Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

NUMBER 30 PRINTED IN U.S.A FEBRUARY 1965

SOME BASIC SAMPLING CONCEPTS REVIEWED

Patrick B. Gee

Tektronix Field Maintenance Engineer

Editor's Notes

The basic concepts reviewed in this article apply to all sampling instruments. The information, however, as it is presented here was developed around the calibration of the Tektronix Type 4S1 Dual-Trace Sampling Unit. It is directed principally toward those who, when exposed to sampling techniques, feel the need for a bit more support. By developing a fuller understanding of these important features of fundamental concern, the author hopes to supply this support and to dispel the needless fear of sampling that seems to hover in the minds of some.

This article has been prepared for those involved in the calibration of the Tektronix Sampling Units, with the Type 4S1 Dual-Trace Sampling Unit being used as an example. It is intended to dissolve a few ordinary misgivings about approaching the unit and to outline an orderly and effective method of system diagnosis and treatment. You should make an effort to thoroughly understand what each adjustment accomplishes. Once you attain this objective, you will no longer need to rely on detailed instructions to calibrate the instrument. You should find it possible to perform all the necessary adjustments on a Type 4S1 in a very few minutes. Performing all the checks that insure the instrument meets original specifications may, however, take an hour or more.

	RISETIME	SAMPLING EFFICIENCY	LOOP GAIN	DOT TRANSIENT RESP.	NOISE	SCALING DRIFT	ATTENUATOR BALANCE	BRIDGE DYNAMIC RANGE
SNAP-OFF CURRENT	X	X		X	X			
MEMORY GATE WIDTH			X	X	X			
"A" BRIDGE VOLTS	A	A		A	A	A		A
"B" BRIDGE VOLTS	B	B		B	B	B		B
AC AMP GAIN (A)	A		A	A	A			
AC AMP GAIN (B)	B		B	B	B			
"A" BRIDGE BALANCE							A	A
"B" BRIDGE BALANCE							B	B
"A" SMOOTHING			A	A	A			
"B" SMOOTHING			B	B	B			
"A" SMOOTHING BAL							A	
"B" SMOOTHING BAL							B	
"A" DC OFFSET							A	A
"B" DC OFFSET							B	B

TABLE I

Excellent performance should not be expected from random adjustments. Rather, an orderly and systematic approach must be taken to restore the Type 4S1 to its proper characteristics. Adjustment is neither a difficult nor an extremely simple thing to do. A few adjustments, because they have an effect on several different characteristics (all of which we wish to hold within specified limits), confound the recalibration. The chart (see Table 1) shows the adjustments that have an effect on several different characteristics. Your principal objective should be to first diagnose the ills by knowing the symptoms, select the most suitable remedy, and *then* perform the operation you have selected.

Let's review some basic sampling concepts with the intent of learning what characteristics are changed by each adjustment within the sampling "head". First of all we should have a good understanding about *sampling efficiency* which is a measure of signal transfer across the bridge diodes sampling gate. Consider the diagram shown in Figure 1. Our purpose in opening the sampling gate is to permit the sampling capacitance (C_1) to "see" the input signal for a small period of time, the duration of the sample being a limiting factor of system risetime. (Instrument risetime can be no faster than the length of time the sampling gate is open.) We know that it invariably takes some time to fully charge a capacitor because the source and current path have impedance. The pre-amplifier input capacitance (frequently called the sampling capacitance) in the Type 4S1 will charge to

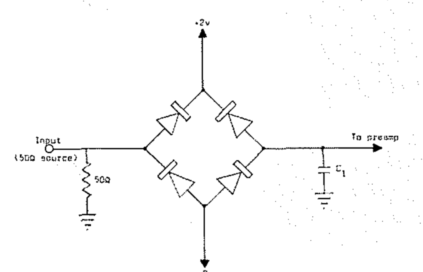


Figure 1. Schematic of a simplified sampling-bridge gate.

only about 25% of the difference in voltage across the sampling gate in 0.35 nanoseconds. This percentage is referred to as the sampling efficiency.

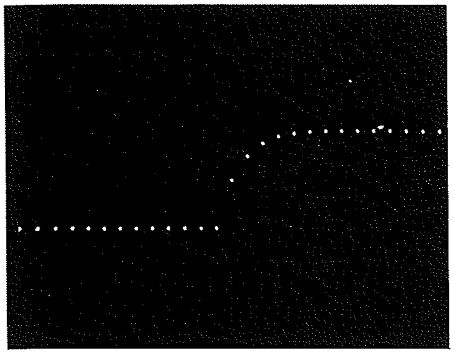


Figure 2. Waveform of the exponential increase in the sampling-capacitance charge with each successive sample, when very few samples/division are taken.

Since this capacitance will not be discharged between samples, we would expect the charge to increase exponentially with each successive sample as shown in Figure 2. Our system would then reconstruct a pulse with severe rolloff even from an infinitely fast step function if very few samples per division were taken. The rolloff would become less obvious, of course, if more samples per division of horizontal deflection were taken. For example, if 10 samples were required to fully charge the sampling capacitance, the rolloff would be evident for 1 division at 10 samples per division. But with 100 samples per division the rolloff would take place in less than one-tenth of a division and would be less apparent.

