

# Spectrum analyzers require high technology

**Thor Hallen**  
Engineering Manager  
Frequency Domain  
Instrumentation

Our present product line consists mainly of spectrum analyzers and the 1500 series of cable testers. Like the oscilloscope, these are general purpose test and measurement instruments but are sold primarily to communications industry users.

The spectrum analyzer is as essential to a communications engineer as an oscilloscope is to a computer engineer. The 1500 series has been highly successful and is used for such things as precisely locating a fault in an underground telephone cable before digging down to fix it.

Tektronix entered the spectrum analyzer business in 1964 when we acquired Pentrix, a small company making spectrum analyzer plug-ins for our 500 series of oscilloscopes. Morris Engelson, our Chief Engineer, was one of the founders of Pentrix.

The spectrum analyzer, like the oscilloscope, plots a graph of signal amplitude. The oscilloscope plots signals as a function of time while the spectrum analyzer plots signals as a function of frequency. We call the oscilloscope a time domain instrument and a spectrum analyzer a frequency domain instrument.

One main difference is that the spectrum analyzer is about one thousand times more sensitive than our most sensitive oscilloscope. To achieve this sensitivity, our packages must be designed as carefully as our circuits to shield out unwanted signals.

The main challenge in designing and manufacturing instruments for our product line is the broad scope of high technology disciplines that are required. Our "edge of the art" tracking generators depend on Tek-made microwave integrated circuits (MIC's) that were computer designed and manufactured with precision mechanical parts and thin film substrates.

Similarly, the performance breakthrough of the 7L5 would not have been possible without custom MOS integrated circuits. With the trend toward microprocessors, we have been required to become as familiar



**TEK SPECTRUM ANALYZER** plays an important role in monitoring a radio station's signal. Here's the 5L4N in a 5111 mainframe.

with software and firmware as we have been with hardware.

As Engineering manager, much of my responsibility is to locate the very talented engineers that can master these technical challenges.

**Dave Friedley**  
Marketing Manager  
Frequency Domain  
Instrumentation

All electronic signals can be described in either time or frequency domain, and they may be measured and displayed in either domain. The choice of the domain depends on the application.

In the time domain, voltage is described as a function of time. The familiar sine wave is an example of a typical time domain display. The basic measuring instrument in the time domain is the oscilloscope.

In the frequency domain, voltages are displayed as a func-

tion of frequency and the sine wave shows up as a single line at a specific frequency. The basic measuring tool in the frequency domain is the spectrum analyzer.

What is a spectrum analyzer? Well, it's really a kind of radio receiver, quite sophisticated and considerably more expensive. If you were to grab the tuning knob on a radio receiver, an AM/FM receiver, like you might have in your hi-fi set and tune it back and forth very rapidly, you would be simulating what a spectrum analyzer does; i.e., repetitively sweeping a band of frequencies.

If you look at the FM dial, you see the dial goes from 88 up to 188 MHz. Stations can be heard at different places on the dial. On a spectrum analyzer each station will be displayed as a vertical line at its designated frequency. The higher the line on the analyzer, the stronger the station.

A major application is related to a new form of pollution—

area rep  
employees  
report

spectrum pollution. The FCC assigns frequencies to broadcast stations, hams, CB radios, police, fire, and other radio services. Although it purposely does not assign interfering frequencies, radio transmitters are not ideal and can generate many frequencies they are not supposed to. For this reason, spectrum analyzers are often used to design, manufacture, and maintain radio systems.

In cable television, signals are particularly troublesome and a spectrum analyzer is a valuable measurement tool. This is an important market for us and we have produced an application note, "No Loose Ends," specifically designed to show CATV people how to use spectrum analyzers.

Other markets for spectrum analyzers include aircraft and shipboard communications equipment, both commercial and military. Analyzers are used in research and development, production, and in some maintenance facilities.

The Olympics were brought to you by satellite, and spectrum analyzers are built in just about all satellite ground stations to monitor both the up and down links. Analyzers are also very important in the design, manufacture, and maintenance of most navigation systems (radar, TACAN, ILS, etc.).

In addition, the audio industry uses spectrum analyzers to design speakers, amplifiers, and tape recorders. We have even sold some of our analyzers to sophisticated hi-fi stores who are using them not only to repair hi-fi equipment, but also to show off the state-of-the-art specifications of their equipment. To help this industry understand the power of a spectrum analyzer, we recently published a "Tektronix Cookbook of Standard Audio Tests."

