Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

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SAMPLING OSCILLOSCOPES AND THE SLIDE-BACK BALANCED-BRIDGE TECHNIQUE

For those unacquainted with the term "sampling oscilloscope", a brief explanation may be in order.

A sampling oscilloscope measures recurrent waveforms point-by-point in progressive steps much as you would plot a graph of amplitude vs. time with a series of points on graph paper. Unlike a conventional scope display where one signal completes one picture, sampling uses up to 1000 individual amplitude-vs.-time points taken electronically. Each point on the plot is called a sample. After each repetition of the signal the circuit, which samples and measures the input waveform, is told to measure the next recurrence a small increment of time later on the waveform than the preceding sample. The process of advancing sampling time in regular fixed increments is sometimes referred to as "strobing". For each increment of strobing, the voltage present on the input at that particular instant is measured—or as we say "sampled"—and simultaneously plotted as vertical deflection on the crt. At this same instant the horizontal motion of the display moves an increment of time in synchronization with the strobing signal. In this manner, a reconstructed signal is reproduced on the crt.

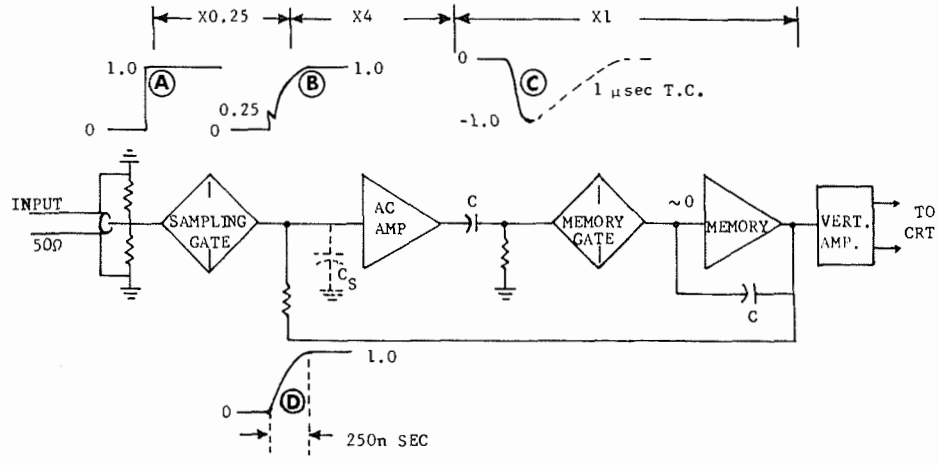

Figure 1

Basic block diagram of circuitry used in the Slide-Back Balanced-Bridge technique.

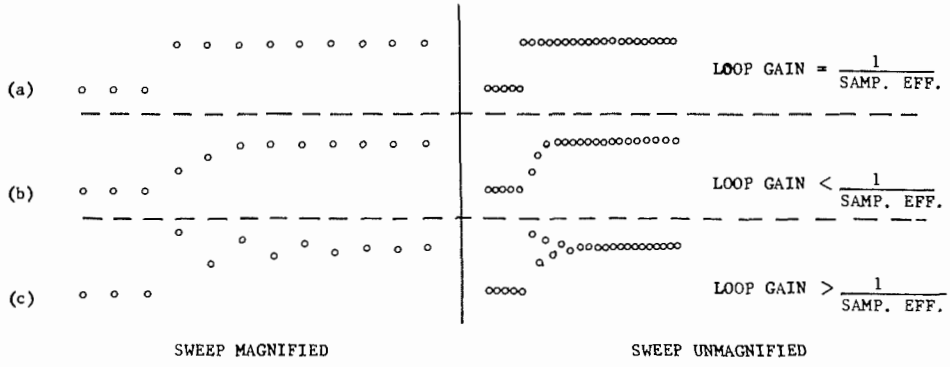

Figure 2

Dot transient response of input circuitry with different loop gains.

What we see is actually an amplitude-vs.-time, point-by-point graph. The reconstructed signal is much slower than the original signal. Thus, it can be handled by conventional, low-speed, high-gain amplifier circuits.

Several techniques are available for obtaining the point-to-point measurements of the applied recurrent waveform. Of these, the Slide-Back Balanced-Bridge technique offers certain distinct advantages. These are: better accuracy, improved linearity and dynamic range, and more effective suppression of noise—the balanced diode gate allows first order cancellation for noise on the interrogate spike.

