Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

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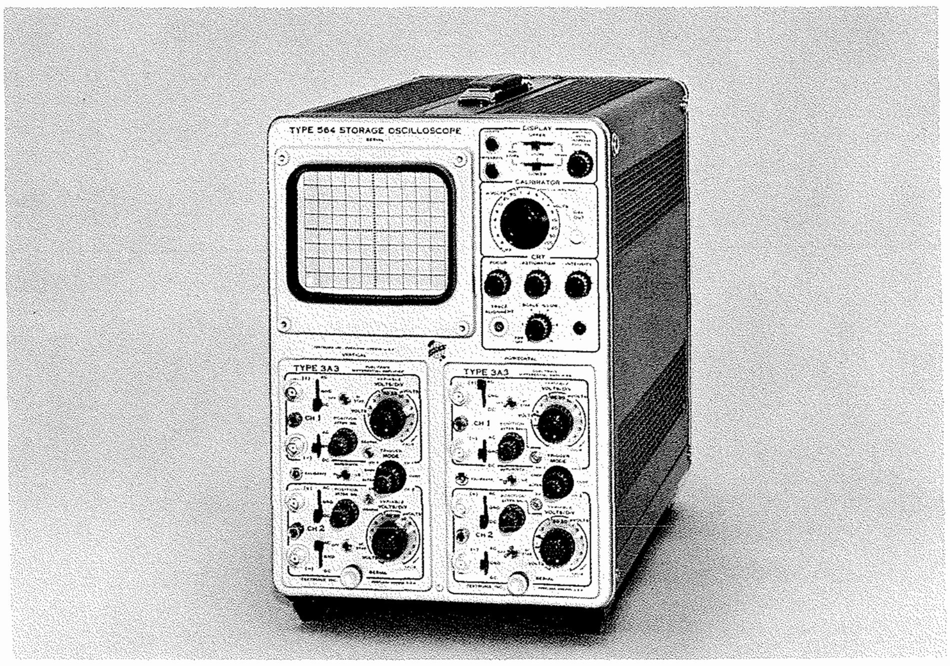
FREQUENCY COMPARISONS USING ROULETTE PATTERNS

Roulette patterns, because they retain their shape under conditions of slight oscillator frequency drift, offer a considerable advantage over the use of Lissajous figures in making frequency comparisons.



Type 564 Storage Oscilloscope with two Type 3A3 Dual-Trace Differential Plug-In Units, one in the vertical and one in the horizontal amplifier compartments.

High-ratio frequency comparisons by use of Lissajous figures are often difficult to observe. Any slight oscillator frequency drift causes the Lissajous figure to change shape. The display appears to rotate in a plane perpendicular to the face of the cathode-ray tube. Since the front and back portions of the figure are not separated, interpretation of the pattern becomes increasingly difficult as the frequency ratio increases.

Roulettes are much easier to interpret than are Lissajous figures because slight oscillator frequency drifts cause a pattern rotation in the plane of the crt screen without a change in pattern shape. Roulettes are readily displayed with oscilloscopes having differential inputs on both the horizontal and vertical amplifiers.

Several Tektronix Oscilloscopes and Oscilloscope/Plug-In combinations lend themselves to this application. The reference chart which appears elsewhere in this article lists these oscilloscopes and oscilloscope/plug-in combinations. It also gives their sensitivity and bandpass capabilities.

The waveforms illustrating this article were photographed using a Type 564 Storage Oscilloscope with two Type 3A3 Dual-Trace, Differential Plug-In Units—one in the vertical and one in the horizontal plug-in compartments. The storage feature of the Type 564 Oscilloscope makes this instrument the ideal choice for this application. As mentioned before, a slight drift in oscillator frequency will cause a rotation of the displayed roulette pattern. The rotation will be in the plane of the crt. The operator, by employing the Storage mode of Display, can "stop" this rotation for ease in counting the points of the roulette pattern. This count, which will be explained later, is a necessary part of the application procedure.

As for the other oscilloscope and oscilloscope/plug-in combinations listed on the reference chart, the best way to "stop" the roulette-pattern rotation on these instruments is to use an oscilloscope camera and photograph the display.

"Stopping" the roulette pattern's rotation is not, however, a necessary part of the application. One can usually control the drift in oscillator frequency to a point where the roulette pattern remains stable enough for an accurate point count.