But let's suppose that the oscilloscope operator should choose to decrease the time required to complete a display of low rep-rate signals. He may do this by reducing the number of samples taken per trace (fewer samples/div). Since under these circumstances a fast rising step function may go from zero volts to its maximum voltage between samples, we must somehow cause the sampling capacitance to become
FULLY CHARGED TO THE ERROR VOLTAGE

ACROSS
the gate with only one sample. The method used here is to amplify the change in voltage on the sampling capacitance and add the amplifier voltage to this capacitance between samples in such a way that it has a voltage equal to the input signal voltage at the instant when last sampled. In other words, the amplifiers and attenuators in the entire loop should cause the sampling capacitance to charge to the level it was exponentially headed for during the preceding sample.

Refer to Figure 3 and assume a one-volt step signal applied to the input of this system. The system we may assume has a sampling efficiency of 25%. The sampling capacitance would therefore charge to 0.25 volts on the first sample. Between samples we could amplify the charge with an amplifier having a gain of four and feed back this one-volt signal level to the sampling capacitance for a period of time that permits full transfer of the charge. We then end up with the required one volt across the sampling capacitance. Now we can change the number of samples per division and the transient response of the observed waveform should remain the same. We could say, then, that our "dot transient response" is correct since we have a gain of exactly one through the entire loop when referred to the input signal. (Remember, though, that this required *a gain of four* when referred to the charge on the sampling capacitance.)

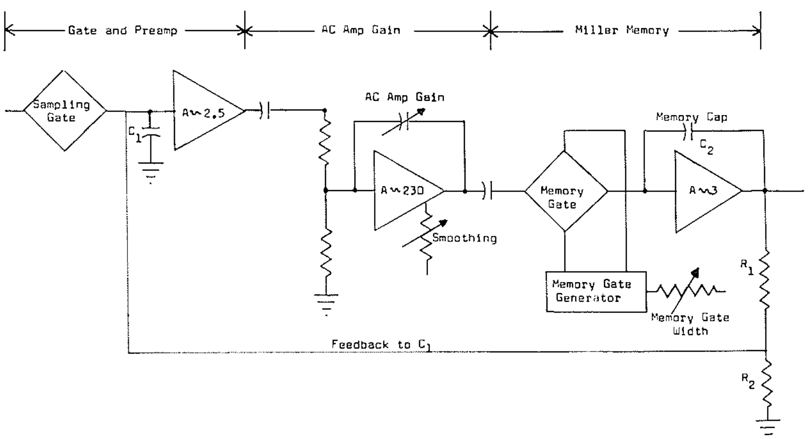


Figure 3. Tektronix slide-back, feed-back sampling system.

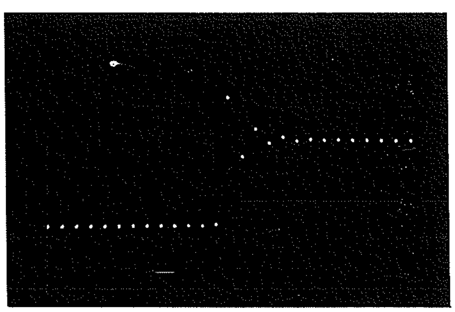


Figure 4. Waveform of overshoot due to the product of sampling efficiency and the amplified feed-back signal being greater than unity.

Obviously then, anything that we do within the sampling loop that changes either sampling efficiency or gain within the loop will also change dot transient response. In other words, *dot transient response is a function of both sampling efficiency and loop gain.*

Suppose that the product of sampling efficiency and the amplified feedback signal were to equal more than unity. Our presentation would then appear to have overshoot and/or ringing as shown in Figure 4. This is just as undesirable as the rolled-off presentation shown in Figure 2.

The four-diode sampling gate performs a few functions which require further explanation. During quiescent conditions the gate is closed so that the signal cannot pass through. To do this, we back-bias the gate with a positive and negative dc voltage of approximately two volts. The dynamic range of the gate is limited by the magnitude of this holdoff bias (BRIDGE VOLTS); a signal greater than two volts might overcome the holdoff bias and improperly charge the sampling capacitance. A trigger pulse from the timing unit initiates the generation of the strobe pulse (to open the sampling gate) and the memory gate pulse (to open the memory gate). The amplitude of the narrow strobe pulse must be sufficient to rise above the holdoff bias for a period of time T, thus forward biasing the bridge diode gate as shown in Figure 5. An increase of strobe amplitude will usually cause an increase in sampling efficiency because the sampling capacitance has longer exposure to the input signal and therefore can charge to a

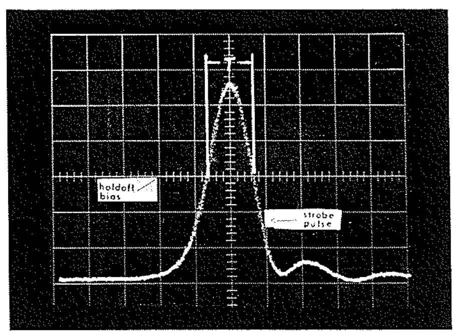


Fig. 5. The narrow strobe pulse rises above holdoff bias for a period of time "T" to forward bias the bridge-diode gate.

higher voltage. Also, a higher strobe amplitude will cause the diodes to exhibit a lower impedance during the sampling interval. The gain required through the amplifiers and feedback attenuators to yield a loop gain of unity (correct dot transient response) is the reciprocal of sampling efficiency, so we would need to reduce loop gain to compensate for an increase in sampling efficiency if we were to maintain proper dot transient response. Note that a reduction of BRIDGE VOLTS (keeping strobe amplitude constant) could cause a similar change in sampling efficiency.

