Service Scope

USEFUL INFORMATION FOR USERS OF TEKTRONIX INSTRUMENTS

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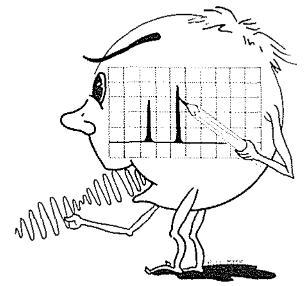


GETTING ACQUAINTED WITH SPECTRUM ANALYZERS

by Russ Myer
Tektronix Advertising Dept.

This article forms a conceptual basis for the understanding of Spectrum Analysis, thus preparing the reader for the several advanced works available on the subject written on the Engineering level.

Part I

WHAT IS A SPECTRUM ANALYZER?

At any given moment, there is an incredible amount of activity within that portion of the Electromagnetic Spectrum that we call the Radio Frequency Bands. These bands range in frequency from about 15 kc to 750,000 Mc.

Assume you have a special radio receiver capable of tuning over this entire range. At the lower end, you'll find maritime ship-to-shore, aircraft point-to-point, high-powered government and commercial transoceanic signals. Tuning higher in frequency, within the familiar 540-to-1600 kc broadcast band, dozens of commercial radio stations compete for your attention. Above these, you'll find more ship-to-shore, and, confined to relatively small portions of the spectrum, thousands of "ham" radio operators pursue their electronic endeavors. Also, interspaced throughout this short-wave band, you will hear much air-ground activity, government point-to-point, many foreign broadcast stations, the Voice of America (and Moscow!), police radio broadcast stations, and some experimental work.

Still higher in frequency, you'll find television stations, starting at 54 Mc, FM stations above 88 Mc and more television above 174 Mc. The area above 400 Mc, once considered experimental, produces myriad signals: microwave, telemetry and others.

These radio transmissions take various electronic configurations, ranging from single-frequency carriers to complex signals produced by changing these carriers in amplitude, frequency and phase.

Regardless of the shape of these signals and how they were produced, or "modulated", each one can be separated into individual sine waves. Each sine wave represents a single frequency. To examine the composition and quality of a signal, you would find it very helpful to extract each individual sine wave that it contains and display it alone on an oscilloscope. Seeing all the sine waves in a "group" picture, each standing alone, would enable you to analyze the complex signal. The instrument that performs this task for you is called a Spectrum Analyzer.

To use an example of a familiar but complex waveform which could be reduced to individual sine waves for analysis, consider an AM radio station. A broadcast transmitter radiates a single carrier frequency from its antenna. Intelligence (speech, music, tones, etc.) is superimposed on this carrier, varying its amplitude at an audio rate. Assume the station is transmitting a 1000-cycle test tone. The carrier frequency of the station is 1 Mc. This carrier is combined in the final stage of the transmitter with the 1000-cycle tone. The antenna, however, through the process of "modulation", is broadcasting not two, but *three* signals. Viewed on a conventional scope, the signal might look like figure 1a.

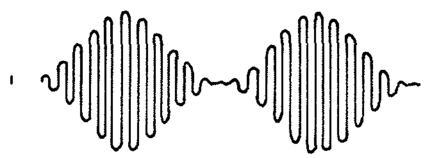


Figure 1a. Conventional oscilloscope display of 1000 kc carrier modulated by a 1000 cps tone.

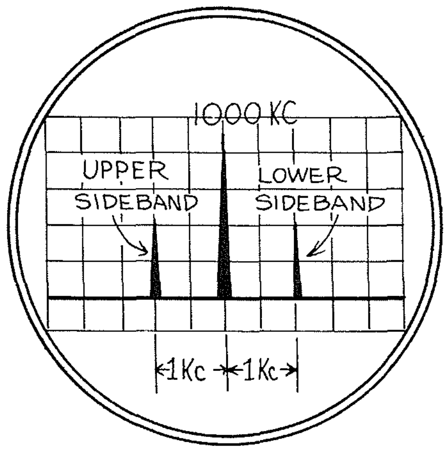
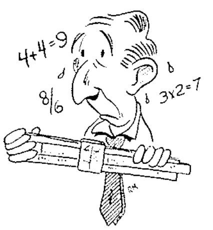


Figure 1b. Display of same signal using Spectrum Analyzer.

Electrically, the carrier is still occupying the 1-Mc spot in the spectrum. Exactly 1000 cycles below this frequency, however, at 999 kc, you will find a new signal, called the "lower sideband". 1000 cycles above the 1-Mc spot, at 1,001 kc, you'll find another signal, identical to the one at 999 kc, called the "upper sideband". The separation is exactly equal to the modulating frequency — the 1000 cycle tone. The Spectrum Analyzer is capable of displaying these three frequencies, individually, on the screen of a cathode-ray tube. Thus, the component frequencies may be individually studied, or "analyzed". Figure 1b shows how the Spectrum Analyzer would display them.