How to set up roulette patterns

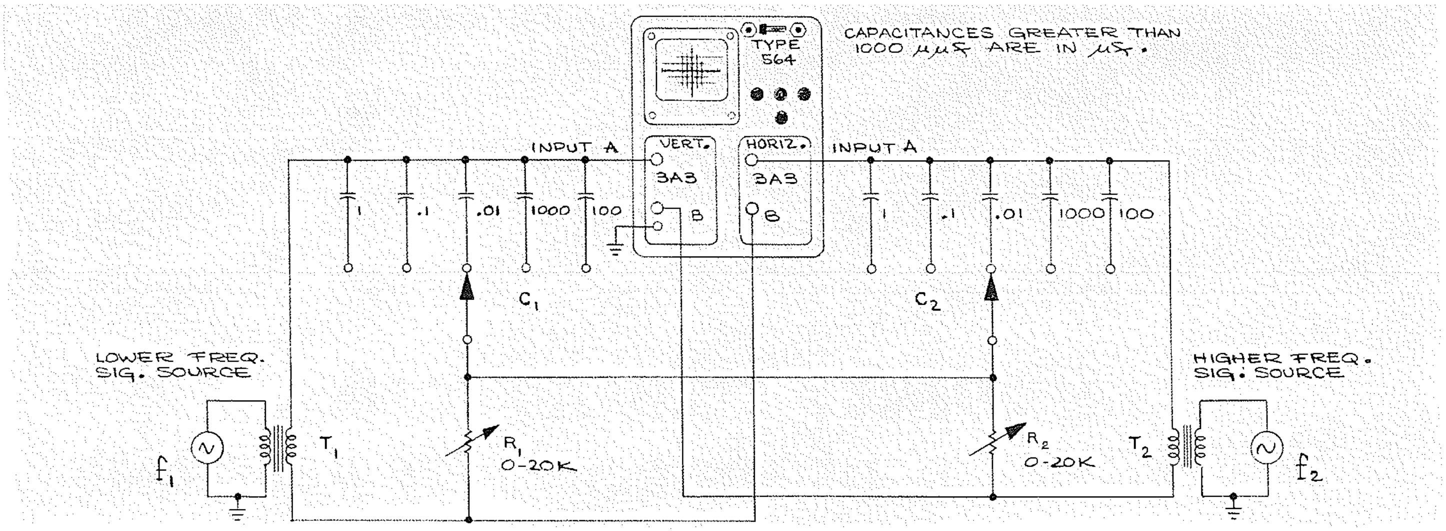


Fig. 1. Circuitry For Displaying Roulette Patterns.

Fig. 1 shows the circuit used in displaying roulette patterns. Transformers T_1 and T_2 provide isolation so that both of the signal sources can be operated with a common ground connection. In many applications either one or both of the transformers can be omitted, provided hum problems are not encountered. If isolation transformers are not used, the signal sources should be operated without a common ground connection. For convenience, we will discuss the display of roulette patterns at audio frequencies. You can use any signal source within the frequency range of your oscilloscope, however, stable radio-frequency displays are usually limited to crystal-controlled frequency sources. The circuit adjustment procedure is as follows:

1. Turn on the equipment and allow a few minutes for warm-up.
2. Using appropriate settings, adjust the plug-in units' V/CM controls to provide equal sensitivities for both the VERTICAL and HORIZONTAL channels. Should later readjustment be necessary, keep the sensitivities equal.
3. Set the output amplitude of both frequency sources to zero.
4. Advance the amplitude control on the higher-frequency generator until an elliptical trace appears on the crt screen. Adjust R_2 and C_2 until the ellipse becomes a circular shape. Return the output amplitude of the higher-frequency generator to zero.
5. Advance the amplitude control on the lower-frequency generator until an elliptical trace appears on the crt screen. Adjust R_1 and C_1 until the ellipse becomes a circular shape.
6. Readvance the amplitude control on the higher-frequency oscillator to obtain the desired roulette. Adjust the frequency of either oscillator for a stationary pattern.

Typical patterns for a 15:2 frequency ratio are shown in Fig. 2. The patterns differ only in that the output amplitude of the higher-frequency generator is greater in Fig. 2b.

To determine the frequency ratio, count the total number of points on the circumference of the pattern (17 points in Fig. 2a). Call this number N_1. Next, determine the number of points passed over in tracing from one point to another along the figure. For instance, in tracing from point 1 to point 3 in Fig. 2a, only one point (point 2) is crossed. Add one to this number and call it N_2. The ratio of the two frequencies is given by:

$$\frac{f_2}{f_1} = \frac{N_1 - N_2}{N_2} = \frac{(17 - 2)}{2} = 15:2 \text{ for Fig. 2a.}$$

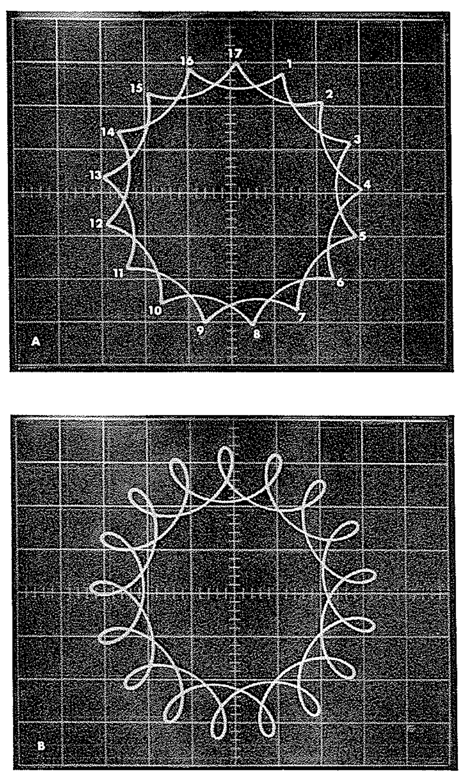


Fig. 2. Typical roulettes for a 15:2 frequency ratio.