A few words are in order concerning the generation of strobe pulses. A trigger pulse from the 5T1A timing unit causes the normally forward-biased snap-off diode to become reverse biased by a reverse current of high and relatively constant amplitude. A peculiar characteristic of the snap-off diode is that this large reverse current ends very abruptly (within a few picoseconds) and the snap-off diode becomes a very high impedance. The reverse current that was flowing down the 50-Ω shorted transmission (clip) line in trying to continue to flow, produces a voltage pulse of short duration that overcomes the back bias on the sampling gate and causes the diodes to conduct. When all the bridge diodes are conducting, they represent a low impedance path for the input signal to get to the input preamplifier. When the voltage pulse is reflected (after about 0.35 nanoseconds) due to current traveling in the shorted clip-line, the sampling gate is returned to its reverse-bias condition thus locking out the input signal once again. The combined snap-off diode and clip-line action produces a very fast rising and falling pulse of a very short controlled duration. Amplitude of reverse current in the clip-line is determined by the stored charge in the diode which is a function of forward SNAP-OFF CURRENT. Reverse current must be sufficient in magnitude so that the voltage created while it travels in the 50-Ω clip line is more than enough to overcome the holdoff bias on the sampling gate.

Let's refer again to Figure 3 and review some of the primary objectives here which are: (1) charge C_1 to the amplitude of the input signal as much as possible during the useable period of the strobe pulse to increase sampling efficiency, (2) feed back an amplified version of this signal between samples to charge C_1 to the full level of the input signal, (3) simultaneously charge C_2 to a value proportional to the input signal level and permit C_2 to retain this charge long enough for us to observe low rep-rate signals.

The voltage on the Memory Capacitor is proportional to the input signal and is used to drive the scope's vertical amplifier. To deflect the dot a given distance with a larger signal at the input requires attenuation of the larger signal before it is applied to the Memory. In other words, the Memory output signal will normally always be proportional to the deflection it causes. Stray capacitance and other factors prohibit using a switched attenuator at the input connector for reducing the deflection sensitivity. It is more feasible to use an attenuator at the pre-amplifier output to limit the signal coupled to the high gain ac amplifier and also prevent overdriving this stage. But we must maintain loop gain close to unity. This requires a second attenuator in the feedback path from the Memory Capacitor to the pre-amplifier input capacitance—one that will track with the ac amplifier attenuator. This will increase the feedback applied to the sampling capacitance as the ac amplifier signal is decreased (as referred to the signal applied to the 4S1 input connector) with less sensitive settings. R_1 and R_2 make up the second attenuator. (Attenuation is reduced here when it is increased between amplifiers with both attenuators operated by the same control knob). The resistor divider ratio of this pair determines the basic calibration of the sampling loop.

Another diode gate precedes the Memory stage. When the fast, narrow strobe pulse is generated, a relatively wide (250-350 nanosecond) pulse is also generated to open the memory gate. The paramount functions of the memory gate circuits are to: (1) control the in-phase feedback to the sampling capacitance and prevent the memory from responding to this regenerative feedback signal, (2) insure maximum coupling of the amplified error signal to C_2, and (3) limit memory capacitor discharge between samples. (Leakage of the charge in this capacitor causes vertical deflection of the dots between samples and is called Memory Slash.) It limits the maximum permissible time between samples for a useful display. This leakage is caused by Memory Amplifier grid current or diode gate leakage.

A cursory analysis of the system as shown in Figure 3 reveals that the following controls all have a direct effect on dot transient response:

1. Those that control *sampling efficiency* are
   a. SNAP-OFF CURRENT—common to both sampling gates
   b. BRIDGE VOLTS—one for each sampling gate
2. Those that control *loop gain* are
   a. AC AMPLIFIER GAIN—one for each sampling gate
   b. MEMORY GATE WIDTH—common to both memories
   c. SMOOTHING—a front panel control for each ac amplifier

The primary purpose of the SMOOTHING control is to reduce random noise by reducing gain of the ac amplifier. Since this is within the feedback loop, it necessarily follows that dot transient response will be effected corresponding to the amount of smoothing used, but may not be apparent when using lots of samples.

Your preparation for recalibration and/or repair should include the following additional presets on the Type 4S1:

MV/CM SWITCH	200
VARIABLE	Calibrated
VERTICAL POSITIONING	Midrange (dot to 12 o'clock)
SMOOTHING	Normal (Maximum loop gain)
DC OFFSET	Adjust for zero volts ±100 mv at the DC OFFSET MONITOR jack

With a free-running sweep, both traces should be well within the central graticule area of a properly adjusted instrument. Severity of imbalance is often indicated in this display and your observations here may help in the diagnosis. If the presentation looks other than normal, first perform steps 3 and 4 of the recalibration guide which follows this article and then start back with step number 1.