Spectrum analyzers are also used in noise and vibration work. Recent government



regulations have forced manufacturers to reduce noise and vibration in consumer and industrial products.

Just as there are different radio receivers covering the AM/FM, TV, ham radio bands, we have different analyzers to cover different applications.

For the audio range we have the 5L4, the 2-wide 5000 Series plug-in. This instrument and a few TM 500 packages make up a complete audio frequency laboratory. The 7L5 is our most sophisticated analyzer, incorporating the latest features in analyzer design, including digital storage, precision frequency readout, and built-in micro-processing capability. It covers the video range up to 5 MHz.

The 7L12 and 7L13 cover the HF, VHF, and UHF frequency bands and are the mainstays of the communications industry. The 7L13 is a 3-wide plug-in and is the most expensive plug-in we make. The price is \$7,500. The 1401 and 491 are our portable analyzers. The 491 is widely used in maintenance of microwave communications and radar systems. The 1405 TV Sideband Adaptor converts the 7L12 into a specialized analyzer for aligning TV broadcast transmitters.

The spectrum analyzer market is relatively new compared to our traditional oscilloscope markets, and we market them a little differently. We advertise not only in the standard magazines where you usually see oscilloscope ads, but also in special communications oriented publications. We also attend exhibits specifically designed for the communications, audio, and microwave industries such as the National Association of Broadcasters (NAB), National Cable Television Association (NCTA), and the Audio Engineering Society (AES).

Our "cookbook" style application notes are useful to many of our customers who are new to analyzers and need assistance in learning how to use them.

The field sales situation is a bit unique in that we use three different Tektronix sales forces

to sell the products. We have specialists who not only sell analyzers, but also provide technical support and training for Measurement Products Field Engineers. The main force is the Measurement Products field sales force. Thirdly, we use the TV Field Engineers to sell into the TV broadcasting marketplace.

How have we done? We started in 1964 when Tektronix bought Pentrix, the manufacturer of spectrum analyzer plug-ins for the old 500 Series. This product line did well for a few years until Hewlett Packard came out with a new line of spectrum analyzers. Finally, after years of development, we introduced the 7L12, first in the 7000 Series analyzer line. Since then, we have grown very rapidly.

Where do we go from here? Since the spectrum analyzer market is still growing, expansion of our product line is one direction to go. Another is to pursue other opportunities in the communications industry where we can apply our marketing and technical expertise.

Our first new product line is cable testers, the 1500 Series introduced last fall. These are portable, rugged instruments designed for a hostile environment, meaning the out-of-doors. The 1502's are used to check cables up to 2,000 feet, and the 1503's check cables up to 50,000 feet.

Why do people need cable testers? Aircraft and ships, for example, are full of cables. The cables get pinched, stepped on, and telephone cables get dug up and run over by bulldozers. Our cable testers detect which cable is bad and find where the fault is so it can be repaired. The 1503 has already received wide acceptance in the telephone industry.

After cable testers—who knows? The communications industry is growing rapidly and opportunities abound.

## Questions for Guest Speakers

*Answered by Tom Long, Steve Kerman, Dave Friedley, Thor Hallen and Charlie Rhodes.*

*What are the unique TV Products of Tek?*

While most of the television products are unique, perhaps the most significant is the vectorscope. The vectorscope is a specialized oscilloscope which enables the TV engineer to display, visualize and adjust the



**BILL POLITS**  
*Management Representative*

color portion of the TV signal. This early contribution to the TV industry by Tektronix made many of the present color television developments easy, if not possible.

*Which companies does Tek deal with mostly?*

Tektronix Communications Division products are used by most of the major electronics companies in the world. The television products are used by every television station and television network both in the United States and overseas. The major manufacturers of broadcast television equipment not only use our products in their plants, but many also supply Tek products as integral parts of their own products.

*What type of TV Products does Tek make?*

Tektronix Television products can be segmented into a few broad categories. The waveform monitor is a very special television oscilloscope. We currently make two families of waveform monitors, the 528 and 1480. The vectorscope is another specialized oscilloscope for displaying the color components of the TV signal. We have two families of vectorscopes, the 520's and the 1420's. Test and Sync Pulse Signal Generators provide the signals needed to time and test the television system. There are several families of generators in our line. We manufacture three families of picture monitors. Two are color monitors and the third is monochrome. The latter is manufactured in Heerenveen, Holland. A miscellaneous category of TV products can be broadly described as correctors. These instruments correct distortions in the TV signal and improve the signal for better home reception. The newest product to be announced is a precision demodulator. This product, using sophisticated devices developed in Tek Labs was introduced in March at the National Association of Broadcasters (NAB) show.