When no points are crossed in moving from one point to another along the trace, the ratio of frequencies is a whole number (an integer), and the ratio is simply one less than the total number of points on the pattern circumference. Fig. 3 shows a 21 point pattern indicating a 20:1 frequency ratio.

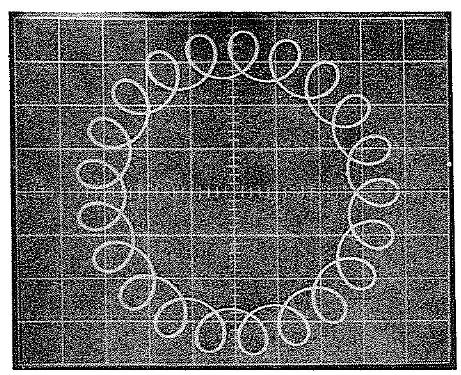


Fig. 3. Roulette pattern for a frequency ratio of 20:1.

Theory

The operation of the circuit of Fig. 1 is best understood by the application of superposition theory. We first determine the crt trace deflections produced by the signal sources operating separately, then we add the resultant deflections vectorially. Fig. 4a shows the circuit of Fig. 1 redrawn and slightly revised. Here, we have replaced the cathode-ray oscilloscope with the crt deflection plates corresponding to the amplifier input connectors. In addition, we have replaced the higher-frequency oscillator by its internal impedance Z_2. The impedances Xc_2, R_2 and Z_2 can usually be neglected when compared to the oscilloscope input resistances (1 megohm). Neglecting these impedances, we get the simplified equivalent circuit of Fig. 4b. If the magnitude of Xc_1 equals R_1 at the frequency f_1, a circular trace appears on the crt screen. If generator f_2 is restored and generator f_1 is replaced by its internal impedance, the analysis outlined above may be repeated. With both f_1 and f_2 in operation, the actual deflection of the electron beam is the vector sum of the positions due to each of the frequency sources acting separately.

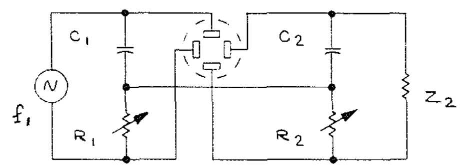


Fig. 4a. Equivalent circuit of Fig. 1, with the higher-frequency generator replaced by its internal impedance.

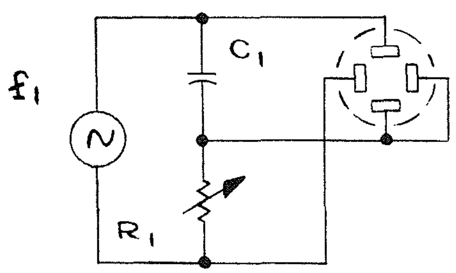


Fig. 4b. Further simplification of Fig. 4a.

The graphical addition of the deflections due to each of the frequency sources acting separately is not difficult. Assume, for example, a 3:2 frequency ratio. Assume, also, that the frequency sources, when applied individually, produce circles C and D as shown in Fig. 5. The numbers on the perimeter of the circles represent the hypothetical position of the beam on each circle at corresponding instants of time. By taking the vector sum of the displacements from the center, as indicated in Fig. 5, the actual position of the spot on the screen can be determined. The locus of many such determinations is the desired roulette. Fig. 6 shows the same pattern displayed on the crt screen.

Roulettes can be analyzed by geometrical analogy. The pattern of Fig. 2a is generated by a point on the surface of a cylinder rolling on the inside of another cylinder. Curves of this type are called hypocycloids. If you interchange one pair of RC elements in the circuit of Fig. 1, the patterns will be turned inside out. This is equivalent to having the generating circle roll on the outside of another cylinder. In this case, the point on the surface of the rolling cylinder generates a special form of inverted roulette called an epicycloid.

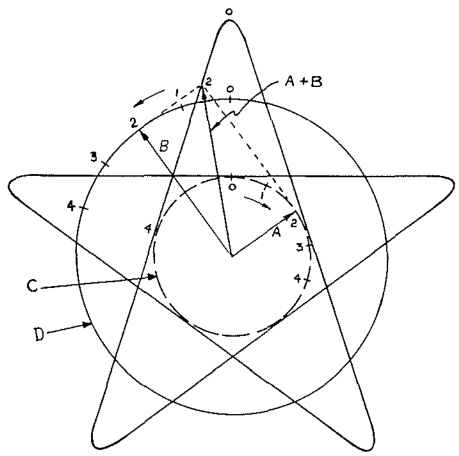


Fig. 5. Graphical construction of a roulette pattern for a frequency ratio of 3:2.