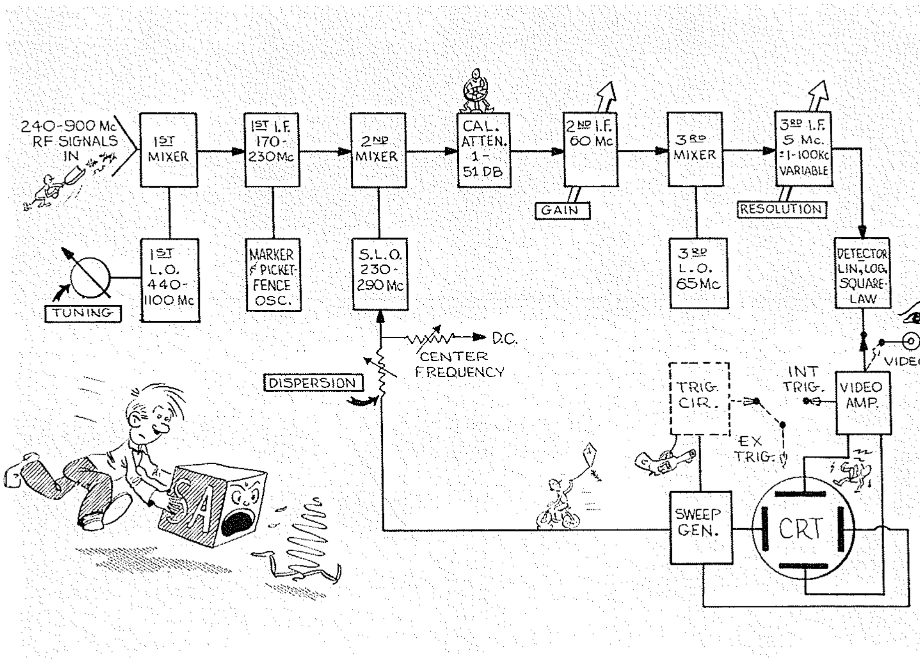
There is nothing difficult about the overall operation of the analyzer. The signals which we will use as examples, however, must be followed in detail through the different sections shown in the block diagram. To understand the conversion of input signals to signals of lower frequencies, you will find it helpful to perform the simple arithmetical computations dealing with the mixer and i.f. (intermediate frequency) sections.

There are several ways that a signal can be broken down into component sine waves. One method is to introduce the signal to a stack of filters, the inputs of which are paralleled. Each filter is tuned, in successsion, to a slightly different frequency than the others. The output of each filter will contain only that portion of the input which corresponds to the frequency it was tuned to. The drawback here is that for most complex signals, you would need hundreds of filters — a costly mechanical burden. Too, it is difficult to design filters with narrow bandwidths to produce good resolution between closely-related signal components.

The prism is also a simple spectrum analyzer. It takes the visible portion of the electromagnetic spectrum and breaks it up into its component frequencies, each representing a familiar color. There are chemical analogies, also, such as the chemist's ability to reduce complex compounds into their individual ingredients. The Tektronix Spectrum Analyzer performs an analysis by purely electronic means.

HETERODYNING

To continue our discussion of the analyzer, we will review, briefly, the principle of heterodyning. Years ago, Armstrong and his colleagues created the "superhet" receiver. They discovered that it was possible to feed two separate single-frequency signals into a non-linear device, usually a vacuum tube, and get *four* signals out! Using suitable filters, they found that besides the two original frequencies, they had a 3rd



Block diagram of typical Tektronix Plug-In Spectrum Analyzer.

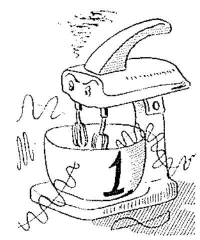
frequency that was equal to the mathematical difference of the input signals. Also, they found a 4th frequency in the output — one equal to the sum of the two original signals. They applied this principle to the superheterodyne receiver, like one you probably have in your home today. The following example illustrates this concept, so necessary to the understanding of Spectrum Analyzers.

Tune in a radio station that has, let us say, a carrier frequency of 1080 kc. This frequency enters the front end of your radio and into a "mixer" tube. A local oscillator in your set, which follows the main tuning, generates a frequency of 1535 kc. This oscillator frequency also is fed into the mixer tube. In the output of this tube, as in the days of Armstrong, you have the two original frequencies *plus* the two new frequencies mentioned before: 2615 kc and 455 kc. The latter, 455 kc, is the one accepted by the tuned circuits of the intermediate-frequency stages of your receiver.

As we tune across the band, we simultaneously tune the local oscillator to a frequency exactly 455 kc above the frequency of the station tuned in. Thus, a highly-efficient i.f. stage can be designed which is responsive to a single frequency — the 455-kc difference between the local oscillator and the frequency present at the front end.

HOW THE ANALYZER WORKS

Tektronix Spectrum Analyzers, built as plug-in accessories for existing oscilloscopes, cover various frequency ranges. Currently, these cover frequencies from 1 Mc to 10.4 Gc (Gigacycles). One of these, the Type L-20, will analyze frequencies from 10 Mc to 4 Gc, in 5 bands. We will consider the range of frequencies covered by band 2 of the Type L-20, roughly 230 Mc to 900 Mc.



Refer to the block diagram of the analyzer. Incoming signals are introduced directly into the first mixer. As in your radio receiver, there is a local oscillator associated with the mixer. This oscillator is tuned by the front-panel control which also rotates the tuning dial indicating the frequency of the incoming signal. It tunes through a frequency range of 440 Mc to 1100 Mc. The output of the mixer is fed into the first i.f. stage. This stage is fixed-tuned to 200 Mc.

Therefore, any input signal that will mix with the local-oscillator frequency in the mixer stage and produce a difference frequency of 200 Mc will pass through the 1st i.f. For example, when the local oscillator (abbreviated L.O.) is tuned to its lowest frequency, 440 Mc (the main tuning dial reading 240 Mc), an input signal of 240 Mc will "beat" with this frequency in the mixer and produce the desired i.f. output of 200 Mc. Tuning the L.O. to 600 Mc means that there has to be an input signal of 400-Mc to produce a 200-Mc difference. The highest setting of the L.O., 1100 Mc, allows a signal of 900 Mc to produce the 200-Mc difference and appear in the first i.f. You will see that *any* signal tuned in from 240 Mc to 1100 Mc will produce the same 200-Mc difference.

