpreted by the otologist.

The tympanometric tests performed by the Grason-Stadler 1720 Otoadmittance Meter expedite clinical diagnosis of hearing losses by pinpointing middle-ear abnormalities faster and more conveniently than with audiometric or bone-conduction tests. In mass-tests of schoolchildren's hearing, the tympanometric measurements of the 1720 have also proven more sensitive and reliable than audiometric screening — often revealing middle-ear problems not detected audiometrically.

The 1720 Otoadmittance Meter also enables diagnostic data to be obtained

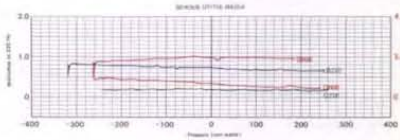
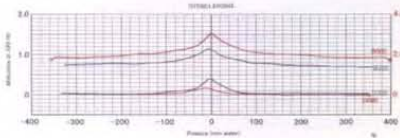
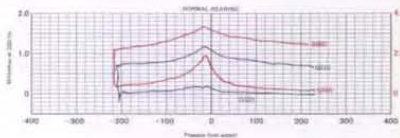
by generating and monitoring a response known as the acoustic reflex. This is a self-protective mechanism in the ear that responds to loud sounds by causing a small muscle (the stapedial tendon) associated with the stirrup to contract with resulting outward stress at the eardrum – increasing the eardrum's impedance and decreasing sound flow.

Since there is a predictable relationship in audiometrically normal people between the hearing threshold level and the reflex threshold level, this test is an added source of diagnostically useful information. The test is particularly valuable under conditions where the subject's cooperation cannot be obtained – such as with individuals feigning a hearing problem, and with babies or retarded persons unable to comprehend test instructions.

The ability of the Grason-Stadler 1720 Otoadmittance Meter to create graphic representations of pathologies outside of audiology, too. For example, the 1720 can be used in neurological diagnosis of facial paralysis such as Bell's palsy. Because the mandibular branch of the facial nerves activates the tendon of the ossicular stirrup, one of the symptoms at the onset of facial paralysis is a diminished acoustic reflex.

With interest in the diagnostic significance of middle-ear measurements growing, the Grason-Stadler 1720 Otoadmittance Meter represents the simplest, most reliable instrument yet developed for accurate measurement of the eardrum's acoustic characteristics.

CHARACTERISTIC TYMPANOGRAMS (B = Susceptance, G = Conductance)



G-S 1720 Otoadmittance Meter used to research hearing of newborn infants



Under direction of Dr. Ross M. Weaver (rear), Philip Allred, BYU graduate student in clinical audiology, uses G-S 1720 Otoadmittance Meter to test hearing of infant at Utah Valley Hospital. Assisting Allred is his wife, Lenna.

The new Grason-Stadler 1720 Otoadmittance Meter is being used in cooperative studies by Brigham Young University and the University of Utah which may aid in early diagnosis of middle-ear hearing problems in newborn infants.

The studies, using both tympanometric and acoustic-reflex tests, are being conducted at the Utah Valley Hospital, Provo, by the hospital's Department of Pediatrics and researchers from the Communicative Habilitation Area of Brigham Young University's Department of Speech and Dramatic Arts.

Heading the project is Dr. Ross M. Weaver, Director of Clinical Audiology in the BYU Department of Speech and Dramatic Arts. Conductive hearing losses in newborns may pass undetected, Dr. Weaver pointed out, because their ears heretofore have not been examined routinely. This is due, in part, to the lack of methodology and suitable instrumentation. Most audiometric techniques now in use are unable to detect anything less than a severe hearing loss.

However, the advent of convenient-to-use tympanometric instrumentation such as the Grason-Stadler 1720 Otoadmittance Meter may ultimately lead to

routine screening of newborn infants for hearing defects. Undetected, a hearing impairment in a child can produce speech disorders, learning disabilities, and psychological problems.