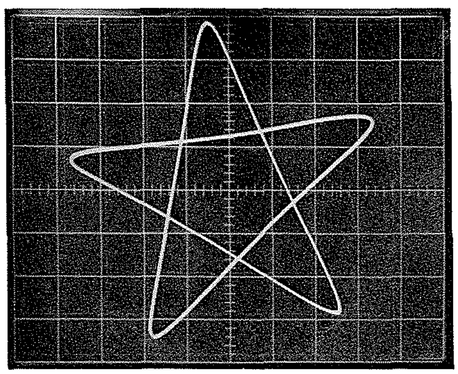


Fig. 6. Roulette pattern for a 3:2 frequency ratio.

Drift Measurements

When the ratio of the oscillator frequencies is not exactly integral (or fractional), the pattern rotates on the crt screen. The number of complete pattern rotations per second is proportional to the number of cycles per second that the lower-frequency oscillator differs from the frequency that gives an exact integral ratio. If the oscillator frequencies are initially adjusted for a stationary pattern, any subsequent rotation is a direct measure of the total frequency drift between the two oscillators. This method of measuring drift is best suited to oscillators that have very small drift rates.

You will usually find that it is easier to count the number of points passing a particular graticule line per second rather than to count the whole number of pattern rotations. The drift expressed in cycles per second of the lower-frequency oscillator is given by:

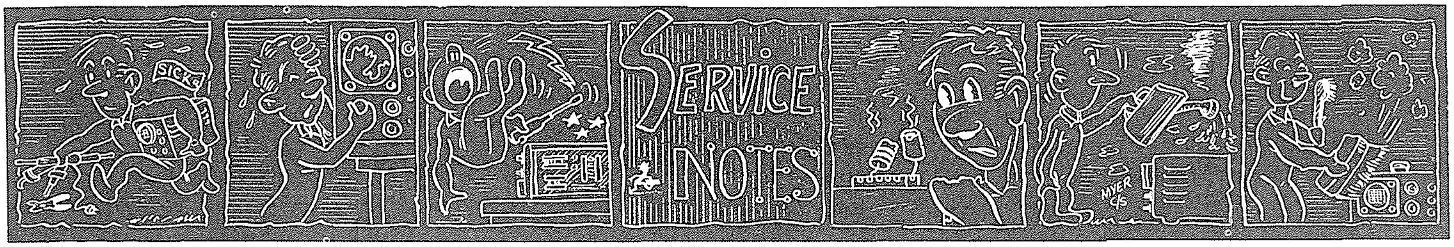
$$\text{Drift} = \frac{(N_2)\ (\text{No. of points per second passing a grat. line})}{(N_1)}$$

where N_2 and N_1 are as defined previously.

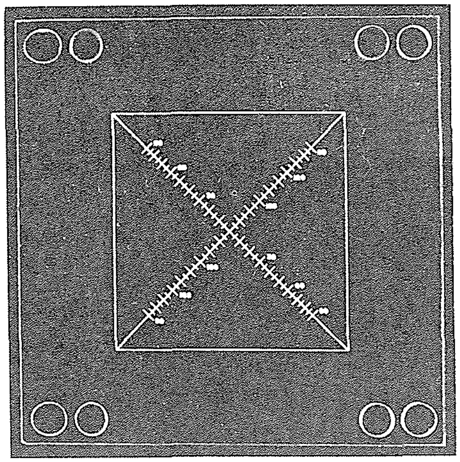
The equivalent drift of the higher-frequency oscillator can be determined by multiplying the equivalent drift of the lower-frequency oscillator by the frequency ratio.

OSCILLOSCOPE TYPE	AMPLIFIER UNIT (plug-in type)	SENSITIVITY	PASSBAND (at 3db down)
502A or RM502A		100 µv/cm	dc to 50 kc
		200 µv/cm	dc to 100 kc
		1 mv/cm	dc to 200 kc
		50 mv/cm	dc to 400 kc
		2 v/cm	dc to 1 mc
503 or RM503		1 mv/cm	dc to 450 kc
536	2-Type CA	0.05 v/cm	dc to 10 mc
	2-Type D	1 mv/cm	dc to 300 kc
		50 mv/cm	dc to 2 mc
	2-Type E	0.05 mv/cm	0.06 cps to 20 kc
		0.1 mv/cm	0.06 cps to 40 kc
		0.2 mv/cm	0.06 cps to 50 kc
		0.5 mv/cm	0.06 cps to 60 kc
	2-Type G	0.05 v/cm	dc to 10 mc
	2-Type Z	50 mv/cm	dc to 9 mc
561A RM561A 564 RM564	2-Type 2A61	0.01 mv/div	0.06 cps to 100 kc
		0.1 mv/div	0.06 cps to 300 kc
	2-Type 2A63	1 mv/div	dc to 300 kc
	2-Type 3A3	100 µv/div	dc to 500 kc

Reference chart of Tektronix Oscilloscopes and Oscilloscope/Plug-In Unit Combinations having vertical and horizontal amplifiers with differential inputs.



