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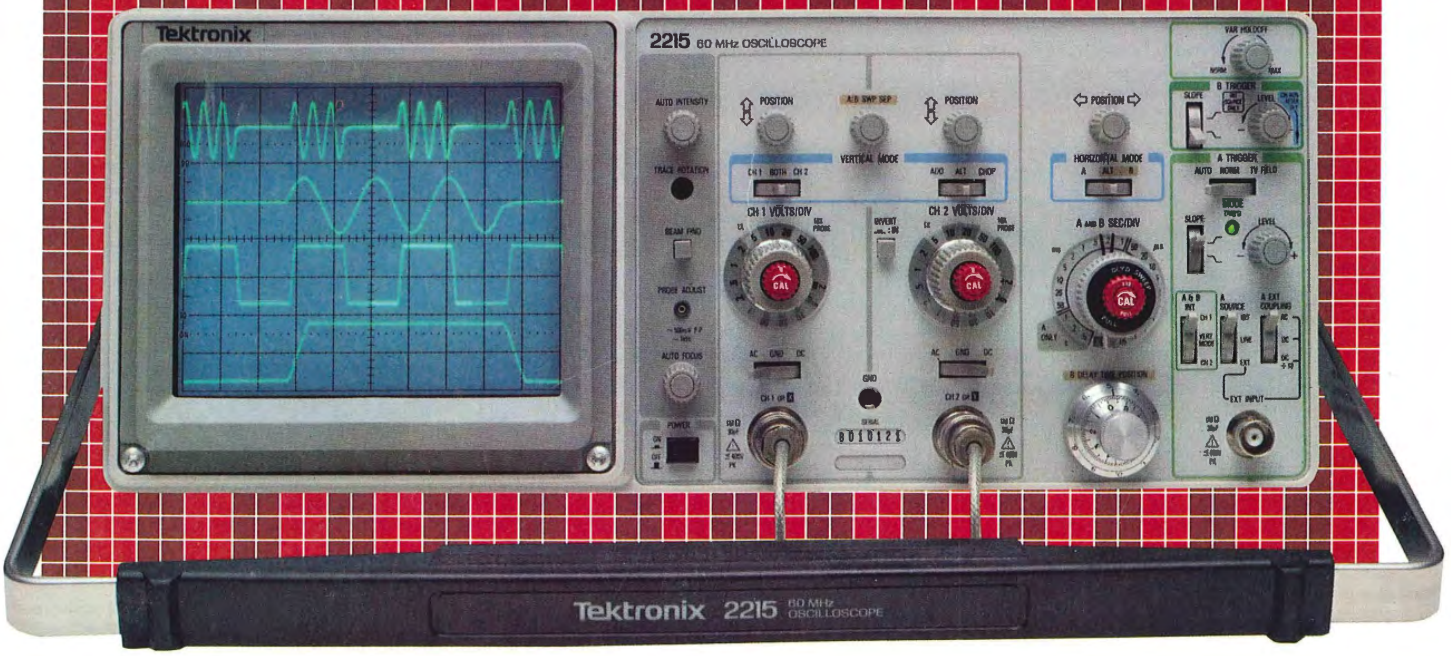
PERFORMANCE



