CHAIRMAN TAYLOR: Thank you very much. Does anyone have any questions?

I have a question regarding the effects of cross-modulation on the weaker carriers in a system. If we take a hypothetical case involving one strong carrier and say 8 or 9 weak ones, does the cross-modulation affect all channels equally or is there a difference?

MR. SIMONS: At this point I believe it is necessary to bring out something that was not stressed in my paper. In this presentation I have been talking about "mathematical" amplifiers. By a "mathematical" amplifier, I mean one which follows exactly the same way at all frequencies. With such an amplifier the cross-modulation from all channels on to any one channel would be identically the same.

The unfortunate thing about this approach is it doesn't work. Real-life amplifiers just don't behave this way. Generally speaking, the cross-modulation which shows up on any one channel in an amplifier is not the same as that showing up on any other channel. These differences are not very great so it is still useful to consider the "mathematical" amplifier as an approximation, but the differences are such that we must measure all combinations of channels if we are to be sure of amplifier performance. Generally speaking, there is no difference between weak channels and strong channels, the difference has more to do with the frequency of the particular channel.

CHAIRMAN TAYLOR: Are there any other questions? Thank you very much, Ken. I think it is quite significant in a matter with which I am quite pleased at this convention that we have several systems operators presenting ideas that they have developed in their systems which can be of use to other operators. This is so in the next paper.

Mr. Robert Scherpenseel is the general manager and microwave technician for the Northwest Video of Kalispell, Montana, a system I know a little about. He was chief engineer with WEVR FM of Troy, New York, chief engineer with KBTK radio, and engineer with KMSO-TV electronics technician at Montana State University in installing and maintaining their television and radio and recording systems. Mr. Scherpenseel is going to talk on "A Low Cost TDR". (Applause)

A LOW COST T.D.R.

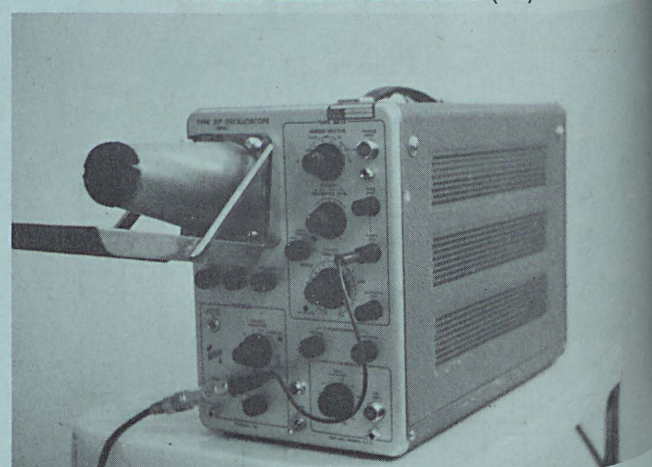
By

Robert H. Scherpenseel

We are probably being a little facetious in calling this instrument a low cost time domain reflectometer. The 1967 catalogue price is $875.00. In a way it is a TDR but with limitations.

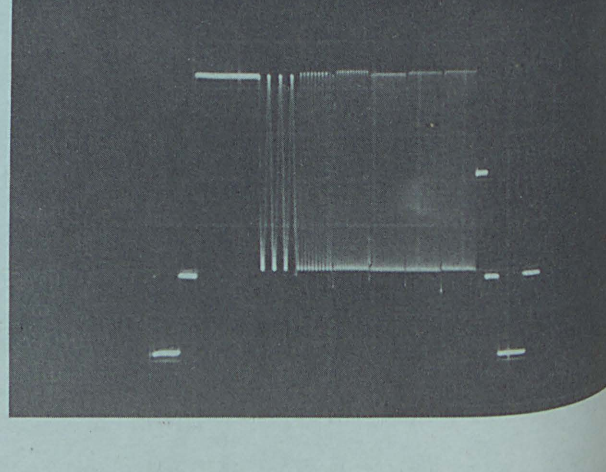
Actually, it is a high quality oscilloscope that has a calibrated time base and a vertical amplifier with a pass of DC to 10 megaHertz. This is a limiting factor cause no determination can be made concerning the quency characteristics of the information displayed 10 megaHertz.