Under Dr. Weaver's supervision, Philip Allred, a BYU graduate student in clinical audiology, recently completed daily tympanometric and middle-ear-reflex measurement on 50 newborn infants ranging in age from four hours to four days – using the Grason-Stadler 1720 Otoadmittance Meter and a pure-tone audiometer. A follow-up study on the emergence of acoustic reflex thresholds was continued weekly on 20 of the infants. The infants were selected at random from the case loads of cooperating pediatricians. Research findings are now being submitted for publication.

The project was suggested by Dr. Geary McCandless, Director of Clinical Audiology in the Communicative Disorders Department of the University of Utah. Dr. McCandless is also associated with the Department of Otolaryngology and Maxillofacial Surgery at the University of Utah Hospital.

A new feature!

GR/TODAY Product Spotlight

To keep you aware of the growing diversity of General Radio products, occasional issues of GR/TODAY will now include this Product Spotlight section. Supplementing the editorial coverage of GR products, Product Spotlight will feature a representative selection of GR's "old standbys" as well as products more recently introduced. Some items, perhaps, you may not have realized were available from GR.

If you'd like a formal price and delivery quotation on any of the products listed, just fill in the attached reply card. No obligation, of course.

Strobotac[®] electronic stroboscope

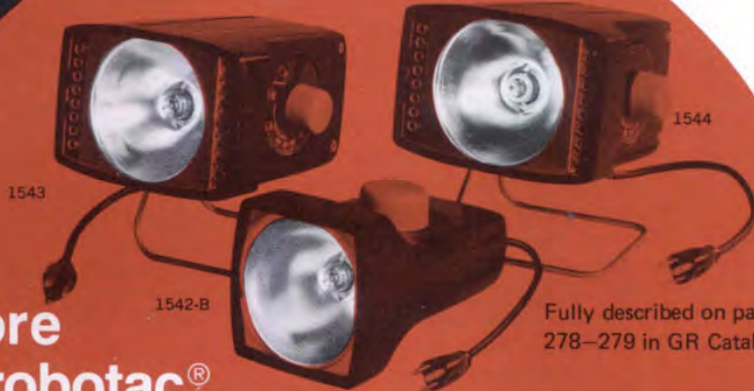
1531-AB

Bright white light for high-speed photography or observation in any normal ambient light.

- Measures speeds up to 250,000 rpm (1% accuracy).
- From 110 to 25,000 flashes per minute.



Fully described on page 277 in GR Catalog 73.



More Strobotac[®] electronic stroboscopes

Fully described on pages 278-279 in GR Catalog 73.

1543 For photographic, educational, general-purpose inspection, and design applications.

- Features line synchronization and contact-closure trigger.
- Permits observing motion as fast as 40,000 rpm.
- From 180 to 3800 flashes per minute.

1544 For printing, textile, photographic, educational (mechanical engineering), mechanical design, and general-purpose inspection applications.

- Features line synchronization, contact-closure and photoelectric triggers, plus delayed triggers.
- Permits observing motion as fast as 40,000 rpm.
- From 180 to 3800 flashes per minute.

1542-B For educational, general-purpose inspection, and design applications.

- Permits observing motion as fast as 40,000 rpm.
- From 180 to 3800 flashes per minute.

Megohmmeters



1863

1864

1863 For production and inspection measurements.

- Five test voltages from 50 V to 500 V.
- Ranges from 50 kilohms to 20 teraohms.
- Direct-reading, safe, and stable.

1864 For laboratory investigations.

- Two-hundred test voltages from 10 V to 1090 V.
- Ranges from 50 kilohms to 200 teraohms.
- Direct-reading, safe, and stable.

Fully described on page 183 in GR Catalog 73.

1683 Automatic RLC Bridge



Ideal for incoming inspection, quality control, and high-volume production applications where components must be measured as quickly as possible.