Tektronix®
COMMITTED TO EXCELLENCE

Designing a New Price/Performance Standard for Portable Oscilloscopes

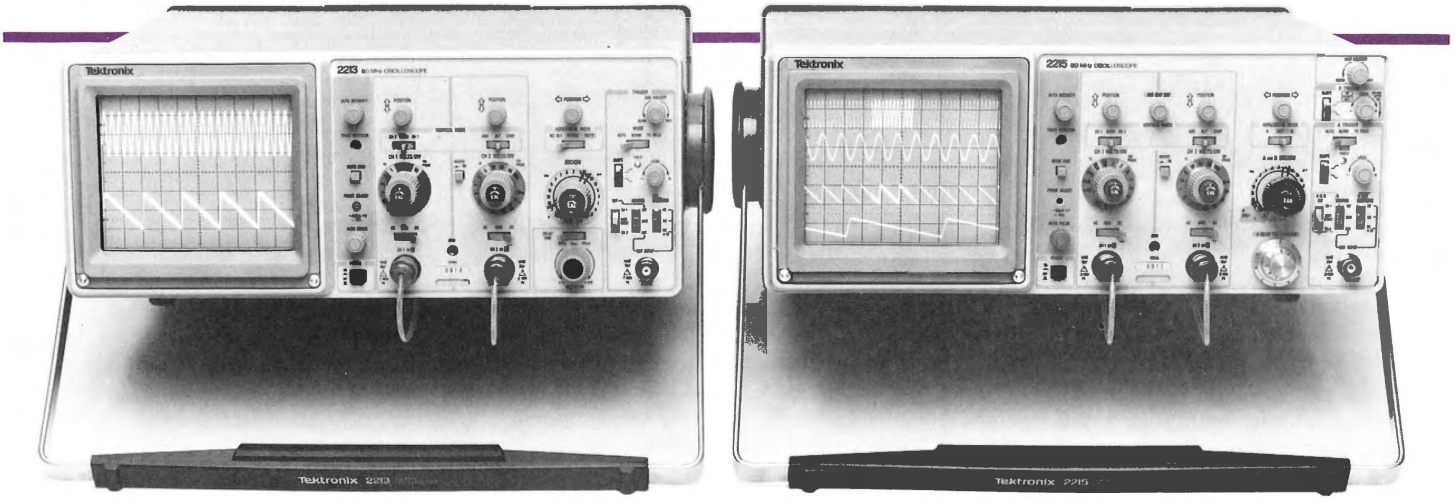


Figure 1. The Tektronix 2213 and 2215 Portable Oscilloscopes provide 60-MHz dual-trace, delayed-sweep operation and a full 8 by 10 cm display in a package weighing only 13.5 pounds (6.1 kg).

Expansion of electronics into nontraditional areas is generating an increasing demand for moderately-priced oscilloscopes to use in designing, manufacturing, installing, and servicing these new products.

Several manufacturers, both domestic and foreign based, recently have introduced instruments to this marketplace. The challenge for Tektronix was to develop a quality instrument which would be superior in performance, competitively priced, and supportable by our worldwide sales and service organization.

A thorough evaluation of the measurement needs indicated a series of instruments should be developed to best serve the diverse applications.

First of the new series to be introduced are the Tektronix 2213 and 2215 60-MHz Oscilloscopes. Both feature dual trace, delayed sweep operation, sweep speeds to 5 ns/division, and 8 by 10 centimeter full size displays. Instrument weight is less than 14 pounds—accomplished by using new construction techniques and a unique high-efficiency power supply design.

A new approach

The price/performance targets set for the 2200 Series were formidable. A new approach to design, manufacturing, and marketing was essential if we were to reach our goals. We took a long, hard look at our traditional manufacturing procedures, looking for areas where we could become more productive. One of the most promising areas for improvement was our basic approach to oscilloscope construction. The typical oscilloscope contains eight to ten printed circuit boards. This requires a lot of board handling, plus cables and connectors to interconnect the boards. We needed a new approach. By contrast, the 2213 has only three circuit boards: a main board, front panel board, and a small attenuator/sweep board. The main and front-panel boards are connected by soldered-in straps, which provide maximum reliability yet afford flexibility for servicing. For example, any component on the front-panel board can be replaced without removing the board.

Most of the cabling in the 2200 Series is in the form of circuit board runs, a technique that requires careful design to avoid crosstalk between adjacent conductors. The new approach reduces cabling and connectors by 90 percent and mechanical components by 65 percent, compared to other instruments of the same class. The reduction in parts and connectors contribute to improvements in reliability, serviceability, and light weight, as well as cost.

Another area that afforded opportunities for cost reduction was component selection. Commonality of parts simplifies stocking and reduces inventory costs. The front-panel lever switches in the 2213/2215 are an excellent example. Most are three-position slide switches (the two-position trigger slope switches are the same switch slightly modified). Limiting the lever switches to three positions has the additional benefit of simplifying the front panel, making the scopes easy to operate.