NEXT SLIDE PLEASE (#2)



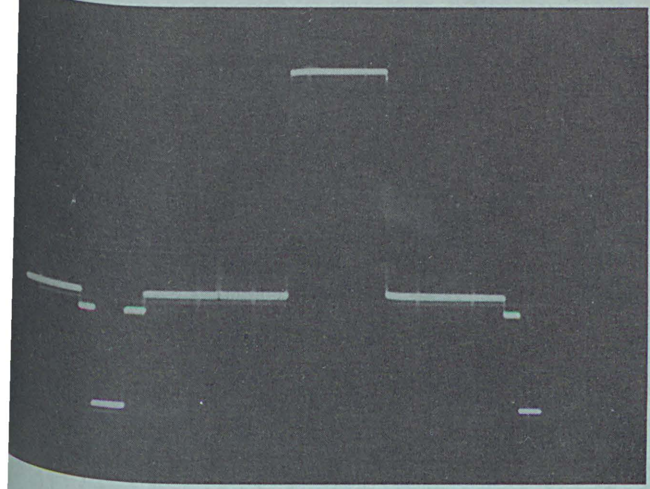
This is a picture of the scope with the camera in place.

NEXT SLIDE PLEASE (#3)



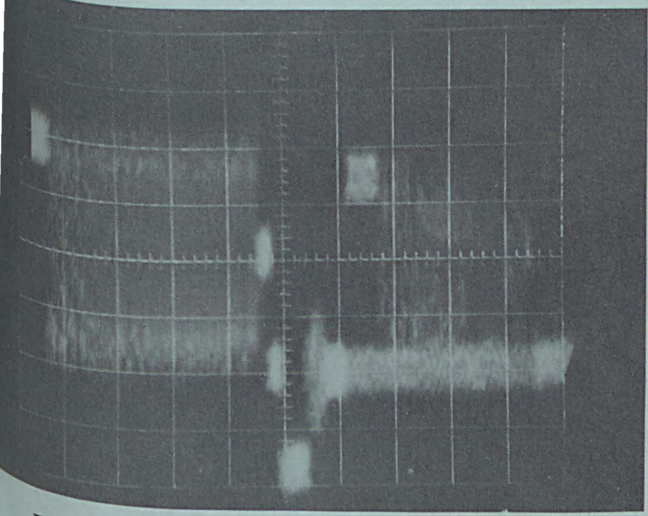
This unit is primarily used in our work for the -play of video wave forms. This is the familiar ilti-burst signal directly from a signal generator.

NEXT SLIDE PLEASE (#4)



This slide is the sine squared and window signal lso from a generator.

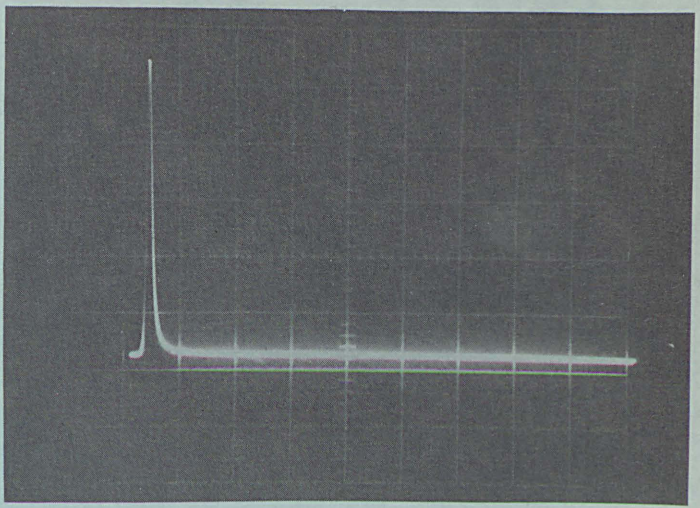
NEXT SLIDE PLEASE (#5)



By an adjustment of the trigger control, we can atch a fleeting glimpse of the vertical interval test signals. The multi-burst on the left is from a Riker test signal generator injected at our microwave terminal and the one on the right is one from network received off the air. This is not the best of pictures but it illustrates that VIT's can be observed with this scope.

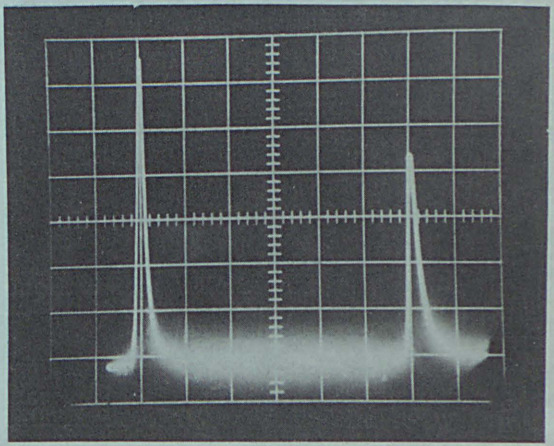
The time domain reflectometer portion is simply the plus gate output. This positive pulse, which starts at ground and rises to approximately 0 volts, has a start and duration coincident with that of the sweep portion of the sawtooth. It CANNOT be directly coupled to a cable for testing because the amplitude is too great. If we try to examine the top of the square wave closely to observe the reflection by increasing the scope gain, it is lost from the display area. If we feed this signal through a small capacitor .001 and a resistor 75 ohms it becomes a spike.