Several methods, each having its own merits, may be used to show dot transient response error. A most useful method is to apply a step-function to the input and use a sweep speed that will display no more than two or three samples on the leading edge of the pulse (low vertical dot density) at 100 or more samples per division. Should the pulse shape or transient response change when switching from 100 to 10 or fewer samples, *then dot transient response is not correct.* Quite often in using only 10 samples/div an important part of the trace may be missing and the overshoot or undershoot that appeared with 100 samples/div will not be displayed because it occured between dots in the presentation. Therefore, when operating at few samples/div you may need to relocate the dots along different portions of the trace or "slide" them back and forth to simulate a solid trace by rotating either the TIME POSITION or VARIABLE TIME/CM control. (The slow sweep speed required for low vertical dot density usually places the beginning of the pulse towards the left edge of the crt. Using the VARIABLE TIME/CM control is generally more desirable for this situation since it moves the trace to the right, towards the center of the screen.)

Another method requires a generator of the mercury-pulser variety (Tektronix Type 109 or Type 110) with a small charge line on one side of the switch and no charge line on the other side. Here the sampling gate is opening on the two inputs alternately. The sampling capacitance most of the time must alternately charge from the amplitude extremes between the voltage at the top of the pulse input and the zero volts from the other input. Response with each sample is manifested in the display. Proper DTR (dot transient response) would give a presentation that should look like Figure 6a. Low loop gain would give a presentation that should look like Figure 6b, and exces-

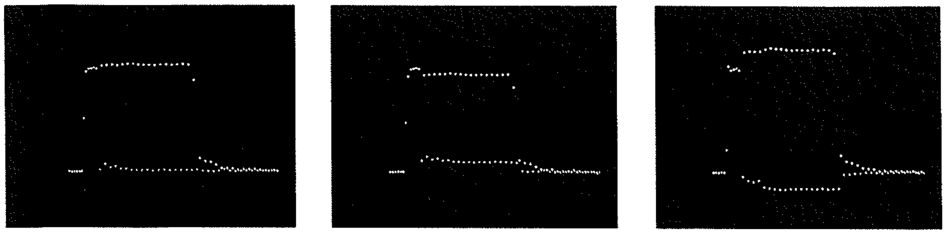


Fig. 6. Waveforms of: (a) correct DTR, (b) low loop gain, (c) excessive loop gain, using a small charge line on one side of the switch and none on the other.

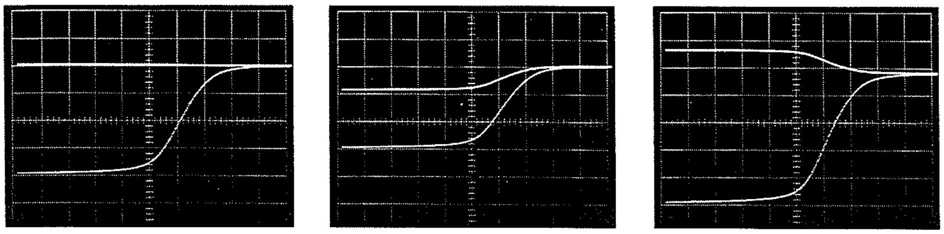


Figure 7. Waveforms of: (a) correct DTR, (b) low loop gain, (c) excessive loop gain, with the 5T1A set up for + INTERNAL triggering at a sweep speed of about 2 NSEC/CM and using a TU-5 Pulser/Adapter operated by a 25-kc square wave from a Type 105 Square-Wave Generator to drive the Type 4S1.

sive loop gain would give a presentation that should look like Figure 6c.

Low repetition rates inherent with mercury-pulsers are sufficiently annoying to warrant investigating other ways of obtaining a similar "twosies" type of display. One such way follows, but requires dc internal triggering: Using a Type 5T1A Timing Plug-In Unit set up for + INTERNAL triggering at a sweep speed of about 2 NSEC/CM, obtain a normal display of the leading edge of a pulse from a Tektronix Type TU-5 Pulser operated by a 25 kc square wave from the Tektronix Type 105 Square Wave Generator. Switching the 4S1 triggering switch from ac to dc trigger coupling should produce a display similar to those shown in Figure 7. Here the trigger circuit is alternately responding to the leading edge and pulse top. Triggering on the pulse top occurs because the pulse top is still more positive than the THRESHOLD setting after trigger recovery takes place making the Type 5T1A ready to trigger again whenever the THRESHOLD level is exceeded. Pulse amplitude after the next recovery cycle will be below the THRESHOLD level which will prevent the trigger circuit from responding until the next positive excursion through the THRESHOLD level setting. The sampling capacitance must therefore charge to the pulse amplitude extremes during the first few centimeters of display with each successive sample.

The chart shown in Table 1 is another useful tool during recalibration. Use it to increase your understanding of the interaction between the various amplifiers and controls.

TYPE 4S1 RECALIBRATION GUIDE

Field recalibration is usually a relatively simple process if previous calibration settings have not since been misadjusted. The following method may be used to perform routine recalibration. This is *not* a complete recalibration procedure, but should serve as a useful reference in conjunction with the regular recalibration procedure in the instruction manuals.

