Tektronix, Inc. Company

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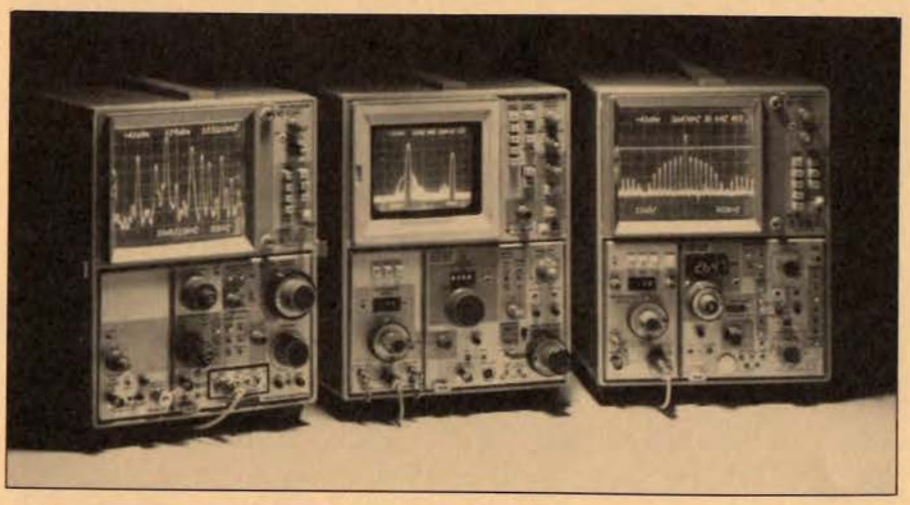
Frequency Domain Instruments Face Expanding Markets



High performance and innovative design distinguish the Tektronix 7L spectrum analyzer family.

A recent readership survey by *Microwave* magazine revealed an astonishing increase in recognition of Tektronix as a supplier of high performance spectrum analyzers. To learn more about these sophisticated instruments, their users, and the business unit responsible for their marketing, FEN talked to Len Garrett, Spectrum Analyzer Product Manager, and Henry Gregor, Cable Tester Product Manager.

Len, most of our readers are familiar with the oscilloscope and other general purpose test instruments, but they may be less aquainted with the spectrum analyzer. Would you explain briefly what it is and how it is used?

Basically, a spectrum analyzer is a highly sensitive superheterodyne radio receiver. Instead of converting radio signals to sound or a TV picture, however, a spectrum analyzer displays the signal's frequency components whose amplitudes and horizontal positions represent the components' strength and frequency, respectively.

This ability has two major uses. The first is to detect and measure the parameters of RF signals and the presence of unwanted or "spurious" emissions from electronic equipment. The other is to analyze the frequency content of non-sinewave signals. This process is equivalent to what is known as "Fourier Analysis," and has many applications in both the electronics and the mechanical worlds.

Spectrum Analyzer Users

Perhaps the foremost user of spectrum analyzers is the general electronics design engineer, particularly in work with amplifiers, filters, oscillators, components, and many related applications. Even in a procedure as simple as checking a power supply's performance, the design engineer might use a spectrum analyzer to measure radiated interference to ensure its meeting certain established criteria.

Once a product gets beyond the design stage and into production, a spectrum analyzer is routinely used to validate performance, especially of telecommunications and mobile communications equipment. As an

example, General Electric manufactures two-way radio equipment in Lynchburg, Va. GE engineers use our spectrum analyzers to design the equipment and validate its performance and to see that it conforms with FCC requirements for spurious response. Further, GE's final test people use spectrum analyzers to ensure that transmitter deviation levels, power output levels, and other performance characteristics meet specifications. So you have the design engineer, quality control engineer, production engineer, and environmental lab — all involved in spectrum analyzer measurements.

Once the equipment gets to the field you have the consulting engineer and the regulatory agencies who use spectrum analyzers to validate equipment for adherence to the manufacturers' performance specifications.

Then there are the people who install the equipment. Collins Radio, for instance, will send an installation team to Pacific Northwest Bell to install a digital microwave system. This team will use a spectrum analyzer to validate the performance of the complete system. And finally, Pacific Northwest Bell, the end user, uses spectrum analyzers to monitor, maintain and service the equipment. So, all the way from the design to the service stages in the development of a single telecommunications system, you have many people using spectrum analyzers.