Three Tektronix Oscilloscopes employ this technique in their vertical circuits. They are, the Type 661 Pulse Sampling Oscilloscope and (when combined with a Type 3S76 Dual-Trace Sampling Plug-In and a Type 3T77 Sampling Sweep Plug-In) the Type 561A and Type 567 Oscilloscopes.

Look at Figure 1. It s a basic block diagram of the circuitry used in the Slide-Back Balanced-Bridge technique. It works like this: The input signal is applied through the 50-ohm delay line to the Sampling Gate. (The Sampling Gate is a balanced diode bridge which acts as a gate for the signal, so you'll hear it referred to variously as the Sampling Gate and as the Sampling Bridge. In this article we'll refer to it, and other circuits like it, as gates. When a gate is "open", the signal can pass through; when a gate is "closed", the signal cannot pass through.)

The waveforms shown in Figure 1 illustrate the operation of the circuit for one sample. As you can see, the entire difference signal applied to the input does not pass through the Sampling Gate during the time it is open. This is due to diode resistance, circuit capacitances, gate-opening duration, etc. The ratio of the signal out of the gate to the signal into the gate is called the "sampling efficiency." The waveforms shown are based on a sampling efficiency of 25%, which is typical.

Waveform A indicates that the input signal has jumped from ground to +1 volt since the last sample was taken. Therefore, when the Sampling Gate opens, the AC Amplifier sees a difference signal of 1 volt. However, the AC Amplifier input is able to move only 0.25 volt before the gate closes again (waveform B). After the gate closes, the AC Amplifier input immediately begins to return toward zero. The AC Amplifier has a gain of minus four, so because its input was moved positively 0.25 volt, its output swung negatively one volt (waveform C). The Memory Gate is also open

at this time so this —1 volt swing is applied to the Memory. The Memory is an inverting Integrator with a gain of one. Its output (waveform D) is applied through the feedback circuit to the input of the AC Amplifier. So this brings the AC Amplifier input up to +1 volt and it is now ready for the next sample to be taken.

Note that there is some time lag between the closing of the Sampling Gate and the arrival of the feedback voltage from the Memory output, as shown by the slight decay in waveform B before Memory output takes over. This is normal.

After the AC Amplifier has amplified the 0.25-volt step of Waveform B, its output decays back toward zero. The low-frequency gain of the AC Amplifier is low enough that it ignores the relatively slow change applied by the Memory at its input.

It can be seen that the gain of the AC Amplifier, Memory Gate, Memory Loop must be equal to the reciprocal of the sampling efficiency for the AC Amplifier input to be brought exactly to the level of the last input sample. Figure 2—waveform A shows the "dot transient response" of the circuit to a step input signal when the loop gain is properly set. If the loop gain is less than the reciprocal of the Sampling Efficiency, the response of the circuit to a step input will look like Figure 2 — waveform B. At each sample, the AC Amplifier input will be brought up only part way to the input signal amplitude, and it will take several samples before the output attains the same level as the input signal. Figure 3—waveform C shows what the output will look like if the loop gain is too high (by a factor of less than two). In this case, the output will overshoot the input signal on the first sample, undershoot the input signal on the second sample, overshoot on the third, etc., until the amount of overshoot and undershoot becomes negligible and the output settles down to the same level as the input. If the loop gain is too high by a factor of more than two, the output will overshoot and undershoot the input by increasing rather than decreasing amounts on each sample. In this case, the loop will be driven into saturation first in one direction and then the other, and there will be no useful output.

To increase the sensitivity of the unit (VOLTS/DIV), we need to increase the output of the Memory relative to the input signal. This is relatively simple; we can just increase the gain of the AC Amplifier. But as mentioned above, this gets us into trouble back at the input. So we must attenuate the feedback signal by exactly the same amount as we increase the AC Amplifier gain. Thus, if we increase the AC Amplifier gain to 20, we'll get five volts out of the Memory for each volt of input signal. Then we'll use a 5X attenuator in the feedback network to keep the proper relationship across the Sampling Gate. It's the 5 volts that goes on into the Vertical Amplifier to drive the crt, of course.

Editor's Note: Authorship of this article can hardly be attributed to any one person. Rather, it is the result of the joint efforts of the people who comprise the Tektronix Field Training group. Paul Thompson of this group is responsible for the literary efforts and the basic discussion is adapted from a seminar originated by the Field Training people and conducted by their Bob Sadilek.