LISSAJOUS PHASE-MEASUREMENT GRATICULE



The 8 x 8 cm phase-measurement graticule (Tektronix part number 331-057), originally designed for use with the Type 536 X-Y Oscilloscope, will work equally well with the Type 661 Sampling Oscilloscope and the Type 504 X-Y Oscilloscope. This special graticule (see Figure 1) is useful in measuring phase differences from lissajous displays.

REPLACING CABLES CONTAINING COLOR-CODED WIRES

Here's a time saver when replacing cables containing color-coded wires. When you remove the old cable, cut the wires about ½ inch from their solder points. If you do this you then have the color codes to go by when installing the new cable.

Jim Hartley, Field Maintenance Engineer with our Orange Field Repair Center, offered this suggestion with the comment that he finds it saves a lot of time over other methods.

FILM-PACK BACK FOR TEKTRONIX CAMERAS

A new Film-Pack camera back adapts all Tektronix Trace-Recording Cameras to use Polaroid's® two recently introduced plastic film packs—3000 speed/Type 107 and Pola Color®/Type 108.

These new plastic film packs offer several advantages over the older roll-type film.

1. They load easier and faster—just slide the plastic pack in place, pull a tab and you're ready to shoot the first picture.
2. They allow you to shoot pictures faster—the exposed film develops the picture outside the camera (black and white in ten seconds, color in 50 seconds). You are free to keep shooting—no waiting for the picture to develop. This can be a big help when a rapid sequence of pictures is needed.
3. Unlike the roll-type film, the new film pack produces flat prints with no bothersome curl to straighten out.

The new Film-Pack camera back interchanges with either the Roll-Film back or the Graflok back. No tools required. Order through your local Tektronix Field Office, Field Engineer or Representative. Specify Tektronix part number 122-671.

TYPE 3B1 TIME BASE UNIT—DELAYED SWEEP TRIGGERS BEFORE END OF DELAY

A large external trigger can sometimes override the lockout circuit and trigger a delayed sweep before expiration of the delay period when the controls of the Type 3B1 are set as follows: MODE to DLY'D, TRIG.; SOURCE (DELAYED SWEEP TRIGGERING) to EXT.

It usually takes a trigger signal of about 20 volts in the non-attenuated external trigger (±15 volts) range to cause this to happen.

An easy cure is to replace R202, a 680 Ω, ¼ w, 5% resistor with a 1 k, ¼ w, 5% resistor (Tektronix part number 315-102).

This information applies to Type 3B1's with serial numbers *below* 2777. Instruments above this number have the change implemented at the factory.

TYPE 525 TELEVISION WAVEFORM MONITOR AND TYPE 526 COLOR-TELEVISION VECTORSCOPE — 6DB6 VACUUM TUBES REPLACED BY 6HZ6 TUBES

Manufacturers of the 6DB6 Vacuum tube have discontinued its manufacture. The 6DB6 was used in the V310 location of the Type 525 and the V14, V24, V304, V314, and V354 locations of the Type 526. As a replacement we recommend the 6HZ6 tube. It has characteristics similar to the discontinued 6DB6 and may be used as a direct replacement in the locations mentioned above. No modification required.

TYPE 517A, TYPE 517, AND TYPE 555 OSCILLOSCOPES — ADJUSTING THE 6.3 VOLT REGULATED HEATER SUPPLY

Setting the Reg. Htr. Adj. control of these instruments requires the use of an ac voltmeter having an iron-vane or dynamometer-type movement and a range of zero to 10 volts rms. A meter employing a d'Arsonval-Type movement—a vtvm, for instance—will not give the required accuracy for this measurement. In measuring ac voltage the accuracy of a meter with a d'Arsonval-type movement is predicated on the ac voltage waveform being a pure sine wave.

The Type 517, Type 517A and Type 555 Oscilloscopes incorporate a saturable reactor in their regulated-heater circuits. The ac-voltage waveform in passing through this saturable reactor undergoes alteration to the extent that it is no longer a pure sine wave. Therefore, the actual value of the regulated heater supply in these instruments, if set to 6.3 volts with a voltmeter of the d'Arsonval-movement type, will be 7.3 volts—1 volt too high.

This excess of 1 volt of filament power will considerably shorten the life expectancy of tubes and seriously degrade the instruments' reliability.

TEKTRONIX CIRCUIT COMPUTER

The Tektronix Circuit Computer, a circular slide-rule device, computes directly problems involving resistance, inductance, capacitance, frequency and time. Its primary design objective is to provide a means of quick computation of time values from other circuit dimensions.

With slide-rule ease the engineer or technician can compute:

1. Capacitive Reactance
2. Inductive Reactance
3. Resonance
4. RC Time Constant and Resistance
5. L/R Time Constant and Reactance

6. Filter Cut-off Frequency

7. Risetime

The computer consists of three circular decks—containing seven accurate scales—and a hairline indicator. Each scale is clearly identified and the scale graduations —jet black on pure white—stand out in vivid contrast and help to provide easily-read answers.