1. Adjust MEMORY GATE WIDTH for maximum loop gain (i.e., maximum overshoot when observing DTR—dot transient response).

NOTE: Before adjusting SNAP-OFF CURRENT or BRIDGE VOLTS, first determine which adjustments need to be made by application of the following concepts:

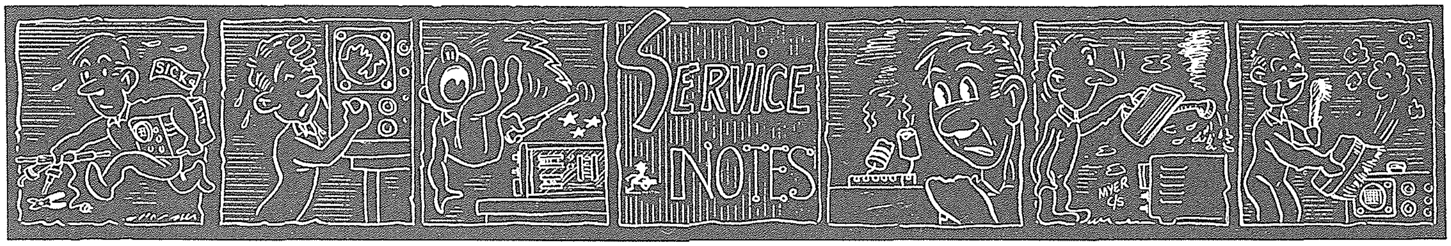
2. *Check* DTR on both channels.
   a. If the same DTR error exists on both channels, adjust SNAP-OFF CURRENT for correct DTR on both channels.
   b. If Channel A DTR is poor and Channel B DTR is good, adjust Channel A BRIDGE VOLTS for proper DTR on Channel A.
   c. If Channel B is poor and Channel A is good, adjust Channel B BRIDGE VOLTS for proper DTR on Channel B.
   d. If both channels exhibit DTR errors in opposite directions (one showing too much loop gain and the other showing insufficient loop gain), perform the following steps:
      (1) Adjust BRIDGE VOLTS on both channels to maximum clockwise positions.
      (2) Adjust SNAP-OFF CURRENT for proper DTR on the channel that has the highest loop gain as indicated by the most overshoot when samples/cm is changed.
      (3) Adjust BRIDGE VOLTS on the *other* channel for proper DTR.
3. Adjust BRIDGE BALANCE on both channels so that the trace remains on the screen throughout MV/CM settings. (DC OFFSET must be zero volts). Be sure not to brush the DC OFFSET control as you rotate MV/CM.
4. Adjust SMOOTHING BALANCE for no trace shift while rotating SMOOTHING—both channels.
5. Apply a known amplitude to B Channel and adjust B GAIN ADJUST for proper deflection.
6. Apply a known amplitude to A Channel and adjust A-B BALANCE (on the front panel) for proper deflection.
7. Adjust INVERTER ZERO on both channels for less than 2 mm trace shift when switching from NORMAL to INVERTED (DC OFFSET MUST BE ZERO).

This completes the adjustments for the Type 4S1, leaving only a series of checks that should be performed to insure that the instrument is functioning properly. The most important considerations include:

a. RISETIME—less than 0.35 nanoseconds computed.
b. NOISE—less than 1 mv (consider 90% of the dots).
c. BASELINE SHIFT—less than 3 mv base-line shift between 50 cps and 100 kc rep-rates. (This is a shift of the dc reference level or base-line with changes of rep-rate. It may come from several sources including improper adjustments, and is usually greatest between 90 kc to 100 kc. Scaling drift is checked by observing a trace with no signal applied and triggering the sweep from 10 cps to 100 kc using a Type 111 Pulse Generator or equivalent.)
d. MEMORY SLASH—less than ½ cm vertical trace slash at 10 cps.
e. OVERSHOOT or UNDERSHOOT—3% maximum.
f. DOT TRANSIENT RESPONSE—correct for both positive and negative going signals of less than ±½ v in amplitude.

If risetime is adequate but noise and/or scaling drift are excessive, decrease BRIDGE VOLTS and readjust SNAP-OFF CURRENT for proper dot transient response, then repeat steps 2, 3 and 4 above. Make sure that BRIDGE VOLTS is at least 2 volts above and below ground for your final setting.

NOTE—Refer to your instruction manual or recalibration procedure for other checks to be performed.



TYPE 575 TRANSISTOR CURVE TRACER — NOISE ON HORIZONTAL AND VERTICAL ATTENUATOR SWITCHES

Under extreme environmental conditions, foreign material can build up on switch contacts and cause excessive electrical noise. This noise can be particularly objectionable.

The application of a *thin* film of Cramolin cleaner and lubricant (Tektronix part number 006-197) will solve this problem. Usage of Cramolin will result in approximately 40 times improvement in reducing noise and wear, over a dry switch.

Cramolin should be applied with a small artist-type camel-hair brush. Just a drop placed on the brush and then applied to the switch contacts and rotor will give good results. After application, rotate the switch back and forth through its range several times. This aids the cleaning and lubrication action. Avoid the use of excessive amounts of Cramolin. Anything more than a thin film will only detract from the neatness of your work and will neither hasten nor aid the cleaning and lubricating action.

Cramolin may be obtained through your local Tektronix Field Engineer, Representative, Field Office or Distributor.