NEW FIELD MODIFICATION KITS

TYPE 502 VERTICAL-SIGNAL-OUT MOD KIT

This modification provides a rear panel, direct-coupled signal out from each vertical amplifier. Output level is approximately 2 volts for each centimeter of crt deflection. Output impedance is 200 Ω. Installation time is approximately 3 hours* for instruments below serial number 1667 and approximately 2 hours for instruments above serial number 1666.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-284. Price $18.50.

TYPE 507 SILICON RECTIFIER MOD KIT—For Type 507 instruments with serial numbers 101 through 211,
and;
TYPE 575 SILICON RECTIFIER MOD KIT—For Type 575 instruments with serial numbers 101 through 4919.

These modification kits replace the original selenium-rectifier stacks of their respective instruments with a silicon-rectifier assembly. Silicon rectifiers provide better reliability and longer life. Approximate installation times are 1 hour* for the Type 507 and approximately 45 minutes* for the Type 575.

Order through your local Tektronix Field Engineer or Field Office. Specify:

For the Type 507—Tektronix part number 040-259. Price $25.00.

Or,

For the Type 575—Tektronix part number 040-223. Price $29.75.

TYPE RM503 AND TYPE RM504 REAR VERTICAL AND HORIZONTAL INPUT MOD KITS

Two separate modification kits—one for the Type RM503 and one for the Type RM504—supply coax-cable assemblies for adding Vertical and Horizontal Inputs to the rear panels of these instruments. These rear-panel inputs parallel the front-panel inputs and introduce an added input capacitance. Because of this additional capacitance, standard passive probes, when used with these modified instruments, cannot be compensated.

Installation requires approximately 45 minutes* for the RM503 and approximately 30 minutes* for the RM504.

Order through your local Tektronix Field Engineer or Field Office. Specify:

For the Type RM503, all serial numbers; Tektronix part number 040-243. Price is $16.00.

Or,

For the Type RM504, all serial numbers; Tektronix part number 040-272. Price is $9.00.

TYPE 575 INCREASED COLLECTOR VOLTS MOD KIT

Installation of this modification converts the Type 575 (all serial numbers) to the Type 575MOD122C which provides the following features:

a. A maximum Collector Sweep voltage of 400 volts (instead of 200 volts), rated at 0.5 amperes maximum.
b. Three (3) more sensitivities (50, 100, and 200 volt per division) on the HORIZONTAL VOLTS/DIV. switch.
c. A ± 1.5 kv supply for checking peak inverse voltage of rectifiers. The high voltage is accessible at the Collector Test terminals and the supply current is limited by an internal impedance of 1.8 megohms.

Note: The output voltage (Collector Terminal voltage) of the 1.5 kv supply varies directly with the line voltage and inversely with the load current (i.e., at 117 v [235 v] line voltage and zero load current of 1 ma, the output voltage is zero).

This modification requires installation of a new front panel (furnished in the kit). When ordering the modification kit, please give the serial number of the instrument in which it is to be installed. We will stamp the new front panel with the serial number of your instrument before shipping the modification kit to you.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-276. Price is $200.00.

* Quoted installation times are for first time installations by a trained technician familiar with Tektronix instruments.

MISSING INSTRUMENTS

During the week end of June 30th, 1962, a Type 503 Oscilloscope, serial number 973, was apparently stolen from the Chemistry Department at Carnegie Institute of Technology. This instrument disappeared during the week end and a check of authorized personnel failed to reveal its presence. The Chemistry Department would like to hear from anyone with information regarding this instrument. Their address is Carnegie Institute of Technology, Pittsburgh 13, Ohio. Telephone number is area code 412, MAyflower 1-2600.

Pennon Electronics, 7500 South Garfield Avenue, Bell Gardens, California reports the loss of two oscilloscopes: a Type 503, serial number 291; and a Type 511AD, serial number 5106. These instruments which disappeared about the middle of June '62 are believed to have been stolen. Pennon Electronics asks that anyone with information on these instruments, please contact them at the above address.

Herbert Gunther, New York Representative for the Control Data Corporation called our Long Island Field Office to report a missing Type 317 Oscilloscope, Tektronix serial number not available. However, a tag on the front panel of the instrument says "CONTROL DATA SN 1883-7363".

Mr. Gunther believes this instrument may have been stolen. He asks that anyone with

information on this scope either contact him at 160 Rockaway Parkway, Valley Stream, New York City, New York—telephone VA 5-8852, or report their information to the Control Data Corporation, 8100 34th Avenue, Minneapolis, Minnesota.