The computer is constructed of laminated plastic—light weight but durable. Mylar laminations over the three decks protect the printed information frôm wear and assure its remaining clearly legible under even the most strenuous use.

Overall diameter of the computer is 7¾".

An 8½" by 11" booklet which accompanies the computer presents, in clearly-written and easily-understood steps, instructions for its use. The booklet also contains a short discussion of Risetime and Time Constant.

These computers are available through your Tektronix Field Engineer or local Field Office. The Tektronix Part Number for the computer is 003-023.

IDENTIFYING POLAROID PRINTS

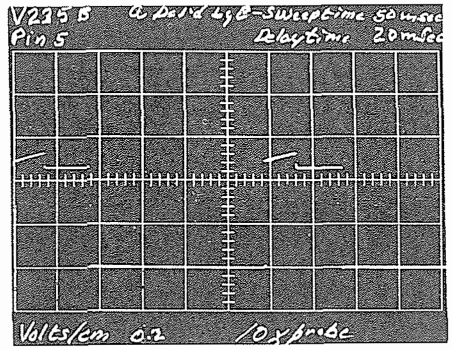


Figure 1. Information noted on Polaroid print with a hot soldering iron.

Ken Steele of the Hartman Electric Company in Mansfield, Ohio volunteers the information that a hot, 25 watt soldering iron employing a ⅛" round tip supplies a convenient way of writing information on Polaroid* prints. Using the iron like a pencil, you just write on the black portion of the print. The information stands out in brilliant white (see Figure 1).

Following Mr. Steele's lead we experimented a bit further and learned that the pencil-type soldering irons in the 15 watt class work equally well and are a bit easier to write with.

Service Scope issues #17, December, 1962; and #13, June, 1962, contain additional suggestions for identifying information on Polaroid prints.

* Polaroid is a registered trademark of the Polaroid Corporation.

NUVISTOR PULLER

Here is a simple-to-make tool that facilitates the removal of Nuvistors from their sockets. Take a large alligator-clip cover and cut it off about an inch from the small end. Discard the large end and "presto" you have a Nuvistor puller.

Pliers, of course, should never be used to remove Nuvistors from sockets.

NEW FIELD MODIFICATION KITS

TYPE 541 AND TYPE 545 OSCILLOSCOPES — VERTICAL AMPLIFIER TUBES

This modification replaces the checked 6CB6 tubes in the distributed amplifier stage with Type 8136 tubes. The 8136 tubes deliver greater reliability, give higher gain and experience only negligible cathode interface over a long period of time.

The modification also changes: R1142, screen resistor in the vertical amplifier circuit, to 820 Ω (2 w, 10%) to provide a more suitable bias for the 8136 tubes; and R1021 and R1024, plate resistors in the input amplifier, to 500 Ω (½ w, 1%) to compensate for the increased gain delivered by the 8136 tubes.

This modification applies to Type 541's, serial numbers 101 through 6474; and Type 545's, serial numbers 101 through 9291.

Order through your local Tektronix Field Representative or Field Office. Specify Tektronix part number 040-360.

TYPE 564 STORAGE OSCILLOSCOPES —REMOTE ERASE FEATURE

This modification provides an external Remote-Erase feature for the Type 564 Storage Oscilloscope.

It installs a circuit assembly which contains two monostable multivibrators — one for the Upper display area and one for the Lower display area. When activated from either the front panel Erase controls or the Remote-Source Erase controls these multis erase their respective display areas. The Remote-Source Erase control can be any switch contact that can short a wire from the Type 564 to ground or any equipment that can provide a negative-going 5-to-10 volt pulse for the multi of each display area.

The external connections are brought out to a four-contact connector on the rear of the Type 564 and a mating connector is included to permit attachment of the Remote-Erase control.

This modification applies to Type 564 Storage Oscilloscopes, all serial numbers. Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-352.

TYPE 502A DUAL-BEAM OSCILLOSCOPE—VERTICAL SIGNAL OUT

This modification provides a rear-panel, direct-coupled Vertical Signal Out from each of the Type 502A's two vertical amplifiers. Output level is approximately 2 volts per centimeter of crt deflection, with an output impedance of approximately 200 ohms.

The modification replaces the 6AU6 Trigger-Pickoff tube (V493) and seven-pin socket with a 6DJ8 tube and a nine-pin socket. This new tube combines a Trigger-Pickoff cathode follower (CF) and a Vertical Output CF in a single tube.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-335.

TYPE 567 AND TYPE RM567 DIGITAL-READOUT OSCILLOSCOPES — POWER SUPPLY IMPROVEMENTS

This modification incorporates several refinements in the power supplies of the Type 567 and Type RM567 Digital-Readout Oscilloscopes.

1. It replaces the 1 w, 10 Ω fuse resistors R600, R660 and R661 with 2 w, 10 Ω fuse resistors and parallels the 1 w, 10 Ω fuse resistor R680 with an additional 1 w, 10 Ω fuse resistor (R681). This increase in wattage rating assures a longer resistor life.

2. It adds a potentiometer and a suitable divider network to the —12.2 volt supply. This provides a means for accurately adjusting the voltage of this supply.