The first i.f. is tuned to a center frequency of 200 Mc. The bandwidth of this circuit is fixed at 60 Mc. Therefore, any signals 30 Mc above or below the 200 Mc difference frequency will also pass through the i.f. This is important to the operation of the Spectrum Analyzer.

We will now follow 3 input signals through the analyzer. Their frequencies are: 280 Mc, 300 Mc, and 320 Mc. Assume you have set the tuning dial on 300 Mc, calling it the "Center Frequency". Actually, you have tuned the L.O. to 500 Mc. This produces a 200-Mc difference between the L.O. and the 300-Mc center frequency. This 200-Mc "beat" frequency falls in the middle of the i.f. tuned circuit. The input frequency of 280 Mc also is beating with the established L.O. frequency of 500 Mc. It produces an output from the mixer stage of 220 Mc. This falls within the 60 Mc bandpass of the i.f. stage. The input of 320-Mc also produces a frequency (180 Mc) that falls within the bandpass of the i.f. stage. You will see, therefore, that at the output of the first i.f. stage, all three input signals are present. They have the same 20-Mc separation but are reduced in frequency. Although converted in frequency, their relationship to one another has not been changed. It is important to realize one difference, however: The 180-Mc i.f. signal represents the *highest-frequency* input signal, 320 Mc. The 220-Mc i.f. signal represents the lowest-frequency (280 Mc) input signal. In other words, there is a reversal of relative frequency.

The three signals at the output of the first i.f. stage are now fed into a second mixer. See block diagram. This mixer is also associated with a local oscillator, and the output is fed into a 2nd i.f. stage. This stage is actually tuned to 59 Mc, but to simplify our example, consider that it is tuned to 60 Mc. The 2nd local oscillator is also tuned and covers a frequency range of 230 Mc to 290 Mc. The tuning is accomplished by electronic means, however. The oscillator frequency is "swept" through this frequency range by the application of an external sawtooth.

The inputs to the 2nd mixer stage always exist within the range of 170 Mc to 230 Mc. No other signals can get through the first i.f. Note that the 2nd local oscillator (Swept Local Oscillator — S.L.O.) sweeps through a range of 60 Mc — the band-width of the 1st i.f. Therefore, any signal from 170 Mc to 230 Mc, when combined with the 230-Mc to 290-Mc "sweep" of the S.L.O. will produce a 60-Mc difference frequency. The 2nd i.f. has a relatively narrow bandwidth and is sensitive only to this 60-Mc difference.

To illustrate how a swept oscillator produces the 60-Mc i.f. frequency, consider the 3 input signals to the 2nd mixer stage. The S.L.O. begins its normal sweep, starting at 230 Mc. To produce the desired i.f. frequency of 60 Mc there would have to be a 170-Mc signal present at the 2nd detector input. There is none, thus no i.f. frequency is produced. The S.L.O. continues its sweep and passes through the frequency of 240 Mc. This mixes with the 180-Mc input and produces the 60-Mc i.f. frequency. As it sweeps through 260 Mc and 280 Mc, it mixes with the other two inputs and also produces the 60-Mc i.f. frequency.

Thus, by using a local oscillator that sweeps a certain range of frequencies, input signals to the mixer can be made to enter the 2nd i.f. stage *one by one,* separated in time. *This is the important thing to remember about the operation of the analyzer.*

Skipping the 3rd mixer and i.f. for a moment, assume you have fed the output of the 2nd i.f. into a detector. As the signals appear one by one at the output of the 2nd i.f., they are rectified, giving positive pulses which will cause vertical deflection on the face of a crt. In our typical spectrum analyzer, the sawtooth that causes the the S.L.O. to sweep through its frequency range is the same one that drives the horizontal circuits of the oscilloscope in which it is used. Thus, you will observe the three input signals on the crt, with the horizontal axis representing frequency. Study the following example, referring to Fig. 2.

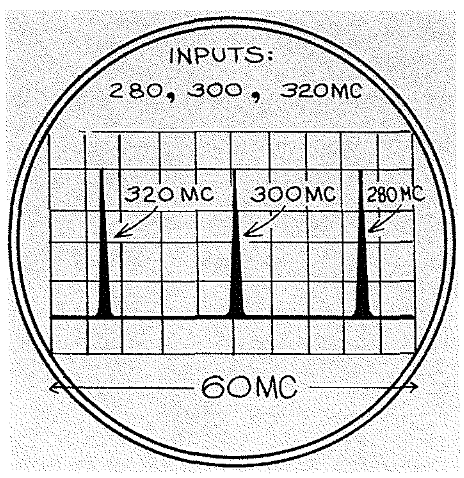


Figure 2. Crt display of output of 2nd i.f. (detected). Each cm = 6 Mc. Note that frequency is read from right to left on Spectrum Analyzer displays.