USED INSTRUMENTS WANTED

1 Type 535 or Type 545	Dr. J. F. McNall Phoenix Engrg. & Computer 7464 Hubbard Avenue Middleton, Wisconsin
1 Type 515 or Type 310	Tom Hall Geotechnical Corp. P. O. Box 28277 Dallas 28, Texas
1 Type 570 Vacuum-Tube Curve Tracer	Stan Mahurin c/o Marine Radio Service Berth 73 San Pedro, Calif.

USED INSTRUMENTS FOR SALE

1 Type 127 Power Supply (for Type A to Z Plug-Ins), s/n 462	Robert Malta George A. Philbrick Researches, Inc. 172 Clarendon Street Boston, Massachusetts
1 Type 317, s/n 314, with Type 123 Preamplifier, s/n 1054	M. H. Schaffner Columbus Bank Note Co. 40 East Spring Street Columbus 15, Ohio Phone: 224-2117
1 Type 536, s/n 104	General Electric Co. D. Dowell/G. Bedore 13430 Black Canyon Hwy. Phoenix, Arizona
1 Type 513D	William Johnson 31 Waverly Road Wyncote, Penn. Phone: TUrner 4-9837
1 Type 310	Arthur Sommers 1875 S. Taylor Road Cleveland Heights, Ohio Phone: area code 216, FA 1-2277
1 Type 514D	Chuck Phillips Tektronix, Inc. 11681 San Vincente Blvd. West Los Angeles 49, Calif. Phone: GR 3-1105 BR 2-1563
1 Type 514AD	Engineering Associates 434 Patterson Road Dayton 19, Ohio Attn: C. C. Littell, Jr.
1 Type 517A with a Type 500A Scopemobile. Both in good condition. Asking $2250.00	A. Lincoln Mekelburg Decisions, Inc. 142 Second Street Fall River, Mass.

SERVICE HINTS

CONDUCTED OSCILLATOR RIPPLE IN TYPE 503/TYPE 504 OSCILLOSCOPES

Appearance of convertor-oscillator ripple at the input of a Type 503 or Type 504, when connected to a low-impedance signal source, has been traced to a conducted ground-loop via the power-cord third wire.

Type 503's with serial numbers above 1385 and Type 504's with serial numbers above 480 have a factory installed modification to eliminate this ground loop.

For instruments already in the field, Tektronix Field Engineer Frank Elardo worked out a simple field modification to correct this condition. Simply move the ground (green) wire of the power cord from its original installation point — the ceramic strip by C652 — to the small hole in the chassis behind V692 (5642). Use a 4-40 self tapping screw (Tektronix No. 213-035) and a No. 4 solder lug (Tektronix No. 210-201). In some early instruments this point was used for grounding C692 A/B and a new screw will not be required.

To determine whether conducted interference is causing ground-loop problems, disconnect the power-cord ground wire by using a three-to-two wire adapter. If the adapter eliminates the interference, then the ground-relocation modification described here should be performed.

REMOVING PAPER CAPACITOR COVERS

Removing the glued-on paper covers installed over the chassis-mounted electrolytic capacitors in some Tektronix instruments can be quite a chore. Tektronix Field Maintenance Engineer Udo Lindemeyer offers a novel approach to the solution of this problem. Using a hypodermic syringe, Udo injects about two cc's of acetone between the paper cover and the capacitor can. He makes the injection about the middle of the capacitor-cover assembly. In about ten minutes, the acetone softens the glue and the cover slips off easily. Some covers, however, may be glued at the top. In these instances it is necessary to invert the instrument and repeat the injection. Udo suggests that to get through the tough hide of the cover, try cutting the hypodermic needle down to about two centimeters and resharpening it.

TIPS FOR TUBE TAPPERS

Tektronix District Manager Harvey Worth reports that during environment tests, one of his customers found that tapping a tube with a pencil created up to 400 G's. They also found that the tapped tube had only 1/5 the life expectancy of a tube of the same type that was not tapped.

We suggest that a less destructive way of testing tubes for microphonics is to use a tool formed from a piece of ¼" plastic or phenolic rod. By means of a file or grinding wheel shape the rod as shown in Figure 1. When testing tubes for microphonics, gently saw the serrated edge of the tool back and forth over the tips of the tubes while observing the effects.