NEXT SLIDE PLEASE (#6)



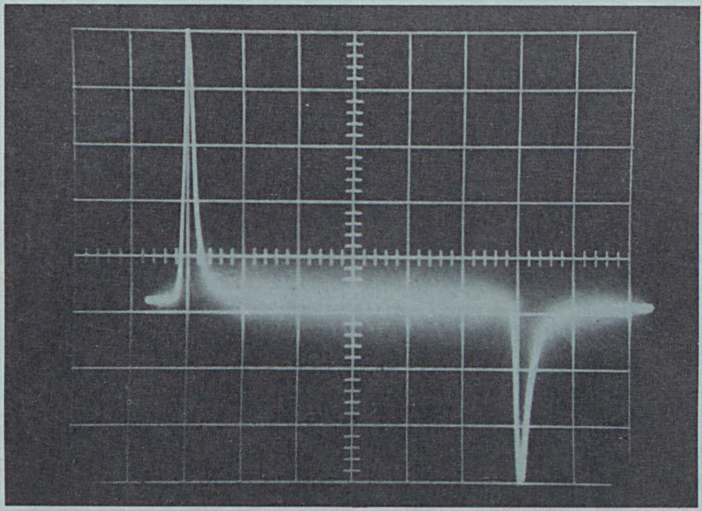
The base line then displays the reflections in the cable under test. Since we know that radio waves travel at the speed of light (186,000 miles per second) and by multiplying this by feet in a mile, we know how far they travel in one second. Our scope time base is calibrated in fractions of a second, we then can determine what each division on the graticule is worth in terms of feet. Using the velocity of propagation of the various types of cable we can then determine how far it is to a discontinuity and back. In foam diaelectric cable using a velocity of propagation .82 times the speed of light, the pulse travels about 800 feet in one microsecond so then one microsecond is equal to about 400 feet of cable because the pulse has to travel to a discontinuity and the reflection returned. If we are using solid polyethylene cable the velocity of propagation is .66 times the speed of light and the pulse only travels about 650 feet in one microsecond. This is equal to half that, or 325 feet of cable. There are some cables with different propagation factors but these two just mentioned are the most common and work quite well for us.

NEXT SLIDE PLEASE (#7)



This slide shows about 1200 feet of foam cable with the end open. The scale horizontally is .5 microseconds per division, equal to 200 feet of cable - vertically is .1 volts per division.

NEXT SLIDE PLEASE (#8)



This is the same cable with the ends shortened.

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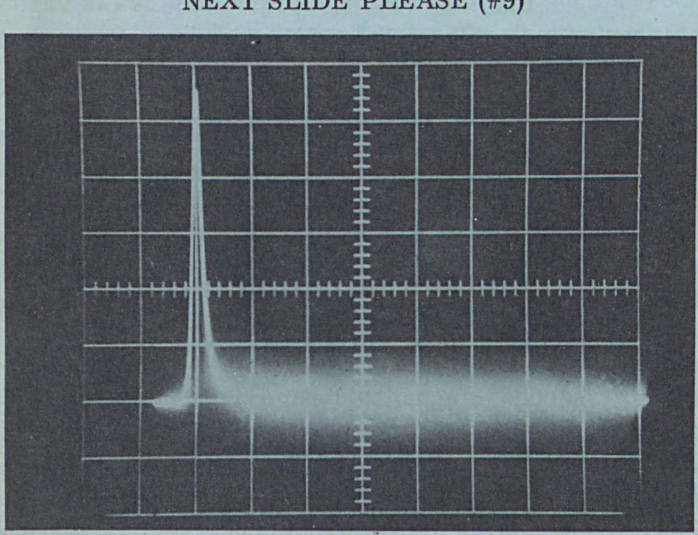

This is the same cable with the end terminated with a 75ohm resistor.