What are the major spectrum analyzer markets?

Commercial telecommunications is presently the largest market for spectrum analyzers. We have not only the communications industry, which includes giants like ITT, Western Union, and the like, but also many smaller systems like those installed by the energy (electric power, natural gas, and oil) industries.

The communications market is expanding at an ever increasing rate. Already, microwave carriers handle a large part of ordinary telephone traffic, either point-to-point or by satellite; and the growing demand for data communications is pushing carrier frequencies higher and higher, where more information can be carried on the wider-bandwidth channels.

New 492 Portable Spectrum Analyzer offers digital storage, full programability and GPIB compatability, among other outstanding features.

The energy industries require external communications networks to transmit both voice and data between pipeline and power-transmission stations, and between stationary and mobile units. Their measurement requirements thus start at the baseband level (a few hundred kilohertz up to the lower megahertz region) where information is impressed on the carrier.

Then they will typically have a VHF/UHF mobile fleet manned by installation, service and repair crews, and finally a point-to-point microwave system that allows them to constantly monitor the status of their pipelines, powerlines, or other distribution systems. These microwave systems are largely "automatic" systems, which transmit data like voltage, current, pressure, temperature, and rate-of-flow from transducers to a central station where operators, sometimes assisted by a computer, monitor and control the system.

At every level — baseband, VHF/UHF and microwave — spectrum analyzers are the primary tool for installation, maintenance and servicing the communications systems.

The aerospace/military community is another large market segment. These people use spectrum analyzers in work such as satellite communications, radar, electronic countermeasures, electronic intelligence gathering, and radio navigation.

Almost any type of military weapons system, whether offensive or defensive, employs a sophisticated, sometimes state-of-the-art, intelligence exchange between operator and machine, or machine and machine. The spectrum analyzer plays an integral part in the development and employment of these systems, since most intelligence takes the form of frequency information.

The surveillance community, both military and civil, find the spectrum analyzer indispensable. By eavesdropping on foreign satellite,

military radar and communications systems we can learn a great deal about what a potential enemy is doing. Without this ability, we could not safely become a party to SALT (Strategic Arms Limitation Treaty). Here again, because the intelligence is extracted from frequency information, the spectrum analyzer plays an important role.

The civil authorities (FBI, Treasury Department, Immigration and Naturalization Service, etc.) also use spectrum analyzers for surveillance, even for something as simple as detecting unauthorized radio signals emanating from the vicinity of a race track. The Bureau of Alcohol, Tobacco and Firearms, the Drug Enforcement Administration, and dozens of other law enforcement activities all have surveillance networks to detect communications associated with illegal activities.

What position does Tektronix occupy in the spectrum analyzer market?

There are only two *major* companies contending for the spectrum analyzer market — Tektronix and Hewlett-Packard.

Tektronix is in somewhat the same position regarding spectrum analyzers as Hewlett-Packard is in oscilloscopes. You might say HP got there "fustest with the mostest" in the spectrum analyzer market, and has established a position of leadership similar to that we enjoy in the oscilloscope market. So we are running second to HP in spectrum analyzer sales — but we're gaining.

Nevertheless, we are doing very well in those market segments we have chosen to penetrate. The popularity of our 7000-series oscilloscopes creates a sizeable potential market for our 7L12, 7L13 and 7L15 spectrum analyzer plug-in instruments, and we do very well there. Not that sales of these instruments are confined to 7000 series owners. In many cases it works the other way — customers become owners of Tektronix oscilloscopes because they buy one of our analyzers.

We have also been quite successful in the area of portable spectrum analyzers. Our 491 has been very popular, especially with the government and military, ever since it first went into production almost 10 years ago. We intend to cultivate these markets even more with our new 492, and also develop the commercial market potential.

Before you go into detail on the 492, will you explain how Tektronix got into the spectrum analyzer business?