The crt spot begins its sweep at the 0 centimeter mark at the left-hand side of the graticule. The S.L.O., in step with the crt spot, is now at the low-end of its frequency range, or 230 Mc. No output is observed, as discussed above; the spot is not deflected vertically. The S.L.O. sweeps through a range of 60 Mc. Thus, a complete sweep of the horizontal represents 60 Mc also, and each major graticule line represents 6 Mc (assuming a normal 10-cm scan, of course). When the beam reaches a point 1.4 cm from the left-hand side, the S.L.O. is sweeping through 240 Mc. This produces an output corresponding to the 180-Mc input signal and the crt beam is deflected vertically. The beam then passes through the 5-cm mark at which time the S.L.O. passes through its mid-range, or 260 Mc. At this time, the crt beam is deflected again, indicating the 200-Mc input signal on the crt. Likewise, the 220-Mc signal is displayed at the 8.6-cm graticule line. The sweep is repetitive in normal operation and the result is a display similar to Figure 2. Note that the highest-frequency signal appears on the left-hand side. Frequency is read from *right to left.*

The previous example considered the S.-L.O sweeping through a 60-Mc range. This affords a "look" at a 60-Mc piece of the electromagnetic spectrum. The S.L.O. was set at maximum *dispersion* (range of frequencies swept by S.L.O.). The portion of the spectrum under analysis can also be narrowed. This is accomplished by decreasing the dispersion. If we set the dispersion at 20 Mc, the S.L.O. will sweep from 250 Mc to 270 Mc. Note that its center frequency is *still* 260 Mc, as before. Figure 3 shows the display obtained on the simplified spectrum analyzer, using this dispersion.

When the S.L.O. begins its sweep at the dispersion setting of 250 Mc, the 180-Mc signal at the input of the 2nd mixer is heterodyned to a frequency of 70 Mc. This falls outside of the bandpass of the 2nd

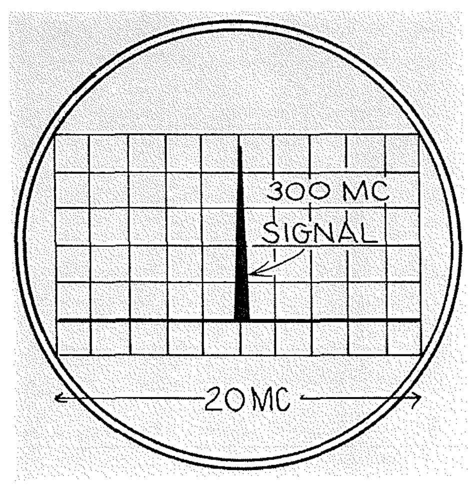


Figure 3. Dispersion, or bandwidth, set at 20 Mc. Each cm = 2 Mc.

i.f., which is tuned to 60 Mc. The 200-Mc signal produces a 50-Mc difference and is not accepted by the 2nd i.f., either. The 220-Mc signal produces an even lower beat; 30 Mc, which is well outside the bandpass of the i.f. As the S.L.O. passes through 260 Mc, the 200-Mc signal from the 1st i.f. produces the 60-Mc beat signal which is accepted by the 2nd i.f. The S.L.O. sweeps to 270 Mc and the same arithmetic proves that no other signal is displayed. Thus, of the original three signals, only one is displayed. The other two fall outside the area "scanned" by the S.L.O. In effect, we have narrowed the "window", through which we observe a portion of the spectrum, in order to take a closer look at it. (A good analogy would be a zoom movie camera that closes in on a subject.) As the dispersion of the S.L.O. is narrowed to sweep a smaller range of frequencies, we "close in" on the center portion of the output of the first i.f. As the observed portion still fills the entire horizontal sweep of the oscilloscope, the signal is spread out more. This gives better resolution in the case of closely-associated sine waves.

Figure 4 represents a display with the dispersion set at 10 Mc. Note that an upper and a lower side-band are beginning to emerge. Although at first we could not see them, these sidebands were associated with the 200-Mc signal all along. With a wide dispersion, the resolution was so poor, they all blended together. The following circuitry of the analyzer can spread, or resolve, these signals even more.

A front-panel vernier labeled "Center Frequency", controls a dc voltage to the S.L.O. This provides a slight shift of the S.L.O. center frequency. This is useful for lining up the display with a desired graticule line for subsequent measurement.

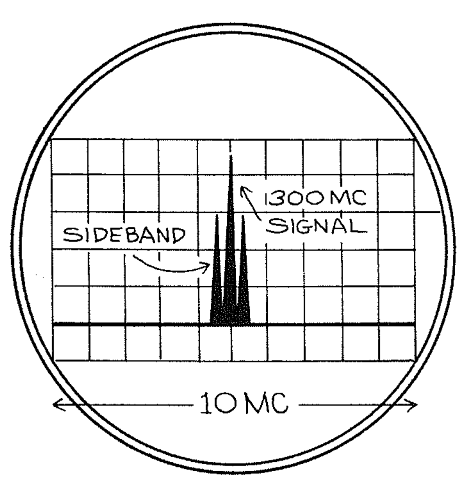


Figure 4. Dispersion set at 10 Mc. Note emergence of sidebands.

Because of the wide range of possible input voltages, a 1 to 51-db attenuator network is inserted between the 2nd mixer and the second i.f. In addition, the second i.f. also has a "Variable Gain" control on the front-panel.

A THIRD I.F. IS ADDED

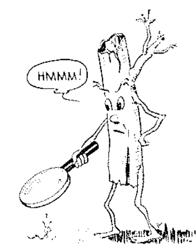
The output of the 60-Mc 2nd i.f. is still too broad for resolution of closely-associated signals. So we convert a 3rd time! A 3rd L.O., operating at a fixed frequency of 65 Mc, beats in the 3rd mixer with the 60-Mc output and produces an i.f. frequency of 5 Mc. This signal is fed into the 3rd i.f. which is fixed-tuned to 5 Mc. This i.f. has variable bandwidth and can be changed from 1 kc to 100 kc. Therefore, we can vary the resolution by changing the actual bandwidth of the i.f. stage. The output of the 3rd i.f. is fed to the detector.