- Measures resistance from 1 microhm to 2 megohms.
- Measures inductance from 0.1 nanohenry to 2000 henrys.
- Up to 20 measurements per second.
- Basic accuracy: 0.1%.

Fully described on pages 138–139 in GR Catalog 73.

1730 Linear Circuit Tester



For circuit evaluation, production testing, and incoming inspection.

- Versatile memory panel sets test conditions and limits – no hard wiring.
- Automatic pushbutton operation.
- Completes full set of tests in less than two seconds – faster if you skip some tests.
- Displays either GO/NO-GO results or measured values.

Fully described on pages 126–128 in GR Catalog 73.

1650-B Impedance Bridge

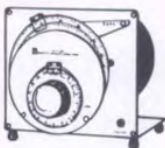


Measures capacitance, inductance, resistance, conductance, dissipation factor, and storage factor.

- Range from 20 Hz to 20 kHz, internal 1 kHz and dc.
- Portable, self-contained, battery-operated.
- Accuracy: 1%

Fully described on page 154 in GR Catalog 73.

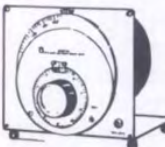
High-Frequency Oscillators



1211-C

500 kHz to 50 MHz

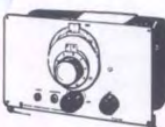
Fully described on page 228 in GR Catalog 73.



1215-C

50 MHz to 250 MHz

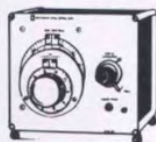
Fully described on page 228 in GR Catalog 73.



1218-BV

900 MHz to 2 GHz

Fully described on page 230 in GR Catalog 73.



1361-A

450 MHz to 1050 MHz

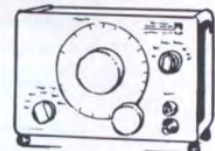
Fully described on page 230 in GR Catalog 73.



1362

220 MHz to 920 MHz

Fully described on page 229 in GR Catalog 73.

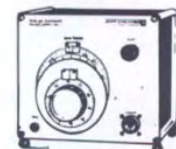


1309-A Oscillator

A general-purpose laboratory oscillator, ideal for distortion measurements.

- From 10 Hz to 100 kHz in four decade ranges.
- Distortion 0.05%.
- 5-volt square-wave or sine-wave output.
- 60-dB step attenuator.

Fully described on page 77 in GR Catalog 73.



1363

56 MHz to 500 MHz

Fully described on page 229 in GR Catalog 73.

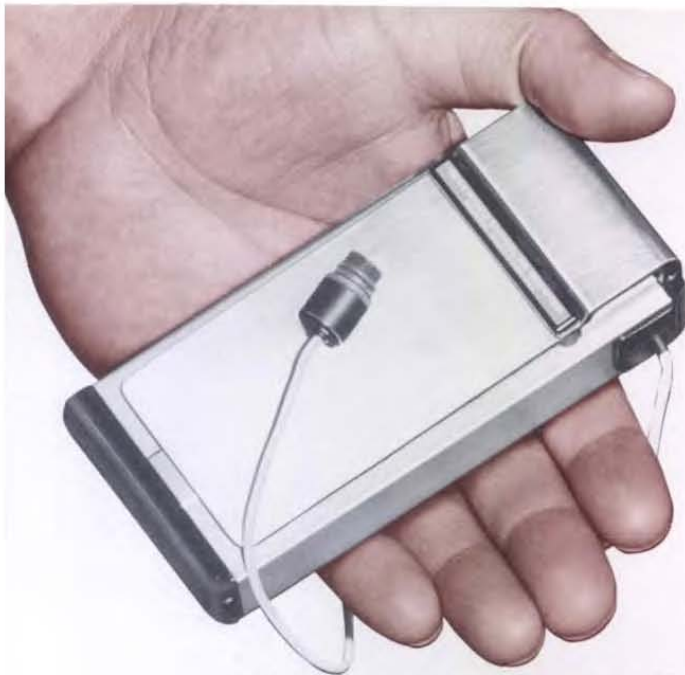


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New remote mike for GR 1944 Dosimeter picks up noise where it counts most

A new model of the personal noise-exposure monitor used in the GR 1944 Noise Dosimeter system features a tiny remote microphone that can be placed anywhere on the person for optimum accuracy in measuring noise under a variety of exposure conditions. This latitude in positioning the microphone is desirable since no single location is ideal for measuring all types of exposure.

