THE XYZs OF USING A SCOPE

Tektronix
COMMITTED TO EXCELLENCE

CONTENTS

INTRODUCTION

If you watch an electrical engineer tackling a tough design project, or a service engineer troubleshooting a stubborn problem, you'll see them grab a scope, fit probes or cables, and start turning knobs and setting switches without ever seeming to glance at the front panel. To these experienced users, the oscilloscope is their most important tool but their minds are focused on solving the problem, not on using the scope.

Making oscilloscope measurements is second nature to them. It can be for you too, but before you can duplicate the ease with which they use a scope, you will need to concentrate on learning about the scope itself: both how it works and how to make it work for you.

The purpose of this primer is to help you learn enough about oscilloscopes and oscilloscope measurements that you will be able to use these measurement tools quickly, easily, and accurately.

The text is divided into two parts:

The first four chapters of Part I describe the functional parts of scopes and the controls associated with those parts. Then a chapter on probes concludes the section.

Part II allows you to build on the knowledge and experience you gained from Part I. The signals you'll see on the screen of an oscilloscope are identified by waveshape and the terms for parts of waveforms are discussed. The next two chapters cover safety topics and instrument set-up procedures.

Then Chapter 9 describes measurement techniques. Exercises there let you practice some basic measurements, and several examples of advanced techniques that can help you make more accurate and convenient measurements are also included. The last chapter in this primer discusses oscilloscope performance and its effects on your measurements.

Having a scope in front of you while working through the chapters is the best way to both learn and practice applying your new knowledge. While the fundamentals will apply to almost any scope, the exercises and illustrations use two specific instruments: the Tektronix 2213 and 2215 Portable Oscilloscopes. The 2213 is a dual-channel, 60 MHz portable designed as an easy-to-use, lightweight, general-purpose oscilloscope. The 2215 is a dual time base oscilloscope with more features and capabilities; it's included so you will understand dual time base scopes and appreciate the additional measurement capabilities they offer.

If you have comments or questions about the material in this primer, please don't hesitate to write.

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PART I. SCOPES, CONTROLS, & PROBES

You can measure almost anything with the two-dimensional graph drawn by an oscilloscope. In most applications the scope shows you a graph of voltage (on the vertical axis) versus time (on the horizontal axis). This general-purpose display presents far more information than is available from other test and measurement instruments like frequency counters or multimeters. For example, with a scope you can find out how much of a signal is direct, how much is alternating, how much is noise (and whether or not the noise is changing with time), and what the frequency of the signal is as well. Using a scope lets you see everything at once rather than requiring you to make many separate tests.

Most electrical signals can be easily connected to the scope with either probes or cables. And then for measuring non-electrical phenomena, transducers are available. Transducers change one kind of energy into another. Speakers and microphones are two examples; the first changes electrical energy to sound waves and the second converts sound into electricity. Other typical transducers can transform temperature, mechanical stress, pressure, light, or heat into electrical signals. You can see that given the proper transducer, your test and measurement capabilities are almost endless with an oscilloscope.

Making measurements is easier if you understand the basics of how a scope works. You can think of the instrument in terms of the functional blocks illustrated in Figure 1: *vertical system, trigger system, horizontal system,* and *display system.*