THE DETECTOR CIRCUIT

All signals appearing at the input of the detector circuit are both positive and negative. We have no need to display the entire signal because one-half of it would simply mirror the other. So the signals are detected, or rectified, and passed on to a video amplifier.

The detector circuit provides three different outputs: LINEAR, LOARITHMIC, AND SQUARE-LAW. We'll consider each in turn.

The LINEAR output increases proportionally as the input increases. In other words, if an input voltage to the detector causes a crt deflection of 4 cm, doubling the input will cause a crt deflection of 8 cm.



The LOGARITHMIC output reflects a decrease in the gain of the detector circuit as the input is increased. This has the effect of compressing the larger input signals and increasing the dynamic range of the detector input. The output is proportional to the log of the input signal to the detector. The crt vertical deflection increases as the *square* root of the input voltage. This is equal to the db gain of the display. Increasing the input amplitude by a factor of 4 only doubles the height of the vertical display.

(Part 2, which concludes this article, will appear in the forthcoming June, 1965 issue of SERVICE SCOPE.)

TEKTRONIX PART-NUMBERING SYSTEM EXPANDED

We, at Tektronix, Inc., recently expanded our part-numbering system from six to nine-digit numbers. Several factors necessitated this change. One factor given major consideration was our desire to give ever more effective support to our customers. The expanded part-numbering system will work to that end.

What we've done is merely to expand the existing part number. The change won't require much getting used to on the part of the customer. (For example, parts categories will remain as they are.)

If a customer's original purchase order used six-digit numbers, here's how he can check his parts against the new numbering system:

Here is the familiar Tektronix part number as our customers know it:

524-268

All we've done is move the description digits (the three digits following the hyphen) one place to the right:

524- 268

Drop in a zero:

524-**0**268

and add a two-digit suffix:

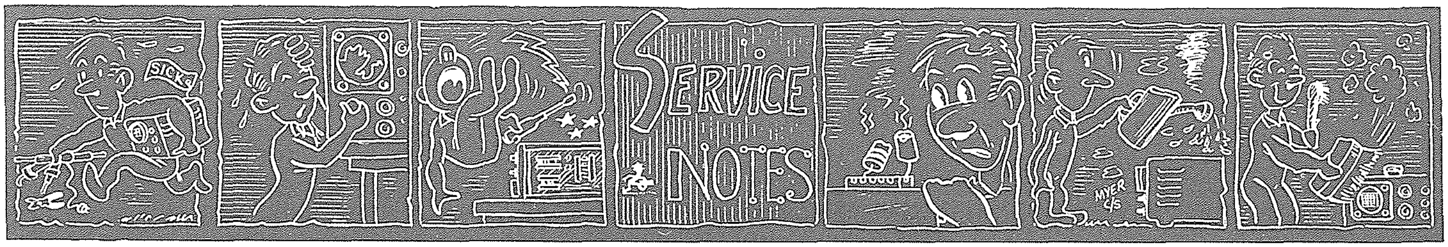
524-**0**268-**00**

That's all there is to it.

This method will work for all Tektronix six-digit part numbers except those few having an alphabetical suffix — 154-058A for example. For help in converting these to the new nine-digit part numbers, please consult your local Tektronix Field Office, Field Engineer or Representative.

During the transition period to our new system, the numbers on the parts customers receive may not jibe with those on the invoice we send. When this happens, by just applying the above simple steps in reverse the customer will find it was the same old part number all the time.

We hope this information helps. In the meantime, we appreciate our customers' cooperation and thank them for their patience while we make this necessary change.



SILICONE GREASE FOR TRANSISTOR HEAT-SINK USE

The need for the use of silicone grease in mounting heat-sinked transistors is apparently not well known.

The maximum power which may be dissipated in a transistor is limited by its junction temperature, T_J. An important factor in determining junction temperature is the ability to conduct heat away from it. There are several "thermal resistances" to be considered in series with heat transfer from junction to ambient air.* Figure 1

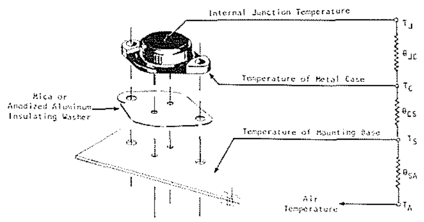


Figure 1. Electrical analog of heat path in a heat-sinked tronsistar. θ_{jc} = Thermal resistance of junction to cose bond. (Controlled by manufacturing process only.) θ_{cs} = Thermal resistonce of mounting. (Silicone grease can improve surface contact between tronsistor ond mounting surface.) θ_{sa} = Thermal resistance of "heat sink" or mounting base. (Usually a designed in factor after other elements have been optimized.)

shows an electrical analogy of these separate "resistances". One of these θ_{cs}, is the thermal resistance from case to heat sink and is influenced by the method of mounting. If a mica insulating washer is used dry, the junction temperature rise per watt of power dissipated is about 1.0°C due to θ_{cs} *alone*. This is mainly due to irregularities in the surface resulting in dead air spaces which do not readily transfer heat. See Figure 2. One way to over-

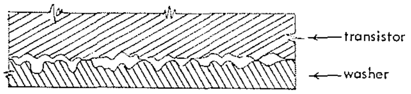


Figure 2. How a magnified cross-section view of the surface might look.

come this difficulty is to fill the dead air spaces with a substance superior to dead air in thermal conduction. Nearly anything is better than dead air, but silicone grease has the advantage of being a good electrical insulator while readily conducting heat. The use of ordinary silicone grease (like Dow-Corning DC-4) can reduce the above mentioned 1.0°C rise per watt of power to about half, and some of the new types of grease bearing metallic oxides claim reductions to the area of 0.1°C/w. As an example, this would mean a difference of 22.5°C in the junction temperature of a power transistor dissipating 25 watts.