The new remote microphone, including windscreen, weighs only 0.3 ounce and measures only 1/2" in diameter. Connected to the monitor by a 36" cord, the microphone can be placed at the worker's ear — for closest proximity to noise entering the ear — or on the worker's collar. The tiny microphone can also be worn under a protective earmuff to evaluate attenuation efficiency.

The microphone's windscreen reduces the effect of wind-generated noise and protects the microphone from dust and industrial contaminants.

Designated as GR 1944-9707, the new noise-exposure monitor equipped with a remote microphone is otherwise identical to the familiar GR 1944-9701 monitor with a built-in microphone —

described in GR Catalog 73. Purchasers of the GR 1944 Noise Dosimeter system may now choose either of the two types according to their needs.

The complete GR 1944 Noise Dosimeter system comprises a noise exposure monitor with microphone (built-in or remote), a noise-exposure indicator, a calibration adaptor, and accessories.



GR 1944 Noise Dosimeter approved by Bureau of Mines

The U.S. Department of the Interior's Bureau of Mines has officially approved the GR 1944 Noise Dosimeter for use in mines. Approval followed performance-evaluation tests conducted for the Bureau of Mines by the University of Pittsburgh.

This approval of performance is in addition to the Bureau of Mines' previous approval for "intrinsic safety" that the GR 1944 has enjoyed since its introduction a year ago.

Westates named strobe distributor for southern California

GR has named Westates Electronics Corporation as authorized distributor for the full line of Strobotac® and Strobolume® electronic stroboscopes and related accessories in the southern California area. Westates has two offices:

20151 Bahama St.
Chatsworth, California 91311
Phone: 213 341-4411
948 Elm St.
Orange, California 92668
Phone: 714 532-6891

Westates Electronics Corporation has been a GR distributor for Variac® adjustable autotransformers for many years, and will now handle both the autotransformer and stroboscope lines of GR products.

New paper discusses fully digital FFT hardware

A new paper titled "Survey of Fully Digital FFT Hardware" investigates the major components of digital Fourier Analyzers, their most important characteristics, and how these characteristics influence the choice of a system. The paper also discusses Fourier transform speed and methods of increasing it.

Written by Ago Kiss, Chief Engineer of Time/Data Corporation (a GR company), the paper was presented at the ASA Meeting held in Boston earlier this year. Free copies of "Survey of Fully Digital FFT Hardware" are available directly from: Time/Data Corporation, 1050 East Meadow Circle, Palo Alto, California 94303.

patron



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Newest GR automatic cable-test system speaks Spanish

The latest in GR's ever-growing number of automatic cable-test system installations is now helping increase the throughput of one of Spain's major producers of multiconductor telephone cable — Cables de Comunicaciones S.A., in Zaragoza.

An affiliate of General Cable Corporation, Cables de Comunicaciones S. A. manufactures cables in sizes up to 1300 pairs. Its modern automated plant, operating round the clock on three shifts, is the first in Spain to be equipped with a fully automatic GR cable-test system.

Through the versatility of its software package, the new GR cable-test system was readily programmed to deliver a direct Spanish-language test report. This software versatility was also instrumental in adapting the GR automatic cable-test system quickly and easily to the requirements of both the cable manufacturer and the Spanish Government Post Office, which

operates the nation's telephone system.

The new GR system measures all resistance and capacitance parameters of 100-pair cable samples in a single test sequence. Being software controlled, the GR system gives Cables de Comunicaciones S. A. flexibility in handling different test procedures and cable types with minimum changeover time and effort.