TEKTRONIX INSTRUMENTS WITH FORCED-AIR VENTILATION — FAN MOTOR SALVAGE

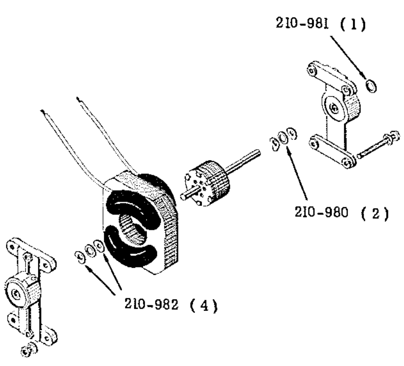


Figure 4. Exploded drawing of fan motor, part number 147-001.

Many Tektronix instruments employing forced-air ventilation use the same type fan motor. Tektronix part number for this motor is 147-001. When these motors begin to display signs of wear (normally after extended periods of service) they may be salvaged to give many more hours of use. Indications of wear can be a noisy motor, and/or excessive end play of the motor shaft. (You should note here that a bent or out of balance fan blade can vibrate and give the appearance of a noisy motor. Check your fan blade before finally assessing the cause of noise.)

The cause of noise or shaft end play in a 147-001 motor is wear on the seven washers shown in Figure 4. To replace the washers shown in this exploded drawing you will need:

Qty.	Part #	
2 each	210-980	steel washers
4 each	210-982	beryllium washers
1 each	210-981	fiber washer

These parts may be ordered through your local Tektronix Field Engineer, Representative, Field Office or Distributor.

The Mechanical parts list in the Instruction Manual for your instrument gives the Tektronix part number for the fan motor. We remind you, the information given here applies only to instruments using fan motors part numbered 147-001.

TYPE 661 SAMPLING OSCILLOSCOPE — DELAYED PULSE MODIFICATION

Here is a do-it-yourself modification that will protect the Tunnel diode D992 (in the Delayed Pulse circuit) from excessive current during the warm-up time of V694 and V814. The modification routes the current supply through relay K601 until the instrument is warmed up, at which time normal supply current is restored. This modification applies to Type 661 instruments serial numbers 101 through 2219.

The following instructions should aid in rewiring the relay:

IMPORTANT: Use silver-bearing solder when soldering to ceramic strips.

( ) 1. Unsolder from relay K601:

( ) white-violet wire

( ) sleeving-covered wire

( ) gray-red-red wire

( ) 2. Replace the sleeving-covered wire with a piece of wire and sleeving that is ⅛″ longer.

( ) 3. Solder the new sleeving-covered wire and the white-violet wire to the terminals shown in Figure 1.

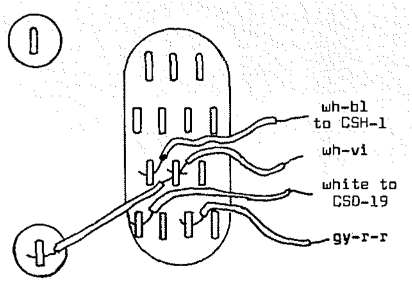


Figure 1. Diagram showing solder terminals on relay K601.

( ) Solder the gray-red-red wire to the terminal shown in Figure 1.

( ) 4. Solder a 10″ piece of #22 white-black wire and a 6″ piece of white wire to the terminals shown in Figure 1.

( ) 5. Solder the other end of the white-black wire to CSH-1 (locate in Figure 2).

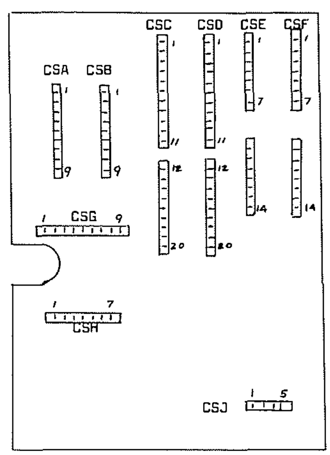


Figure 2. Diagram showing layout of ceramic strip terminals referred to in Delayed Pulse Modification.

( ) 6. Solder the other end of the white wire to CSD-19 (locate in Figure 2). This completes the modification.

( ) 7. Check wiring for accuracy and change Interconnecting Sockets diagram in the Type 661 Instruction Manual to agree with Figure 3.

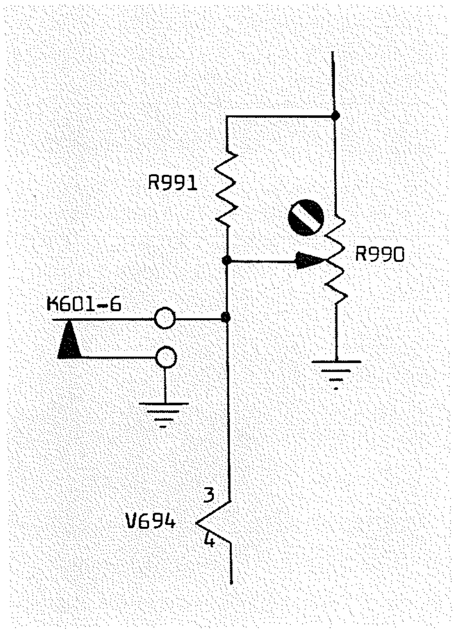


Figure 3. Schematic of K601 relay after performing Delayed Pulse Modification.