Back in 1966 Tektronix bought a small New York-based company called Pentrix, which was making plug-in spectrum analyzers for Tektronix 540-series oscilloscopes. The Pentrix engineer-owners, Arnie Frisch, Larry Weiss, and Morris Engelson came to Beaverton and developed the first Tektronix instruments, the 1L20, 1L30, and 1L10 for the 540-series oscilloscopes, then shifted to the 3L5 and 3L10 for the 560 series, and finally developed the 491, our first portable monolithic spectrum analyzer.

Swept IF Systems

When we began development of the 7L series spectrum analyzers for the 7000 series oscilloscopes, we didn't just continue on the same path. You see, the 1L and 3L series, as well as the 491, were all "swept IF" instruments; that is, the broadband input was first mixed with the output of a fixed-frequency local oscillator to produce an intermediate frequency (IF) band. This narrower band was then "swept" by mixing it with the output of a sweep-tuned, voltage-controlled oscillator (VCO) to separate the various signal frequencies present at the front end.

This technique was dictated by the bandwidth limitations on the local oscillators then available. Unfortunately, swept IF systems are handicapped by relatively narrow scanning widths, and troublesome spurious responses.

About the time we were working on the 1L and 3L series and the 491, HP introduced their first swept-front-end analyzers, employing a backward-wave oscillator with a very wide scanning range. This was the first really significant advance in spectrum analyzer technology in many years, and it put them way out in front — so far that they were just about the only ball game in town. They had a wide sweep, the first calibrated reference levels, db per division, a "clean" display and other features we take for granted today.

Tektronix Goes High-Technology

When the 7000 series oscilloscopes were in the planning stage, we saw an opportunity to get into the state-of-the-art spectrum analyzer business. The Yttrium-Iron-Garnet (YIG) oscillator had just emerged from the experimental stage, and with its wide sweeping range we could switch to a swept-front-end system, and thus match the performance of HP's instruments. Our first swept-front-end analyzer was the 7L12, which was an immediate success and sells almost as well today as it did when we first introduced it.

Then came the 7L13, the 7L5 and the 7L18. The 7L5 was our first digital-storage analyzer, which led the way for the 7L18, the first digital *microwave* analyzer on the market. The 7L18 gave other evidence of Tek's contribution to microwave technology. At the time of its introduction it was the highest performing spectrum analyzer on the market. We had developed our own preselector, a device for eliminating images and other spurii — sort of an automatic tracking filter. The 7L18 had better stability, less residual FM, and narrower resolution than any instrument in its frequency range. It also had a very significant improvement we first introduced with the 7L5 — digital storage. The 7L5 was also the first analyzer in its frequency range with a local oscillator that could be tuned in discrete steps (250 Hz or 10 kHz). This gave the analyzer an unprecedented absolute frequency accuracy. So although Tektronix may still take second place in spectrum analyzer sales, it is gaining recognition as a leader in microwave technology. **Microwave** magazine's recent readership survey provides direct evidence of Tek's gain in recognition as a competitor in the

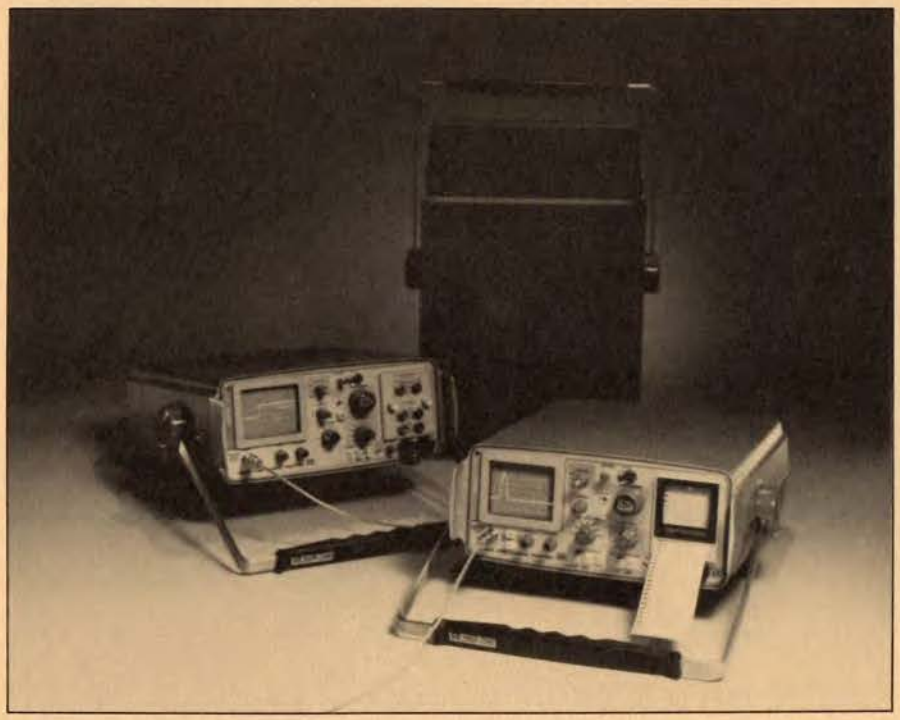
spectrum analyzer market. Noting that Tektronix ran only eight pages of spectrum analyzer advertising in the three major microwave magazines (as opposed to HP's 141 pages), the editor labeled our 1978-1979 gain in recognition from less than 20% to 36.3% both "sizeable" and "notable". (Of course he also noted that HP's 90.1% was hard to improve on).