Of the many readily available silicone dielectric compounds, we recommend Dow Corning Type 4 or Type 5 Silicone Compound for heat-sink use in current Tektronix instruments. These types of silicone grease we know will meet the thermal conductivity requirements and temperature range requirements of our "environmental" instruments.

As previously mentioned, there are some other types of silicone greases containing metallic oxides which increase thermal conductivity. However, we haven't fully tested the special metal oxide-bearing "Silicone Heat Sink Compounds" so we are not sure that they will meet our environmental temperature range requirements. This is, the ability to retain the desired fluid consistency from the lowest (storage) to the highest temperature range that any of our instruments are specified to operate over; and, the range of temperatures that could occur at the point in the instrument where the grease is used.

A practical general rule is to use silicone grease whenever replacing *any* heat-sink-mounted transistor. Apply a thin film of silicone grease between the transistor case and the heat sink. The error, if any, in the amount used should be on the generous side. (The excess that squeezes out when the mounting bolts are tightened can be neatly wiped off.)

If a mica or other type electrically-insulating washer is used between the transistor and heat sink, apply a thin film of grease to both sides of the insulating washer as well.

In some cases (such as the Type 547 Oscilloscope Vertical-Amplifier output transistors), the transistor is electrically insulated from the chassis by a white beryllium oxide disk. If you remove the heat-sink disk, you should also apply silicone grease where the disk contacts the chassis.

The Dow Corning Type 4 Silicone Compound is available in 2 oz. and 8 oz. tubes through electrical and electronic supply houses.

*For a more complete analysis of thermal characteristics, see "MOTOROLA POWER TRANSISTOR HANDBOOK", copyright 1961.

A CORRECTION

In the article "Some Basic Sampling Concepts Reviewed" which appeared in the February, 1965 issue of SERVICE SCOPE, one line is missing.

On page two at the bottom of column one, the line " . . . fully charged to the error voltage across . . . " should be added. Properly corrected the sentence, which begins five lines up from the bottom and in the center of the column, should read: "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 one sample".

The type was set correctly but somehow in the mechanics of production this line was lost in the shuffle.

Our sincere apologies to the author and our readers for this omission from an otherwise excellent article.

The Editor.

C12, C13, C19 and C27 TRACE-RECORDING CAMERAS—CLEANING AGENT FOR FOCUS PLATE

Any of the liquid dishwashing detergents (Joy, Vel, Lux, Swan, etc.) performs effectively as a cleaning agent for the focus-plate assembly supplied with these cameras. Used in fairly concentrated form, these readily-available detergents will easily remove oily residues as well as ordinary dust and dirt.

As a rule of thumb, you should avoid most all organic solvents such as Fotocal, Socal, flux remover, trichlor, etc. These agents will attack either the Plexiglass plate or the silk-screening. One which you can use without harm, however, is DuPont Freon TF. This is available locally from your chemical supply house.

TYPE 262 PROGRAMMER — RESISTOR KITS

The Type 262 Programmer Instruction manual, on page 2-8, tells how to place the No-Go Limits on a program card by soldering resistors to the NO-GO LIMITS terminals. On this same page Table 2-1 lists the required resistor values and the corresponding numbers.

The resistor values listed are available in a kit. Each kit contains a total of 176 resistors. These are ¼ w, 1%, precision (Std Mil-Bel) resistors in the following quantities and values:

Quantity	Value	Number
36	887 Ω	0
25	1.58 k	1
20	2.26 k	2
20	3.01 k	3
10	3.83 k	4
25	4.64 k	5
10	5.49 k	6
10	6.34 k	7
10	7.15 k	8
10	8.06 k	9

These kits are available through your Tektronix Field Engineer, Representative, local Field Office or Distributor. Ask for Tektronix part number 016-0056-00.

TYPE 3T77 SAMPLING SWEEP UNIT AND TYPE 3S76 DUAL-TRACE SAMPLING UNIT — TRIGGER-TO-VERTICAL KICKBACK

Sometimes, when a Type 3S76 Dual-Trace Sampling Unit is set to trigger internally from either A or B Channel, a certain amount of sweep gating voltage from the Type 3T77 Sampling Sweep Unit gets coupled into the vertical channel.

This voltage will appear on the displayed waveform. You can detect the aberrations with the sweep free running at 5 nanoseconds per division and sensitivity set at 2 mv per division. Their amplitude is affected by what might be connected to the input and is least with no signal applied.

An additional decoupling capacitor placed between the base of Q14 (the trigger input isolator in the Type 3T77) and ground will usually reduce the amplitude of the aberrations to a negligible amount. We recommend a 500 pf capacitor (Tektronix part number 283-0025-00). Solder the capacitor in place without leads (if possible) right at the point where the base lead of Q14 transistor socket emerges from the socket. A word of caution here. Too long leads on the capacitor or a sloppy soldering job will aggravate rather than relieve the difficulty. Perform your work carefully, neatly and with a critical eye.