*Is it true that engineers in the Communications division got re-*

*ranged to 13, 14, 15 and 17? If so, why not the rest of the engineers?*

Some reranging of Engineering is occurring and it is expected that further changes will occur when all of these jobs have been reviewed by the corporation.

*Roughly, what part of corporate sales is due to the Communications division? Is that share growing?*

What per cent of Tek business does the Communications division contribute?

*What per cent of Tek total yearly sales are the TV Products?*

These questions cannot be answered directly. If some individuals want relative figures, we'll be glad to provide them, but they cannot be published.

*Who are the main competitors of Grass Valley?*

The main competitors of Grass Valley are two Canadian firms, Central Dynamics Limited and Richmond Hill, and a U.S. firm called Vital Industries. There are some companies in Japan and Europe that are also competitive.

*How critical do you feel the need to switch to digital television is? In other words, is digital TV the way of the future?*

Digital television is the technology of the future because of overwhelming economic advantages. Tektronix has developed one of the key items, a reasonable cost Analog to Digital (A/D) Converter which was shown to selected customers at NAB. It depends on proprietary I.C.'s developed by Tek Labs and proprietary circuits done by the television engineering group. This development will materially speed the development of other digital equipment.

Home receivers will never be affected by digital television techniques, at least in our lifetime, so don't be concerned about your present set becoming obsolete in the foreseeable future.

Digital techniques will be used by the broadcasters in their studios and in transmitting pictures to distant cities, probably via satellite. Digital television cameras can be expected within five years.

*Are in-house semiconductor components a significant part of your circuitry?*

Yes. In combination with the Grass Valley Group, we identified a need in a wide variety to our (and their) television products for a television sync generator on a chip (large scale integration). Because we are a multi-national company, we needed one which would work for all three major international television systems. Such a device has been developed.

It is fair to say that the economic advantage we enjoy in an increasing number of our products is due in part to the proprietary I.C.'s. Additional I.C.'s being developed by Tek Labs



are in process and will be used by the Grass Valley Group as well as here in Beaverton. I would rather not go into details concerning these items. At least one will probably be retrofitted into many of our present products and will certainly be used in the majority of our future products because of its performance advantages.

The most technically significant I.C. developed by Tek Labs for our television products is a surface-wave acoustic filter for the new demodulator shown at NAB '76. This device uses manufacturing techniques similar to those used for an I.C. It involved significant break-thru in filter design which gives us a clear advantage in cost and performance over all competitors.

We believe that our surface wave acoustic filter technology will be used in a number of products, not all of which will be television. It is fair to say that the entire television demodulator project was totally dependent upon the break-thru accomplished by engineers in Tek Labs.

*Are the people who work at Grass Valley under the same benefits as the people at Beaverton, such as profit share, insurance, retirement, etc.?*

Many of the benefits are the same at Grass Valley as at Tek, but there are some differences. Although Grass Valley does not have a profit sharing system, other benefits are commensurate with those at Tek.

*Why is it that when Tek buys products from the Grass Valley Group we must pay the normal selling price without a discount? We are treated as though we are just another company buyer, and yet we are supposedly the same company.*

These transactions between Tek and Grass Valley are really not any different than divisions buying Tek-made products. These are all handled at catalog price in order that managers and people involved recognize the opportunity cost. The actual accounting is done at cost as required by law.

Incidentally, Grass Valley pays catalog price for Tek-made products.

*What is the Communications division doing to improve the reliability and field failure rates of high technology instruments such as the 7L5, 7L12 and 7L13 spectrum analyzers?*

Glad you asked! High technology instruments such as the spectrum analyzers you mentioned pose enormous problems in maintaining Tektronix standards for high reliability. Let's consider the 7L5 for example. The 7L5 is the newest and



**LOUISE GRAY (Spectrum Analyzers) checks output of Tek's 1503 TDR Cable Tester. This model has the optional chart recorder.**

most dense analyzer to date. It has approximately 2200 electrical parts packed into a two wide plug-in. (The 7L12 and 7L13 are slightly less dense.) With such a high parts population, a .5%/year failure rate for individual parts would be disastrous.