TYPE 575 TRANSISTOR CURVE TRACER—VIEWING FIELD EFFECT TRANSISTORS' CURVES

Normally, a Type 575 Transistor Curve Tracer is limited in displaying a family of curves for an FET (field effect transistor). When the STEP SELECTOR control of the Type 575's Base Step Generator is set to the maximum (200 ma) position it will not completely cutoff the FET.

A simple modification is to place a 10 k, ½ w, 1% precision resistor between the base and emitter terminals of the Type 575 and then set the Base Step Generators STEP SELECTOR control to 0.05 ma. This gives an IR drop between the gate and source terminals of the FET of 0.5 volts per step. This is sufficient to view the complete family of curves from zero to cutoff.

TYPE 530, TYPE 530A, TYPE 540, TYPE 540A, TYPE 540B, TYPE 550, TYPE 585 AND TYPE 585A OSCILLOSCOPES — EXCESSIVE DELAY BEFORE CRT BEAM COMES ON

Time-delay relays used in the above oscilloscopes delay their operation for approximately 45 seconds after the power switch is turned on. This brief delay allows the tubes to warm up to near their operating temperature before the dc operating voltages are applied. At the end of this delay period the cathode-ray beam should appear on the face of the crt.

A more lengthy delay (two or more minutes — or up to 30 minutes in aggravated cases) can very often be traced to low emission by one or both of the 5642 tubes in the crt grid supply and the crt high-voltage cathode supply. Or, it may be due to low emission in the crt itself.

To determine if the 5642 tubes are at fault, remove the ground strap from the crt-cathode connector located on the rear panel of the oscilloscope. Patch a cord from the calibrator output to the crt-cathode connector and feed in 10 volts of calibrator signal. With the sweep free running you should now see a modulated trace on the face of the crt. Advance the calibrator control through the 20, 50, and 100 volts positions. If the modulated trace remains on the crt face the 5642 tubes are most probably functioning properly.

To check for low emission in the crt, remove the calibrator signal from the crt-cathode connector and reconnect the ground strap. Adjust the FOCUS and ASTIGMATISM controls for largest diameter spot. With the sweep turned off, adjust the INTENSITY control to where the de-focused spot on the crt face has a very slight halo. Remove the left-hand side panel from the oscilloscope. Then, with the tip of a magnetized screw driver, touch the base of the crt near where it joins the glass neck. While moving the tip of the screw driver around the available circumference of the crt base, check for dark areas within the defocused spot on the crt face. If dark areas are observed the crt is suffering from low emission.

If either the 5642's or the crt are low in emission they should be replaced.

TYPE CA PLUG-IN UNIT — LACK OF DUAL-TRACE DURING WARM UP

Type CA Plug-In Units, serial numbers 101 through 34790, may exhibit a lack of dual trace during the period when the instrument is warming up. The problem is caused by V3382. This 6AL5 tube in the switching circuitry has its cathodes returned to the —150 volt supply through a 1.8 meg resistor in the oscilloscope via pin 16 of the interconnecting plug. The 1.8 meg resistor provides a current source for the 6AL5 that tends to balance the multivibrator plates (V3375) in the CA unit; both halves saturate and prevent multivibrator action.

A 330 k, ¼ w, 10%, composition resistor (Tektronix part number 316-334) added between pin 5 of V3382 and +225 volts will cure the problem.

NEW FIELD MODIFICATION KITS

TYPE 111 PRETRIGGER PULSE GENERATORS—PULSE WAVEFORM IMPROVEMENTS

This modification reduces overshoot, ringing, and other aberrations in the pulse waveform. It also improves the risetime of the negative pulse.

Primarily, the modification consists of replacing the Avalanche transistor (Q84) and reworking the associated circuitry on the etched circuit board. New "transition pieces" are used to connect the Charge Line and Output Polarity coaxial cables to the board.

Parts Replacement Kit 050-216 is also included to replace the OUTPUT POLARITY switch and Charge Line cable.

This modification applies to Type 111 instruments with serial numbers below 800. Order through your Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix Part Number 040-392.

TYPE 4S2 DUAL-TRACE SAMPLING UNITS—TRANSIENT RESPONSE IMPROVEMENTS

This modification improves the transient response and reduces ringing on fast-rise signals in the Type 4S2:

1. Replacing Gate (bridge) diodes with closer-matched and lower-capacitance diodes.
2. Making the sampling bridge compensation networks adjustable.
3. Substituting 200 Ω resistors for the ferrite beads between sampling bridge and Nuvistor grid.
4. Terminating the strobe pulse lines with 100 Ω resistors.
5. Adding grid-bias balancing potentiometers for each Nuvistor.
6. Decoupling the —100 and +300 voltages to the Sampler and Gate-Generator circuits.

This modification applies to Type 4S2 instruments with serial numbers below 301.

Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-379.

TYPE 53/54C AND TYPE CA DUAL-TRACE PLUG-IN UNITS—SLAVE TO AUTOMATIC DISPLAY SWITCHING

This modification allows Channels A and B of either Type 53/54C, serial numbers 3710-up, or Type CA, serial numbers 101 through 64009, to be slaved to the respective sweeps of the Type 547 Oscilloscope, when the Type 547 is operated in A ALT B mode. The modification does not change the operation of the Type 53/54C or Type CA when operated in any other instrument.

Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-391.