BEER-CAN OPENER WEARS TWO HATS—The so-called "church key" type beer-can opener makes a handy tool for removing the large copper-clad staples used to close and secure the cartons in which Tektronix instruments are shipped. A carelessly used pliers or screw-driver employed to remove these staples can eject them with sufficient force to endanger the eyes or appearance of surrounding personnel. The bottle-top opening end of the ubiquitous beer-can opener works almost as well as a commercial staple-removing tool. It eliminates the hazard of flying staples and—the price recommends it. Our thanks to Rick Le Forge, Field Engineer with our Van Nuys Field Office, for passing on this information.

NEW FIELD MODIFICATION KITS

TYPE 5T1 TIMING UNITS — TIME-EXPANDER AND GENERAL IMPROVEMENTS

This modification improves the performance and versatility of the Type 5T1, s/n's 101 through 996, to nearly correspond with that of the Type 5T1A. The modification adds to the SAMPLES/CM switch a '1000' position for greater display resolution; and, a TIMED slow-scan position for use with a Y-T recorder. A new front-panel, screwdriver adjusted potentiometer adjusts the TIMED scan speed between the limits of 5 to 8 sec/cm (approx.).

The modification adds a TIME-EXPANDER control which provides X1, X10, X20, X50 and X100 sweep 'magnification' but does not affect the number of samples per centimeter.

A TIME-POSITION control replaces the old TIME-DELAY control. This new control supplies a variable time-delay for positioning the signal display when the TIME-EXPANDER switch is in the X1 position. In the expanded positions, the TIME-POSITION control moves the time 'window' anywhere within the original range displayed in the X1 position of the TIME-EXPANDER switch.

A new Fast-Ramp board with improved linearity for the Fast-Ramp waveform replaces the original Fast-Ramp board.

Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-0311-00.

TYPE 5T1 AND TYPE 5T1A TIMING UNITS — IMPROVED SINE-WAVE TRIGGERING

By providing a high-frequency mode of operation, this modification reduces jitter and improves stability when triggering on high-frequency sine waves. The operating procedure for the instrument is not altered. To synchronize on high frequencies, the THRESHOLD control is simply advanced into the free-running portion of its range. Both positive and negative trigger circuits are modified for improved performance.

This modification applies to Type 5T1 Units, s/n's 101 through 996 and Type 5T1A Units, s/n's 997 through 2089. Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-0390-00.

TYPE 2A61 DIFFERENTIAL PLUG-IN UNIT — INCREASED DYNAMIC RANGE

This modification replaces C437, a 13000 μf capacitor, and its protective diodes, D437 and D438, with a larger non-polarized capacitor. It also adds tube shields to V484 and V584 to prevent negative feedback caused by capacitor-tube coupling. The net result is an increase in the range of the Type 2A61's dynamic "window" from ±90 mv to better than ±300 mv. The improvement is in the 0.01, MV/DIV through the 0.5-MV/DIV attenuator positions.

(Please note: The increased value of C437 increases the time constant of the circuit to a dc input.)

This modification is applicable to Type 2A61 Units, s/n's 100 through 986. Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-0361-00.

TYPE 2A61 DIFFERENTIAL PLUG-IN UNITS—NOISE AND DRIFT REDUCTION

This modification minimizes drift and reduces low-frequency noise and microphonics when the plug-in is used in the differential mode.

By replacing the floating preamplifier chassis with one that utilizes nuvistors in special, heat-stabilizing shields, and changing the circuitry to permit greater stability of the DIFF BAL control, the modification accomplishes its purpose.

This modification applies to Type 2A61 Units, s/n's 100 through 986. Order through your local Tektronix Field Engineer, Field Representative, Field Office or Distributor. Specify Tektronix part number 040-0397-00.