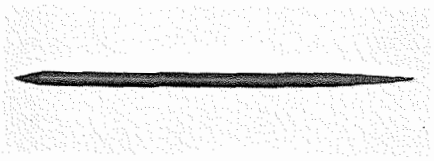

Figure 1

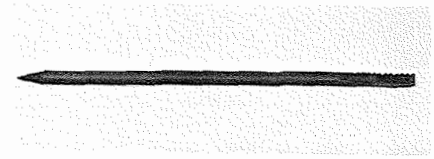

Figure 2

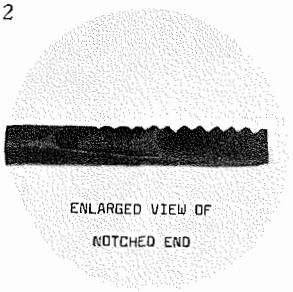

Figure 3

You'll also find that this tool makes a handy aid to hold wires and components in place while soldering. In addition, it makes a dandy non-conducting probe to poke around in an instrument when looking for loose leads or damaged components.

EFFECTIVE AIR-FILTER CLEANING AGENT

Tektronix Field Engineer Duncan Doane sent us the following information: A customer demonstrated the effectiveness of a new (to me) cleansing agent for cleansing the aluminum air filter on Tektronix instruments. He sprayed it on a filter choked with dirt, then merely held the filter under the hot water faucet. The filter came out sparkling! This customer buys the agent in gallon cans and transfers it to a window-cleaner type spray bottle, the name: Grease Off, Garden Products Corporation, Two Rivers, Wisconsin. The customer says it is available in Los Angeles at: Harvey's Butchers and Packers Supplies, 4506 S. Western Avenue, Phone: AXminister 4-8718. Price is $3.85 per gallon.

TRACE BOWING, POOR REGISTRATION AND COMPRESSION

Tektronix Field Engineer Tom Smith received a complaint of bowing, poor registration and compression in a new T502 crt. Investigation revealed about 2 mm of bowing when the trace was positioned to the perimeter of the crt.

Using a soft rag saturated with Anstac "M" *, Tom wiped the face of the crt and the graticule to remove the static charge and then dried them with a soft cloth. Following this action, Tom checked the crt display with a special geometry graticule and found the crt to be good in all respects.

* Anstac "M" is a product of the Chemical Development Corporation, Danverse, Massachusetts. We have found it effective in

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removing the static charges which sometimes build up on crt's and graticules. We recommend it also for removing dirt, grease and finger marks from these components.

6U8A TUBES NOT SATISFACTORY AS REPLACEMENT FOR 6BL8 TUBE

Chassis identification and instruction manuals for several Tektronix instruments (Type 503, 504 Oscilloscopes; Type 67 Time Base Plug-In) have indicated that the type 6U8A tube may be substituted for the type 6BL8/ECF80 originally supplied in the sweep generator circuit (V160 in Type 503 or Type 504, V161 or V145 in Type 67).

Recent tests indicate, however, that the percentage of presently available 6U8A's that will operate satisfactorily in these circuits is extremely low. Tektronix no longer recommends this substitution, and references to it on chassis and in manuals will be deleted.

REMINDING YOU —

... that your Tektronix Field Engineer is your best possible source of information pertaining to oscilloscopes, their purchase, use, maintenance and repair.

... that you should apply Filter Coat (Tek no. 006-580. Price $1.00/pint) to the filter element after cleaning.

... that you *should not* apply oil to the air filter element.

... that you should oil the fan motor each time you clean the air filter.

... that to obtain accurate and reliable measurements when using an attenuator probe, you must compensate the probe to the oscilloscope. (See oscilloscope instruction manual).

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CALIFORNIA	San Diego... 3045 Rosecrans Street, San Diego 10...TWX: 714-276-4265	ACademy 2-0384
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	• *Orange*... 1722 E. Rose Avenue, Orange...TWX: 714-633-2542	633-3450
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	• *West L.A.* ... 11681 San Vicente Blvd., West Los Angeles 49...TWX: 213-490-3958	GRanite 3-1105 From Los Angeles telephones call: BRadshaw 2-1563
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FLORIDA	• Orlando... 205 East Colonial Drive, Orlando...TWX: 305-275-1734 (also serves Puerto Rico)	GArden 5-3483
GEORGIA	• Atlanta... 467 Armour Circle, N.E., Atlanta 9...TWX: 404-527-1029	873-5708 Huntsville, Alabama Area: WX2000
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MICHIGAN	• Detroit... 27310 Southfield Road, Lathrup Village...TWX: 313-357-4618	ELgin 7-0040
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	Westchester County, Western Conn., Hudson River Valley...144 Morgan Street, Stamford, Connecticut TWX: 203-327-9538	DAvis 5-3817
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