Another component cost-saving technique involves the X1–X10 gain-switching amplifier used in the vertical amplifier system. To get the component density needed to achieve the targeted bandwidth, the attenuator resistors are thick-film deposited on a substrate. A commercially-available, 5-transistor array in a 16-lead dual-in-line package is then attached to the substrate using reflow soldering techniques. This takes much less time than bonding the individual wires of a chip to the substrate.

As you would expect, automated parts insertion is employed extensively, with about 70 percent of the parts machine inserted.

Some operating niceties

While manufacturing efficiencies were a prime design consideration, equal attention was given to achieving the high performance and reliability goals set for the 2213 and 2215.

One of the goals was to include a delayed sweep capability in the 2213, the lowest-priced scope in the series. A unique approach that does not require a separate delaying sweep provides a low-cost delayed sweep capability suitable for many applications.

In the INTENSified horizontal mode, the signal that triggers the sweep also starts a delay generator. When the selected delay time has elapsed, a Z-axis signal is generated that intensifies the trace for the remainder of the sweep. Delay is selectable over a range of 0.5 μs to more than 4 ms.

Switching to the DLY'D horizontal mode displays the same sweep (without intensification) but the start of the sweep is delayed with respect to the trigger signal by the amount of delay selected.

For the more complex delaying sweep applications, the 2215 provides dual time base delaying sweep operation with alternate-sweep display and triggered B sweep.

The 2213 and 2215 also include operating conveniences not found on even the more expensive oscilloscopes. Automatic intensity and focus circuitry maintains a bright, sharp trace over a wide range of sweep speeds. Automatic intensity control eliminates the need for a separate intensity control for the delayed sweep, which was sometimes a confusion factor for novice scope users.

The auto-intensity circuit (figure 2) looks at the sweep duty cycle and generates a Z-axis control signal proportional to the duty cycle. Separate duty cycle circuits are used for the delaying and delayed sweeps and produce Z-axis correction appropriate for each time-base.

The auto-intensity signal is also applied to the focus circuitry to cause the focus voltages to track changes in intensity level.

Versatile triggering

Both the 2213 and 2215 feature peak-to-peak automatic triggering with level control over the full range of the trigger signal. A TV FIELD mode provides stable triggering at TV field rates. Triggering on horizontal sync and other repetitive pulses is enhanced by a variable holdoff control.

In the interest of operating simplicity, selection of some trigger modes, such as INTERNAL AC and DC are not provided for on the front panel. They are, however, operative within the instrument. When you are in the NORMAL triggering mode, the trigger is DC coupled. Conversely, in the AUTO mode, the trigger is, essentially, AC coupled. All triggering is independent of the vertical position control setting, and the trace can be positioned anywhere on-screen without having to readjust the LEVEL control.