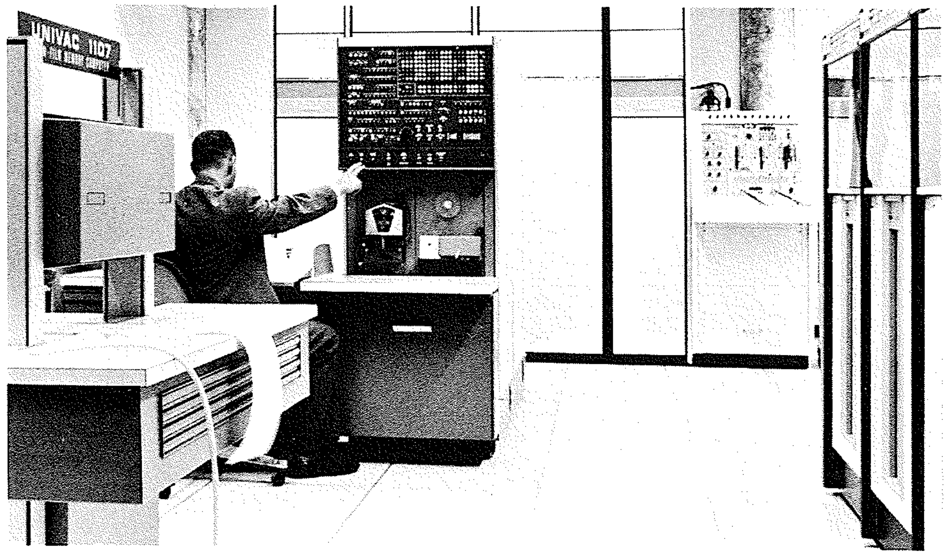
TORONTO TRAFFIC CONTROL SYSTEM USES TEKTRONIX OSCILLOSCOPE

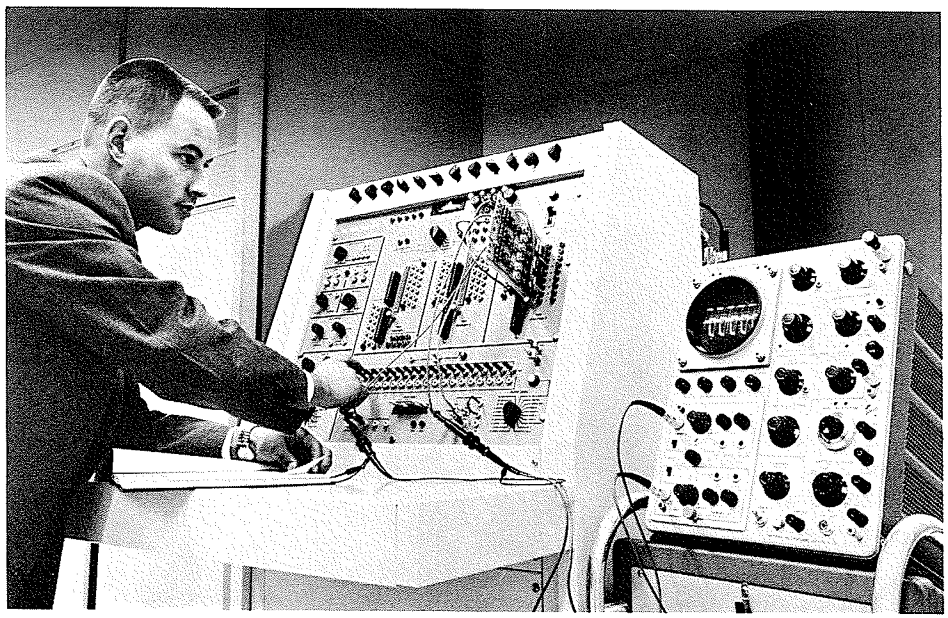
At the new Traffic-Control Center in Toronto, Canada, a Tektronix Oscilloscope aids the engineer in preventive maintenance. This new automatic traffic-control installa-ation uses thousands of printed circuit cards in the UNIVAC 1107 Thin-Film Memory Computer.

In the larger photo on this page, an engineer observes waveform displays on a Tektronix Oscilloscope. The waveforms are from a printed circuit board undergoing tests in the card analyzer shown to the left of the oscilloscope. This is a preventive maintenance test accomplished quickly and reliably with a card analyzer and Tektronix Oscilloscope. The tests give the engineer added assurance of computer proficiency in daily work of traffic simulation and analysis.

The smaller photo, taken at City Hall in Toronto, shows the UNIVAC 1107 Computer (left), the special-purpose Traffic Control Computer (center), and the card analyzer featured in the larger photo (right). Here the engineer is checking the console of the control computer which accumulates data at high speeds from traffic-detector sensors in metropolitan Toronto's new traffic-control system.

The computer-based system, which was designed by the UNIVAC Division of Sperry Rand Corporation, continously and automatically analyzes movement of vehicles within a controlled area of intersections. It will, sometime in 1965, control traffic flow at over 1000 intersections.





GRATICULE SWITCHING A PROBLEM? TRY THIS

Mr. Edward G. Morgis, Maintenance supervisor at Trans Canada Telemeter, offers a suggestion that will interest oscilloscope users who must interchangeably use graticules scribed as regular rasters and in Percentage of Modulation.

Mr. Morgis uses a 6 x 10-cm graticule (Tektronix part number 331-0037-00) and a TV graticule (Tektronix part number 331-0009-00) sandwiched in between the green filter and the bezel. He positions the two graticule lights so that one lights the front graticule, the other the rear graticule.

He replaces the scale-illumination potentiometer with a 75-ohm wire-wound potentiometer. By electrically placing the potentiometer between the two graticule lights with the center tap connected to 6.3 volts, the control acts like a "fader". Full rotation to either end of the control will illuminate one graticule leaving the other invisible.

Naturally, illumination of either graticule by only one light will not afford as even a raster as using both. Also, some increase in parallax will be apparent when using the front graticule. But if your work requires you to change graticules often, these negative features may be a minor consideration compared to the convenience Mr. Morgis' modification affords.

USED INSTRUMENTS FOR SALE

The University of Alberta Hospital in Edmonton, Alberta offers the following instruments for sale:

1—Type 551 Oscilloscope, s/n 002951
1—Type CA Plug-In Unit, s/n 026921
1—Type Q Plug-In Unit, sn 00525

Equipment is in very good condition. Contact: Mr. R. M. Allen, Asst. Purchasing Agent. Telephone: 439-5911.

TO OUR READERS

Do you have an item of local origin or interest that you would like to see in Service Scope? If you have send the information to Mr. E. C. von Clemm, General Manager, Tektronix Canada Ltd., 5050 Sorel Street, Room 12, Montreal 9, Quebec.

Items, in general, should relate to oscilloscopes and associated instruments. Ways and means that you have found helpful in using and maintaining your instruments may aid someone else to do a better job. Unique applications are often interesting, also.

We can not guarantee that all items received will be used in Service Scope. We can assure that all items will be thoughtfully considered and those that we feel have a broad appeal will be used. The decision as to which articles meet these objectives must be the responsibility and perogative of the editor.

Service Scope

USEFUL INFORMATION FOR

USERS OF TEKTRONIX INSTRUMENTS

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

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P.B. METER 336216

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

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