The Spanish cable manufacturer had previously tested cable by manual methods that included tedious hand calculations. The high-speed minicomputer of the GR automatic cable-test system now completes the same calculations within seconds.

Two fanning fixtures are used in the Spanish installation to maximize the operator's productivity. Once a reel of cable is connected and the automatic testing procedure begins, the operator is freed to connect the next reel of cable to the second test fixture in readiness for the next sequence of tests.

To start a testing sequence, the operator merely answers a few simple

program-generated questions, using the teletypewriter keyboard. These may include: number of cable pairs connected, cable length, wire gauge, and ambient temperature. This is the extent of operator involvement. The system can be readily operated by unskilled personnel with no knowledge of programming or computers.

With its new GR automatic cable-test system operational, Cables de Comunicaciones S. A. now performs its cable tests faster, more thoroughly and accurately than by previous methods. The firm now obtains more data on more transmission parameters, and has better control over product quality and consistency.

Negotiations for this GR automatic cable-test system were handled by GR's local authorized representative, Hispano Electronica S. A., Madrid. Personnel of Hispano Electronica S. A. provided valuable assistance in translating the English test-report text into Spanish, and in training the Spanish-speaking operators.

ATOS DE IDENTIFIC:

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 PARES: (METROS): 1333
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 CALIBRE (MM): 0-3
 TEMPERATURA (GRADOS): 20
 SITIO NUM: 1

ERROR UMbral 5-332 NF
 (**C MUTUA (CORRECLDA)
 LIMITS MAX 100.00 NF/KM
 MIN 70.00 NF/KM
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GR automated laser trim system speeds Sony's hybrid-circuit output

A new GR computer-controlled functional laser trim system recently installed at the Atsugi, Japan, plant of Sony Corporation has fully automated the trimming and testing of thick-film and thin-film resistors on hybrid circuits used in Sony's electronic products.

GR's functional laser trim system enables Sony to trim with greater speed, accuracy, and flexibility than possible with their previous semi-automatic air-abrasive technique, which was limited to simple cuts. Through the very powerful, versatile software language of their GR computer-controlled system, Sony can now perform more sophisticated and difficult trimming than before. In addition, Sony can use their new GR system to scribe substrates to separate multiple circuits.

A major innovation in Sony's new laser trim system is fully automatic loading and unloading of substrates. The substrates are stacked in a magazine on the automatic loader and are fed one at a time onto a four-station rotary indexing table. The table precisely positions each successive substrate under the laser head for programmed trimming and testing. The automatic system then unloads the trimmed substrates and sorts them into "pass" and "reject" bins — all without human intervention.



Another major feature of the new Sony system is programmable laser power. Through the system's versatile software, the intensity of laser power can be programmed to vary according to the thickness and type of material of each specific resistor.

Sony Corporation selected the GR functional laser trim system as the most cost-effective system for their trimming needs. In addition to increasing throughput and accuracy, the new GR laser trim system enables Sony to use lower-skilled labor than was required for their previous air-abrasive trim system.

While Sony will initially be doing functional trimming on dc voltage parameters, their GR system is designed and integrated for easy addition of modules for trimming and measuring other parameters such as ac voltage and frequency.

Negotiations for the new GR functional laser trim system installation at Sony Corporation were handled by GR's systems distributor in Japan, Tokyo Electron Laboratories, Inc.



New modules for GR 1523 recorder expedite product noise analysis

Two new plug-in modules for the GR 1523 Graphic Level Recorder give you recording capability for more versatile real-time 1/3-octave analysis and serial narrow-band analysis essential to solving product noise problems.