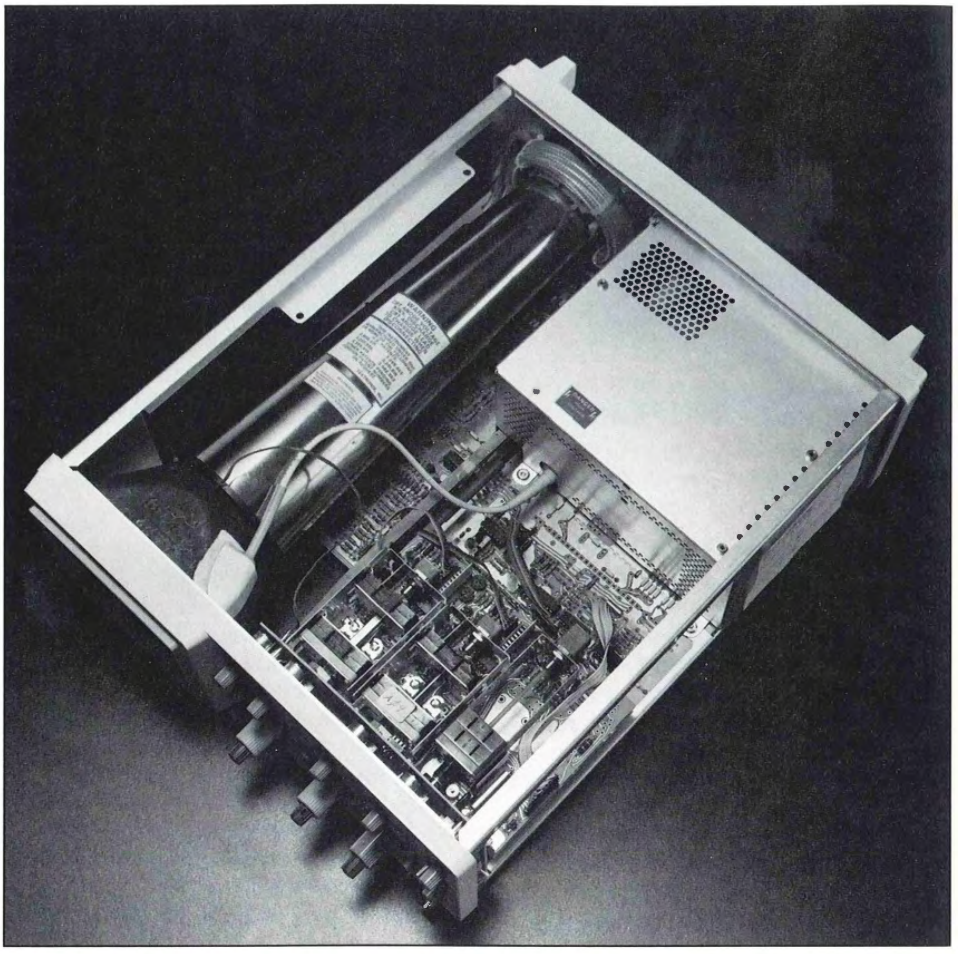


Figure 3. New design and construction techniques result in the use of only three circuit boards in the 2213. Most cabling is in the form of circuit board runs, which reduces the need for connectors and enhances reliability.

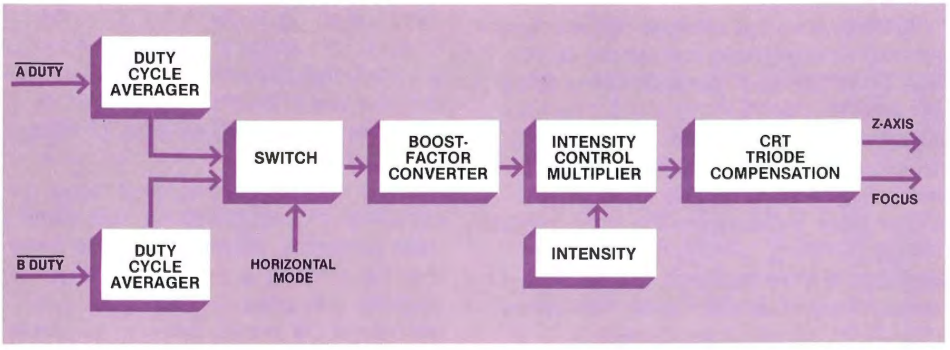


Figure 2. Simplified block diagram of automatic intensity and focus circuitry. Circuit accommodates changes in both A and B sweep rates.

Reducing the weight

In a portable instrument, a few pounds make a lot of difference. Weight reduction received a lot of attention in the 2213/2215 design. The mechanical package is a monocoque; that is, the instrument case contributes greatly to the structural strength of the package. This technique limits the need for heavy internal structural members.