In order to deliver better reliability, extraordinary steps are being implemented within the manufacturing area. All benches have been covered with "pink poly" to make a static-free environment for the sensitive Metal Oxide Semiconductor (MOS) circuits of the 7L5. Assemblers and technicians are being trained in static handling of these devices.

The most embarrassing reliability problem that can occur is when the customer has an instrument failure within the first few hours of operation. To prevent this, the 7L5 goes through an extensive 7 day cycled burn-in. Each day the instrument is checked for electrical performance. Any failures are repaired and the burn-in is continued until the instrument has completed the 7 days. Any failures in the last two days will cause the burn-in to continue until the instrument displays two consecutive days without a failure.

Along with burn-in and special handling, extensive effort is given to analysis of field and plant failures for reliability problems.

In answer to your question, we have only discussed the 7L5, but the 7L12 and 7L13 receive similar treatment. There is no final solution to improved reliability. As instruments increase in complexity and reliability, challenge increases proportionately.

*How many TV stations use our TV equipment in the Portland area and which stations are they?*

All of the television stations in the Portland area use Tektronix television products.

*Are analytical products connected*

*with Communications Division?*  
No.

*Does Communications division represent a specific product line?*

Yes. Three product lines are included in the Communications division: Television Products, Frequency Domain Instrumentation, and the products of the Grass Valley Group.

*What are Communications products used for?*

Our products are used to time, test, measure and correct the television signal before it is transmitted to your home. Spectrum analyzers are used to give a visual representation, a graph, of electrical signals over a broad spectrum of frequencies. Grass Valley products are used in the production and switching of television programs. Special effects like split screen and inserts are made possible by the use of Grass Valley switchers in the TV control room.

*Does a chemist use Communications products?*

Generally chemists do not use spectrum analyzers. The 7L5 and 7L12 have been used occasionally in ultrasonic studies of materials and solutions.

*Who are the users of spectrum analyzers?*

Major spectrum analyzer users are the manufacturers of radio communication equipment (mobile, CB, ham, marine, aircraft radios) broadcast equipment (AM, FM and TV), microwave link systems (earth and satellite), and radar systems (air and marine navigation and military). The analyzers are also used extensively as service instruments to support much of the above equipment in the field. Other important users are the government agencies, both U.S. and foreign, who are in charge of regulating and communicating and spectrum utilization. Spectrum analyzers are also

used as a means of teaching frequency domain principles in schools and universities.

*How does spectroscopy relate to spectrum analyzers?*

Spectroscopy is related to spectrum analyzers of the optical spectrum. Our spectrum analyzers are designed to be used at audio and radio frequencies which are much lower in frequency than light waves.

*Can you explain where your different products affect different phases of broadcasting a TV signal?*

TV Products are used throughout the TV broadcast plant. Our sync generators are frequently used as the basis of the timing of the signal from the first camera. Subsequently both the color and monochrome portions are monitored by waveform monitors and vectorscopes. The signal is then assembled with a Grass Valley switcher and sent on to the transmitter. The transmitter is monitored by a Tek demodulator and a sideband analyzer and spectrum analyzer combination, and then corrected by one of our correction amplifiers. We are there from the beginning until the signal is radiated.

*How does the structure of the Communications division relate to the rest of Tek?*

The Grass Valley Group, Television Products and Frequency Domain Instrument's personnel report to Tom Long and Tom reports to Bill Walker.

*What's the biggest bread-and-butter instrument in the Communications Division?*

No single product stands out. The waveform monitor, picture monitor and signal generator are certainly important to the Television Products. The 1600 Series production switchers are very key to Grass Valley success. There are a number of spectrum analyzers and cable testers that are very important to the Frequency Domain Instruments.

*What's the role of Tek Communications products in advanced technology such as communications satellites?*

Communications satellites have opened a new vista of long line communications. As such, communications satellite transmission of television signals is not unlike the more conventional terrestrial methods used by carriers like the phone company. Our products are used in the same way by the satellite carriers. Other Tek products, however, have played a large and important role in the development of the satellites as well as the systems used to launch and maintain them.

*How many people are in the Communications Division?*

More than 700.

*How many products do you make in the Communications Division?*

Approximately 65.