3. It adds a 100 μf capacitor (C633) from the base of the transistor Q634 to ground to reduce ripple in the —12.2 supply.

4. It adds potentiometers and suitable divider networks to the +125-volt and +300-volt supplies to provide a means for more accurately adjusting these supplies.

This modification applies to Type 567's with serial numbers 101 through 407 and Type RM567's with serial numbers 101 through 149 with the following exceptions:

Type 567, serial numbers:

183	333	354	375	394
206	334	355	384	395
286	341	367	391	397
291	342	368	392	401
320	346	369	393	404

Type RM567, serial numbers:

129	136	141
131	137	144
134	138	147
135	140	148

These instruments had this modification installed at the factory.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-319.

TYPE 67 TIME-BASE UNIT—SWEEP LOCKOUT FOR SINGLE SWEEP OPERATION

This modification adds a sweep lockout feature to the Type 67 Time-Base Unit to allow the electron beam to sweep once after receiving a triggering pulse. The lockout circuitry then prevents any subsequent trigger pulse from activating the sweep until the operator resets or "arms" the sweep circuit by depressing the lever arm of the MODE switch. This feature allows the viewing of "one shot" (non-repetitive) phenomena. A front-panel READY light indicates when the sweep is armed and ready to fire on the next trigger pulse.

The modification adds a sweep-lockout transistor circuit and installs a new front panel and a MODE switch. It is applicable to Type 67 Time-Base Units, all serial numbers.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-318.

TYPE 3A1 DUAL-TRACE UNIT — INCREASED VERTICAL DEFLECTION

Installation of this modification increases the linear vertical deflection of the early Type 3A1's. It adds a linear hybrid amplifier to obtain this increase.

The following chart lists the oscilloscopes compatible with the Type 3A1 and notes the vertical scan before and after modification.

Instrument Type	Vertical Scan Area	
	Before	After
561* RM561* 567* RM567*	±2 cm (4 cm overall)	±3 cm (6 cm overall)
561A RM561A 564 RM564 565 RM565	±3 cm (6 cm overall)	±4 cm (8 cm overall)

* When used in these instruments it may be necessary, in some cases, to increase the internal 0.01 v/div and 0.02 v/div gain settings of the Type 3A1 to provide adequate front panel "Calib" control range for instruments with low-sensitivity crt's.

The modification also offers improved linearity by increasing the plate voltage of V364 and V374 (8233 tubes in the output amplifier) by 10 volts, and better stabilization of the correct voltage level at the cathode of the Trigger Pickoff cathode follower (V383A) by changing the values of resistors R381 and R382 in the grid circuit of this tube.

The modification applies to Type 3A1's, serial numbers 101 through 4327.

Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-349.

TYPE 581 AND TYPE 585 OSCILLOSCOPES — IMPROVED VERTICAL-AMPLIFIER STANDARDIZATION

This modification is a combination of Field Modification Kits 040-275 and 040-324. *It should not be used if either of these kits has previously been installed.*

The modification standardizes the vertical amplifiers of the Type 581 and Type 585 for use with the Type 82 Dual-Trace Unit, Type 86 Unit, or any future Type 580-Series plug-in units by improving the impedance matching between the delay line and the termination networks. This improvement also enhances the transient response of the Vertical Amplifier.

Another benefit of the modification is decreased compression on the Vertical Amplifier output stage. V1284, a dual-tetrode 7699 tube, is replaced with two single-pentode 7788 tubes. The crt support bracket is also replaced.

Finally, the modification adapts the Type 80 Plug-In Units (serial numbers 101 through 3386) and the P80 Probe for use in the "standardized" Type 581 and Type 585 Oscilloscopes.

The modification applies to Type 581's, serial numbers 101 through 949 and Type 585's, serial numbers 101 through 2584.

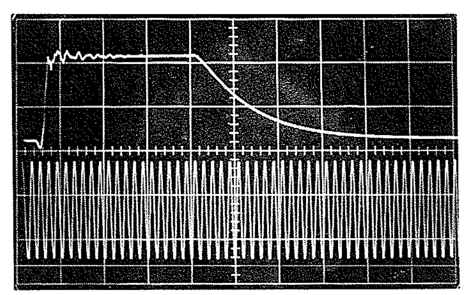
Order through your local Tektronix Field Engineer or Field Office. Specify Tektronix part number 040-364.