A new high-efficiency power supply design allows operation over a wide range of ac line voltages without the need for the typically heavy ac power transformer. A single high frequency transformer supplies all of the secondary voltages needed, including the crt anode voltage drive via a

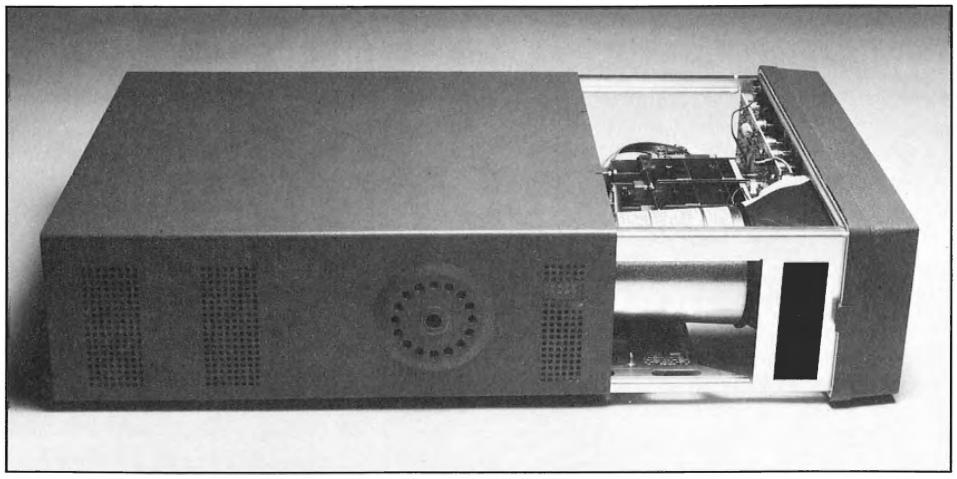


Figure 4. The one-piece cabinet provides structural strength, helping to eliminate the need for heavy structural members.

high voltage multiplier. All of these factors contribute to the light weight of the new portables.

Complete accessories

Accessories are an important element in oscilloscope design. The new P6120 10X attenuation probes designed for the 2200 Series provide full 60-MHz bandwidth operation at the probe tip. A new IC-grabber probe tip makes it easy to connect to integrated circuit pins with minimum danger of shorting between pins.

For the traveling user, an optional front cover and accessories pouch provide protection for the front-panel controls, and keeps manuals and probes conveniently stored.

The Tektronix C-5C scope camera and Model 200C SCOPE-MOBILE cart are also among the optional accessories available for the 2200 Series.

A new marketing concept

An important part of the 2200 Series planning involved discussions on how to most effectively market moderately-priced instrumentation. Research indicated that relatively few purchasers of this type of equipment need a demonstration before making the purchase decision. Accordingly, a factory order desk was established to provide price and delivery, or technical information, directly to the customer. Those customers requiring a demo, or service of their instruments, have our sales and service facilities available to them worldwide.

Summary

Designing a new price/performance standard for portable oscilloscopes has proven to be an interesting challenge. A new approach to building oscilloscopes has shortened production times, improved reliability, reduced instrument weight, and produced a quality instrument of superior performance at a competitive price.

Acknowledgements

In any major project, many people are involved with translating an original design concept into the finished project. Roland Crop headed up the electrical design team, with Roger Stenbock doing the sweep and z-axis. Roger also assisted Dick Schuessler and Ron Barrett on the vertical. Calvin Diller designed the trigger circuitry and vertical attenuators. Dennis Keldsen contributed the unique power supply design. Jamie Navia and Bob Twigg had responsibility for the mechanical design. Primary responsibility for product evaluation was handled by Matt Zimmermann, Stan Kohl, and Harvey Gjesdal. Valuable marketing viewpoints were provided by John Gragg, Jack Doub, and Marshall Pryor. My thanks to these and all who have worked so hard in making the 2200 Series project a success. ■

Jerry Shannon is an innovator of products that provide more measurement capability at lower cost. Prior to proposing development of the 2200 Series of portable oscilloscopes, Jerry was responsible for development of two other major product families at Tek—the TM 500 Series of modular instruments and the 5000 Series of low-cost plug-in oscilloscopes. When he isn't busy figuring out new ways to do more with less, Jerry enjoys flying and camping.