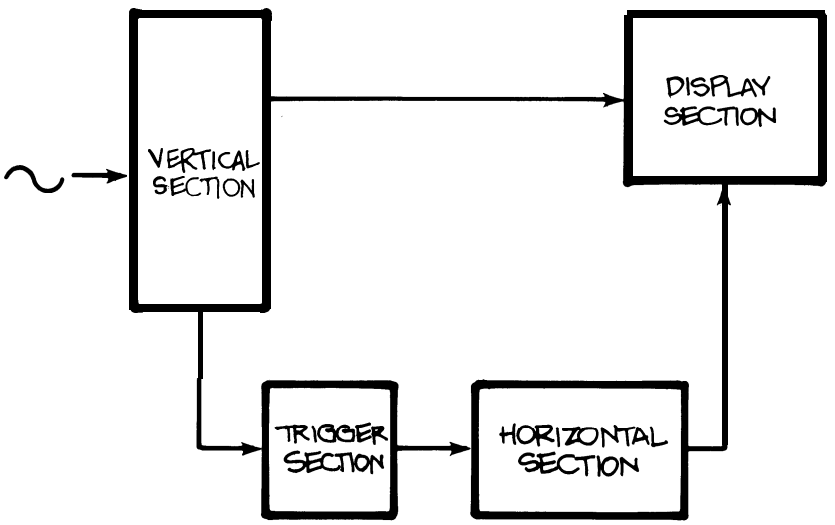

Figure 1.
THE BASIC OSCILLOSCOPE in its most general form has only four functional blocks: vertical, horizontal, trigger, and display systems (and sometimes, sections). The display system is also sometimes called the CRT (for cathode-ray tube) section.

Each is named for its function. The vertical system controls the vertical axis of the graph; anytime the electron beam that draws the graph moves up or down, it does so under control of the vertical system. The horizontal system controls the left to right movement of the beam. The trigger system determines when the oscilloscope draws; it *triggers* the beginning of the horizontal sweep across the screen. And the display system contains the cathode-ray tube, where the graph is drawn.

This part of the primer is divided into chapters for each of those functional blocks. The controls for each block are named first, and you can use a two-page, fold-out illustration of a Tektronix 2213 front panel at the back of the primer to locate them on your scope. Next the controls and their functions are described, and at the end of each chapter there are hands-on exercises using those controls.

The last chapter in this section describes probes. When you finish reading these five chapters, you'll be ready to make fast and accurate oscilloscope measurements.

But before you turn on your scope, remember that you should always be careful when you work with electrical equipment. Observe *all* safety precautions in your test and measurement operations. Always plug the power cord of the scope into a properly-wired receptacle before connecting your probes or turning on the scope; use the proper power cord for your scope, and use only the correct fuse. Don't remove the covers and panels of your scope.

Now fold out the front panel illustration at the back of the primer, so that it is visible as you read. Use the foldout and follow Exercise 1 to *initialize* (set in standard positions) the scope controls. These standard settings are necessary so that as you follow the directions on these pages, you'll see the same thing on your scope's CRT as is pictured or described here.

Exercise 1. INITIALIZING THE SCOPE

Use the foldout figure and callouts to locate the controls mentioned here.

DISPLAY SYSTEM CONTROLS: Set the AUTO INTENSITY control at midrange (about halfway from either stop). Turn the AUTO FOCUS knob completely clockwise.

2. VERTICAL SYSTEM CONTROLS: Turn the channel 7 POSITION control completely counterclockwise. Make sure the lefthand VERTICAL MODE switch is set to CH 7. Move both channel VOLTS/D/V switches to the least sensitive setting by rotating them completely counterclockwise. And make sure the center, red VAR controls are locked in their detents at the extreme clockwise position. Input coupling switches should be set to GND.

3. HORIZONTAL SYSTEM CONTROLS: Make sure the HORIZONTAL MODE switch is set to NO DLY for no delay. (If you're using a 2275, move the switch to the A sweep position.) Rotate the SEC/DIV switch to 0.5 millisecond (0.5 ms). Make sure the red VAR (variable) switch in the center of the knob is in its detent position by moving it completely clockwise. And push in on the VAR switch to make sure the scope is not in a magnified mode.

4. TRIGGER SYSTEM CONTROLS: Make sure the VAR HOLDOFF controlis set to its full counterclockwise position. Set the trigger MODE switch (2275: A TRIGGER MODE) on AUTO. And move the trigger SOURCE switch (A SOURCE on a 2275) to /NT (internal) and the INT selection switch (A&B INT on a 2275) to CH 7.

After following the steps in Exercise 7, you should plug your scope into a properly-grounded outlet and turn it on. With a Tektronix 2200 scope, there 's no need to change the scope's power supply settings to match the local power line; the scopes operate on main power from 90 to 250 Vat at 48 to 62 Hz.