AUTOMATIC DISPLAY SWITCHING

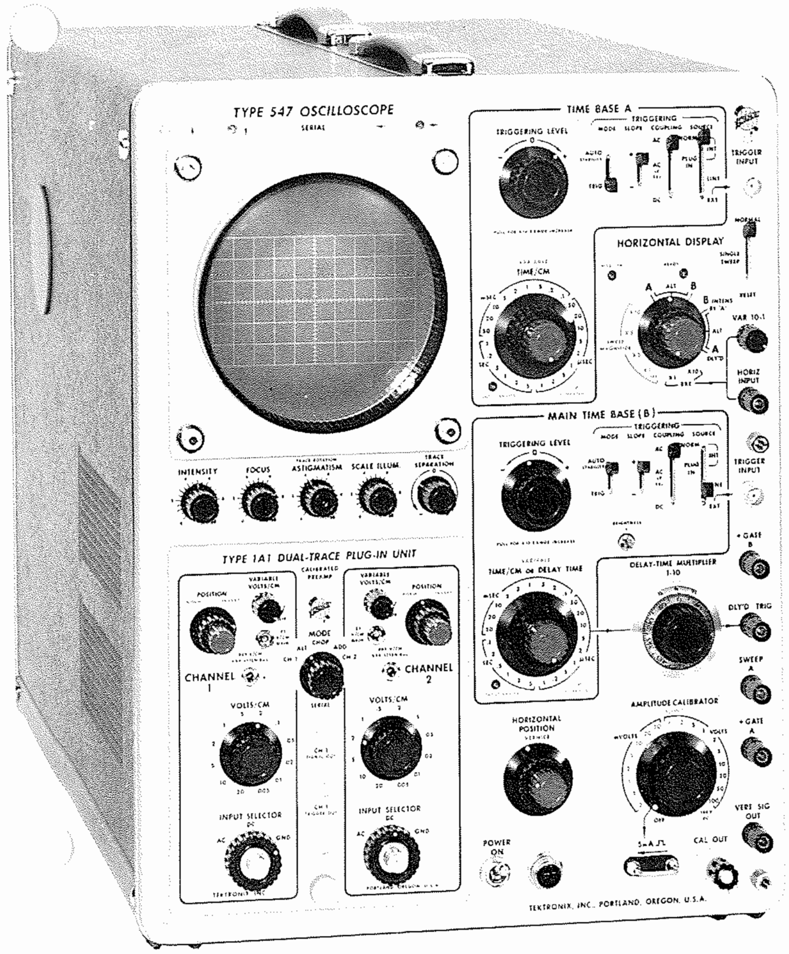
Featured In The Type 547 Oscilloscope

Electronic switching between 2 wide-range time bases allows an alternate presentation of the same signal at 2 different sweep rates. Gallium Arsenide diodes in the switching circuit provide fast switching between time bases, and insure that only the desired time base is displayed at one time.

Two different signals can be alternately displayed at the same or different sweep rates with a dual-trace unit such as the new Type 1A1. In many applications, this dual-scope operation provides the equivalent of two oscilloscopes, and at a considerable savings. Since a single-gun tube is used, beam registration and geometry problems of dual-gun tubes are avoided. Dual displays are viewed with accuracy of the single-beam construction. Also, the full 6 x 10-cm screen area can be used to display signals on either time base. A trace separation control operates in conjunction with the normal vertical positioning to allow full control of dual displays.



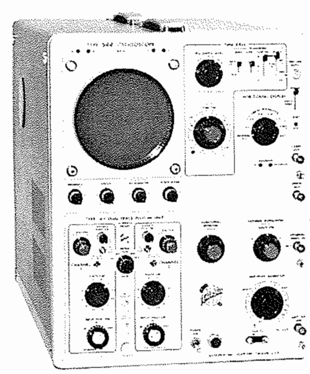
Dual-Scope Operation—independent control of each signal with Channel 1 of the Type 1A1 Dual-Trace Unit locked to Time Base A, and Channel 2 locked to Time Base B.



A NEW GENERATION OF TEKTRONIX OSCILLOSCOPES

TYPE 540-SERIES

TYPE 546



TYPE 544

BRIGHT 6 x 10-CM DISPLAYS

ILLUMINATED NO-PARALLAX GRATICULE

SMALL SPOT SIZE, UNIFORM FOCUS

COMPLETELY NEW VERTICAL AMPLIFIER

FULL-PASSBAND TRIGGERING

WIDE SELECTION OF VERTICAL PLUG-INS

MAJOR CHARACTERISTICS

OSCILLOSCOPE	PASSBAND Ⓐ	SWEEP RANGE	SWEEP DELAY	SWEEP MAGNIFIER
Type 543B	DC to 33 MC	0.1 μsec/cm to 5 sec/cm in 24 calibrated steps, variable uncalibrated from 0.1 μsec to ≈ 12 sec/cm.	None	2, 5, 10, 20, 50, 100X
Type 545B			1 μsec to 10 sec	5X
Type 544	DC to 50 MC		None	2, 5, 10, 20, 50, 100X
Type 546			0.1 μsec to 50 sec.	2, 5, 10X
Type 547		Same characteristics as Type 546 plus Automatic Display Switching.		

Ⓐ Passband with Type 1A1 or 1A2 Dual-Trace Plug-In Units at 50 mv/cm sensitivity. Passband of the Type 1A1 at 5 mv/cm sensitivity is dc to 28 Mc with Type 547, 546, or 544, dc to 23 Mc with Type 543B and 545B.

Service Scope

USEFUL INFORMATION FOR

USERS OF TEKTRONIX INSTRUMENTS