We expect to extend our recognition and sales gains with the recently-announced 492. This is a very rugged, high performance, monolithic portable spectrum analyzer with some features that will make it highly attractive to the communications industry as well as the military. For example, it can be dropped twelve inches on any axis without affecting its performance. This ruggedness will be appreciated by people in satellite communications, microwave communications, and similar areas of application where the spectrum analyzer may get a lot of abuse. They need an instrument that can be tossed on a truck and transported to the site.

But ruggedness and portability are not the 492's only attractions. It is also a high performance instrument that will be equally appreciated in a lab environment. The 492 has digital storage, a GPIB interface, is fully programmable, and has some niceties, like a delta mode that makes signal comparisons possible in quarter-db steps. This is a significant advance over the typical 1-db capability of most spectrum analyzers.

Many of the terms you use in talking about spectrum analyzers have an "off-beat" sound to one more familiar with oscilloscopes and other traditional T&M instruments. Does this have any bearing on the fact that spectrum analyzers are sold by SE specialists?

Yes, it does. You see, in the course of acquiring an education, and later on in contacts with the electronics industry, the SE is exposed only occasionally to the RF environment. So the average SE doesn't have the opportunity to become thoroughly familiar with the customer's measurement requirements, nor to demo our spectrum analyzers often enough to become thoroughly familiar with their capabilities. It takes a specialist — one who, for one reason or the other, has devoted a great deal of time to the study of RF and microwave technology, to discuss our customers' measurement problems and effectively demonstrate our instruments.



Tektronix 1502 and 1503 set industry standard for portable TDR cable testers.

This is especially important in view of our second-place position in the market. We must have sales engineers who can bring the maximum expertise and empathy to the customer's problems, in the same tradition that has characterized Tektronix' relations with oscilloscope customers.

Some of Tek's old timers get a certain wry amusement from the fact that many of our newly-hired SE's are primarily digital-domain-oriented, and find the oscilloscope time-domain environment a little esoteric, in the same way that our oscilloscope people have viewed the spectrum analyzer frequency-domain environment. They wonder whether the time is coming when oscilloscopes may have to be sold by "time-domain specialists."

How does FDI marketing support the sales force?

Well, first of all, we perform the same functions as other business unit marketing and support groups — set objectives, develop long- and short-term strategies, and devise action plans for promoting individual products.

Specifically, we support both specialist and nonspecialist SE's with technical application notes and trips to the field, where we assist in sales to customers who have special requirements or a large order potential. We give technical assistance to our service people, and special training classes for SE's and customers. We conduct seminars and produce video tapes as selling and training aids. We try to do everything we can, through influence (media ads and public relations) and direct assistance, to help the SE make a sale.

It is not unusual for our FDI marketing manager, Morris Engelson, to personally conduct seminars for high-level engineers at the customers' locations. Morris is an internationally-recognized authority on spectrum analyzer measurement

applications and holds the title of chief engineer as well as marketing manager. His participation in our support activities is probably the most convincing evidence we could offer to our customer of our expertise in, and commitment to, the spectrum analyzer business.

What happens when one of our non-specialist SE's encounters an opportunity for a spectrum analyzer sale?