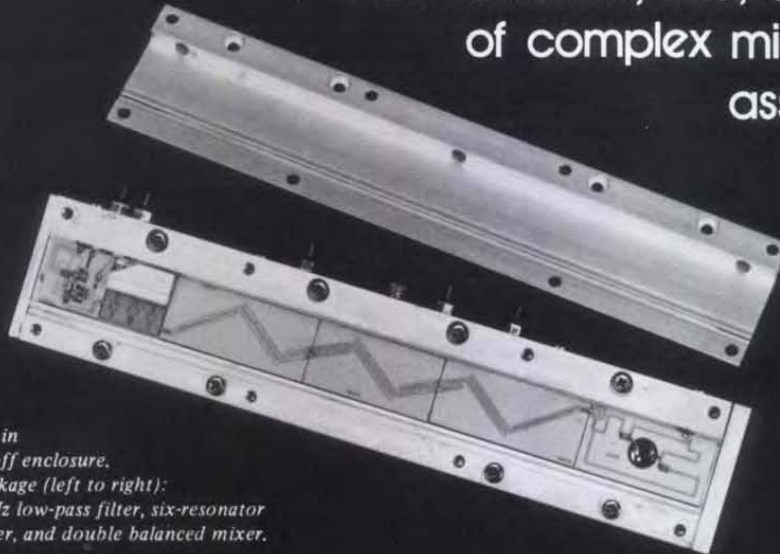
The first of the new plug-ins is the GR 1523-P5 DC Preamplifier that enables the graphic level recorder to be linked to the GR 1921 Real-Time Analyzer for automatic recording of 1/3-octave spectra. A remote command from the real-time analyzer initiates the recording. The preamplifier is easily operated from a few simple controls.

A unique feature of the GR 1523-P5 DC Preamplifier is a "Repeat Chart" mode that automatically rewinds the chart paper to its starting position after a plot is completed. This permits several different spectra to be overlaid on the same chart section for instant comparison. For identification, each plot can be color-coded in red, green, or blue ink by a simple change of pens.

The second plug-in module, a GR 1523-P4 Narrow-Band Wave Analyzer, allows the GR 1523 Graphic Level Recorder to be used directly for detailed narrow-band analysis of any frequency range in which a noise problem has been detected. Bandwidths of 10 Hz and 100 Hz permit the identification of pure-tone components buried in noise. The plug-in modules are easily interchanged in minutes.

Several other plug-in modules available for the GR 1523 Graphic Level Recorder further enhance its versatility for a variety of other measurement functions. These additional modules include the GR 1523-P1 Preamplifier for level-vs-time recordings, the GR 1523-P2 Sweep Oscillator for level-vs-frequency recordings, and the GR 1523-P3 Stepped 1/3-Octave-Band Analyzer for spectrum recordings.

Novel packaging cuts radiation, size, and cost of complex microwave assemblies



Filter-mixer assembly in waveguide-below-cutoff enclosure. Inside 7-inch-long package (left to right): 2-GHz amplifier, 2-GHz low-pass filter, six-resonator 1.7-GHz bandpass filter, and double balanced mixer.

The more complex an assembly of conventional waveguide and coaxial components becomes, the larger and costlier it can also become.

A more compact design might be achieved by use of microstrip circuitry. But conventional exposed microstrips can introduce radiation and cross-coupling. Shielding the individual microstrips and linking them by coaxial cable can solve the radiation problem — at a sacrifice in compactness and economy that puts you almost back where you started.

This is a problem that General Radio faced in its efforts to design — at reasonable cost — compact, reliable, and well-shielded microwave circuitry for the GR 1710 RF Network Analyzer and the GR 1062 Frequency Synthesizer. Circuitry included mixers, amplifiers, filters, oscillators, and couplers, with operating frequencies up to 2 GHz.

The solution was found in a novel approach that uses neither waveguide nor coaxial components.

To achieve the optimum combination of miniaturization, reliability, and economy, microwave integrated circuits are fabricated on ceramic substrates by photoetching the conductors into a .0003" gold film plated on the substrates. Width of the conductors estab-

lishes the impedance of the transmission line. Transistors and capacitors are soldered directly to the thin-film gold conductors.