RELAY RACK CRADLE ASSEMBLY

Three new Field Modification Kits provide a rear support cradle for installing rack-mounted instruments in a backless relay rack by the use of slide-out tracks. The slide-out tracks are not included in the modification kits and must be ordered separately.

Slide-out tracks allow the instrument to be pulled out like a drawer. When pulled out, the instrument can be locked in one of seven positions: horizontal, or 45°, 90°, or 105° above and below horizontal.

Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor from the following information.

Field Modification Kit, Tektronix part number 040-344, applies to the following instruments:

Type 127	serial numbers	309 - up
Type RM15	serial numbers	101 - up
Type 526	serial numbers	101 - up
Type RM561	serial numbers	101 - up
Type RM561A	serial numbers	5000 - up
Type RM564	serial numbers	100 - up
Type RM647	serial numbers	100 - up

Order slide-out track assemblies separately, as follows:

Types 127, RM15, and RM647	1 ea. 351-006
Types RM561, RM561A, RM564	1 ea. 351-050
Type 526	1 ea. 351-001 1 ea. 351-011

Field Modification Kit, Tektronix part number 040-346, applies to the following instruments:

Type RM565 serial numbers 101 - up
Type RM567 serial numbers 101 - up

Order slide-out track assemblies, Tektronix part number 351-055 (1 pr.), separately for these instruments.

Field Modification Kit, Tektronix part number 040-345 applies to the following instruments:

Type RM16 serial numbers 101 - up
Type RM17 serial numbers 101 - up

Order slide-out track assemblies, Tektronix part number 351-083 (1 pr.), separately for these instruments.

TYPE 3T77 SAMPLING PLUG-IN UNITS, S/N'S 840 TO 1999 — IMPROVED SINE-WAVE TRIGGERING

This modification imparts a greater stability to the display during triggering on high-frequency sine waves. A trigger-circuit change allows switching to a lock-on type of operation when displaying high-frequency sine waves and eliminates display break-up caused by drift in recovery time.

A new push-pull Recovery control replaces the old control.

Pulling the control to the ON position synchronizes the circuit on sine waves above approximately 30 Mc. With the control pushed in the instrument triggers on signals below 30 Mc. Order through your local Tektronix Field Engineer, Field Office or Representative. Specify Tektronix Part Number 040-366.

SCOPEMOBILE® CART ADAPTER

This modification adapts the Type 202, Type 202-1, Type 202-2 and Type 204 Scopemobile carts for use with a Type 502 or Type 502A Oscilloscope. Two adapter plates fasten to the Scopemobile cart and prevent the oscilloscope from shifting sideways. Order through your local Tektronix Field Engineer, Field Office or Representative. Specify Tektronix Part Number 040-365.

TYPE 502 AND TYPE 502A OSCILLOSCOPES—SAWTOOTH AND +GATE OUT

This modification installs two UHF output connectors (one for the direct coupled Sawtooth and one for the +Gate Out waveforms) on the rear panel of the Type 502 or Type 502A Oscilloscopes. The +Gate Out waveform is 40 volts and of the same duration as the +150-volt Sawtooth waveform. The waveforms are dc coupled to the connector via a dual cathode-follower assembly which mounts on the Time/CM switch bracket.

Order through your local Tektronix Field Engineer, Field Office or Representative. Specify Tektronix Part Number 040-312.

TYPE 502 OSCILLOSCOPE—SILICON RECTIFIER

This modification replaces the selenium rectifier (SR642) used in the Type 502 with silicon rectifiers which offer more reliability and longer life. Order through your local Tektronix Field Engineer, Field Office or Representative. Specify Tektronix Part Number 040-383.

TYPE 108 FAST-RISE MERCURY PULSER — SILICON RECTIFIER

This modification replaces the original selenium rectifiers (SR3A,B) with silicon rectifiers which offer more reliability and longer life.

The modification is applicable to all Type 108 Mercury Pulsers.

Order through your Tektronix Field Engineer or local Field Office. Specify Tektronix part number 040-388.

TYPE 527 WAVEFORM MONITOR—LINE SELECTOR

This modification installs a prewired Video Output-Amplifier chassis in the Type 527 to allow a picture monitor to be connected directly to the Type 527 and to display the signal, being displayed on the Type 527, on the picture monitor.

The modification also installs a prewired Line-Selector chassis circuit for detailed observation of any one TV line in a frame. A Field-Shift circuit provides line selection from either the odd or the even field. A Line-Intensification circuit rapidly identifies the line being observed and the selected line is intensified on the picture monitor via the Video-Output connector of the Type 527 Waveform Monitor.

Order through your local Tektronix Field Engineer, Field Office or Representative.

Specify for:

Type	S/n's	Tektronix Part Number
527	151-579	040-356
RM527	151-979	040-354
527	580 and up	040-359
RM527	980 and up	040-358

Service Scope

USEFUL INFORMATION FOR

USERS OF TEKTRONIX INSTRUMENTS

Tektronix, Inc.
P. O. Box 500
Beaverton, Oregon

BEAVERTON OREG. MAR-2'65 U.S. POSTAGE 05 PB METER P.B.336216

CMO

Gordon Marsh, Engineer
Department of Transport
Maint. & Operations Dept.
Temporary Building #3
Ottawa, Ontario, Canada 9/63