For assistance of any kind, the SE should immediately call the local spectrum analyzer specialist in the SE district. (We have five specialists in the East and five in the West.) In the rare case where specialists need assistance, they call us here in Beaverton.

Henry, the Cable Tester Business Unit also comes under FDI management. Just what kind of measurement do cable testers make?

The term "cable tester" can include everything from a simple meter-type device like a "megger" (megohm insulation tester) to those based on the time-domain-reflectometry (TDR) technique, like our 1502 and 1503.

Basically, the TDR technique resembles that employed in radar and sonar. The cable tester applies a pulse of electrical energy to the cable under test. The pulse travels, almost at the speed of light, down the cable until it encounters some type of discontinuity. Here, a part of the transmitted energy reflects back to the cable tester, which measures the time between transmission and reflection, converts it to distance, and displays the shape of the reflected pulse. From this information a skilled operator can determine not only the location of the discontinuity, but also the probable cause, such as water-soaking, opens, shorts, poor connections, and similar faults.

You said the operator can "locate" the fault. What does this mean, in practical terms?

To a layman, the most dramatic demonstration of a modern TDR cable tester's capabilities would probably be provided by a telephone line repair crew. He would first see them take a measurement from the cable tester, then travel miles across country, stop at a particular spot, dig down to a subterranean cable and find the faulty section on the first try.

Less dramatic, but technologically more impressive is the cable tester's ability to locate faults in short cable runs, since the elapsed time between transmitted pulse and reflected pulse must sometimes be measured in fractions of a nanosecond.

Where are cable testers used?

Wherever cable is used for transmission of intelligence or data. As one would expect, the telephone industry is the largest user; but practically any communications system depends to some extent on cables, so even the radio and TV industries employ them to a large extent. CATV and CCTV systems are, of course, natural customers.

The military are also important customers. And not just for maintenance of their overland communications systems. A typical aircraft carrier for instance, contains thousands of miles of densely-packed cable for the transmission of voice and data. A typical fighter plane carries so much cable that without cable testers, it could sometimes take weeks to locate a fault.

How did Tektronix enter the cable tester business?

Primarily through our involvement with sampling oscilloscopes. Because very-fast-risetime pulses are necessary in TDR systems to obtain practical time (and thus distance) resolution, only a sampling oscilloscope could display them in the early days of TDR history. As we became involved in this area of application it was a natural step to the development of a complete TDR system.

At the present time, what instruments does our cable tester line include?

Tektronix makes two cable testers, the 1502 and 1503. The 1502 is a high-resolution unit, with a maximum range of 2000 feet, designed for locating faults in short cable runs. It can distinguish between faults separated by as little as 0.6 of an inch, a resolution unmatched by any other portable cable tester. The 1503 has a range extending to 50,000 feet, depending on the cable type, with a resolution of three feet on shorter cables. Both models are rugged, portable, all-environment instruments (the 1502 has been displayed at trade shows operating under a steady spray of water). The traits of high resolution, portability and resistance to abuse are responsible for Tek's leading position in the TDR cable tester market.

Are cable testers also sold principally by FDI specialists?

For the most part, yes — and for reasons similar to those Len outlined for spectrum analyzers. A good share of our sales are made by our government specialists, since government agencies are among our best customers.

How about your support activities?

What Len has said about his support activities pertains also to our efforts for cable testers.

Len, How is FDI organized?

FDI is one of four subdivisions of the Communications Division, managed by Tom Long. In addition to FDI, the Communications Division includes TV Test Instruments, Medical Products, and of course the Grass Valley subsidiary which manufacturers in-line TV equipment. Vince Lutheran is business unit manager for FDI. Morris Engelson manages FDI marketing (and also doubles as Chief Engineer for Spectrum Analyzers).

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Frequency Domain continued

The cable tester and spectrum analyzer business units each have a product manager. Sometime in January, Stuart Fox will be coming over from England to be product manager for the 7L-series spectrum analyzers, and I will have the 490-series. John David will have responsibility under me for the programmable 490-series instruments. Gary Mott will report to Stuart Fox for the 7L-series and Jay Snell reports to Henry Gregor. That makes up the FDI organization.