GR's photolithographic reproduction process yields a very accurate pattern that makes possible fixed-tuned devices. Since the circuit characteristics are fixed by geometry, no future trimming is ever required. Once a pattern is made, the circuits are easily reproduced in any quantity. The resulting MIC's are 60% smaller than equivalent circuitry made using waveguide or coaxial components, as well as less expensive.

The problem of effectively shielding the microwave circuitry on the substrates was solved by enclosing the substrates in a waveguide-below-cutoff aluminum enclosure. This permits many circuits to be combined in a single package with virtually no radiation or coupling between conductors.

The waveguide-below-cutoff enclosure is made of two identical split-L aluminum extrusions that form an inexpensive base and cover assembly. All dc and coaxial connections are made through the side wall. Silver-loaded silicone gasket material forms an rf-tight seal between the cover and base. The MIC substrates are easily accessible with the cover removed.

To achieve 100-dB isolation between two circuits in the same enclosure, the circuits are merely spaced $2\frac{1}{2}$ " apart down the waveguide. No partitions, feed-throughs, or compartments are necessary. Typical circuits made possible by the waveguide-below-cutoff enclosures include microwave amplifiers with gain as high as 30 dB at 2 GHz, and fixed-tuned bandpass filters 100 MHz wide with 90-dB rejection. This packaging enables a dynamic range of 100 dB to be attained in the GR 1710 RF Network Analyzer, as well as a noise floor of -115 dB.

This novel approach to design and packaging of microwave integrated circuits has enabled General Radio to produce complex, high-performance microwave circuit assemblies at much more reasonable cost than with conventional waveguide or coaxial components. GR's extraordinarily reliable MIC's capitalize on the compactness of microstrip techniques *without* the inherent radiation problems of microstrip circuitry.

This packaging technique is described in a paper titled "Microstrip in Instrumentation," by Kingsley W. Craft, GR Engineer. Copies of the paper are available via the attached reply card.

GR active in overseas trade shows



IN POLAND . . . GR's booth at the recent Poznan International Technical Trade Fair featured working displays of the GR 1710 RF Network Analyzer, GR 1666 DC Resistance Bridge, GR 1523 Graphic Level Recorder, GR 1944 Noise Dosimeter, and the full line of GR sound-level meters. Staffing the GR booth were Othmar Reiter (left) and Ajai Singh of General Radio (Overseas), Zurich, Switzerland.



IN ISRAEL . . . GR products were prominently displayed at the IEEE Exhibition held earlier this year in Tel Aviv. Among the instruments shown at the booth of GR's Israeli distributor, Eastronics Ltd., were the GR 1683 Automatic RLC Bridge, GR 1710 RF Network Analyzer, GR 1684 Digital Impedance Meter, GR 1656 Impedance Bridge, GR 1523 Graphic Level Recorder, and GR 1730 Linear Circuit Tester.

GR 2260 speeds testing of coaxial-line repeaters in Canada



At Northern Electric Co. Ltd., Lucerne, Quebec, Product Engineer Allen Austin uses new GR 2260 Automatic RF Network Analyzer System to speed production-testing of repeater subassemblies for Canada's new LD-4 Long-Haul Digital Coaxial Cable System. The thick-film subassemblies include equalizers, amplifiers, and regenerators.

Developed by Bell-Northern Laboratories, Ottawa, the LD-4 telecommunications system operates at a rate of 281 megabits/sec for distances of up to 4,000 miles. Total route capacity is over 20,000 standard voice circuits or the equivalent.

Multiple repeaters are installed in manholes located every 6,000 feet along the transmission line. The testing requirements for the high volume of repeater subassemblies were especially critical — combining speed, extreme accuracy, and operating simplicity. Northern Electric found the answer to its needs in the new GR 2260 Automatic RF Network Analyzer System.

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