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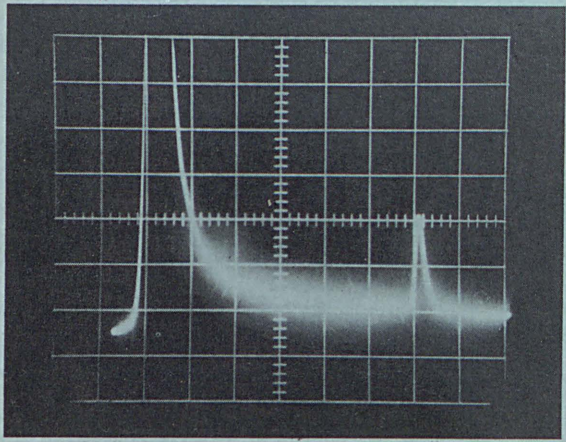

This is the same cable with the end still terminated with the gain of the scope at maximum and we begin to see some of the physical defects in the cable.

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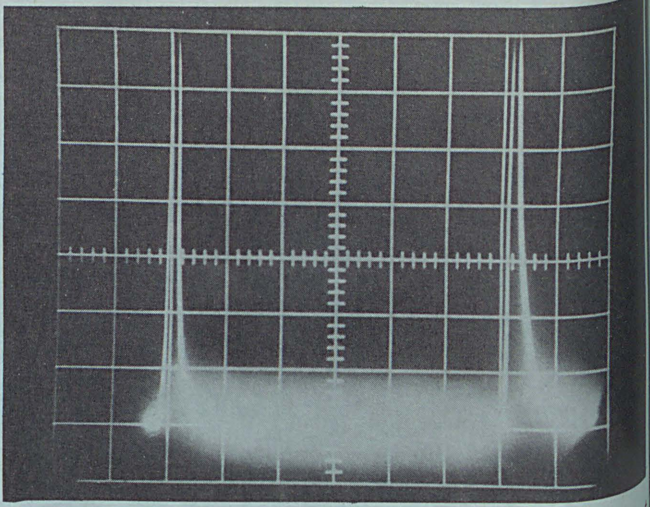

The scale here is 1 microsecond per cm., or about 400 feet per division over 6 divisions equals about 2500 feet. Here we see about 2500 feet of two types of cable. The first 1400 feet is fairly new cable with a splice at 1100 feet and another splice at 1400 feet. The remaining is older cable that has been in the air for a number of years.

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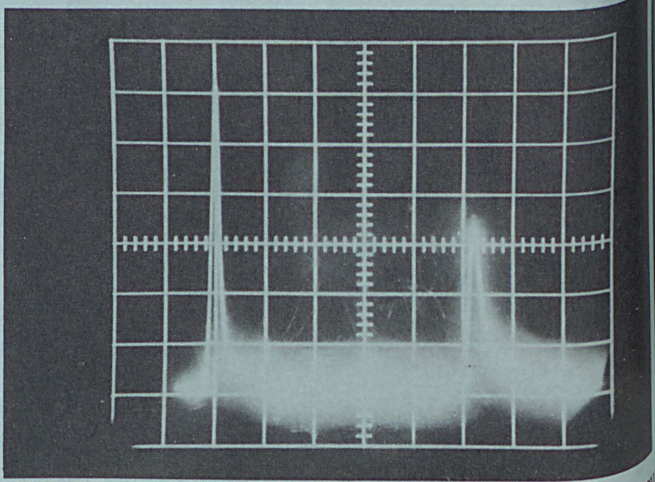
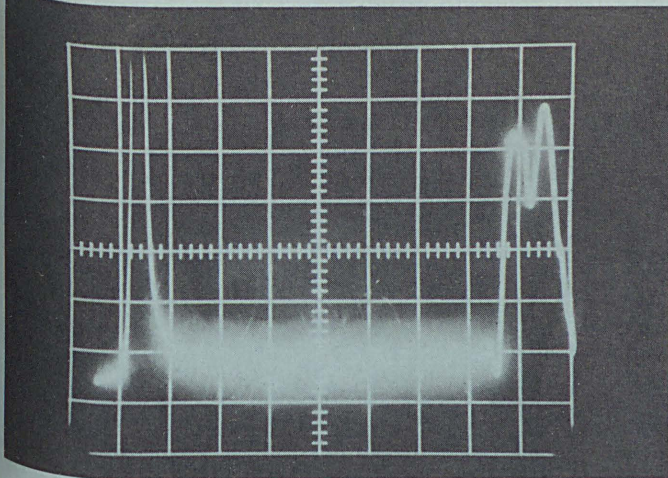


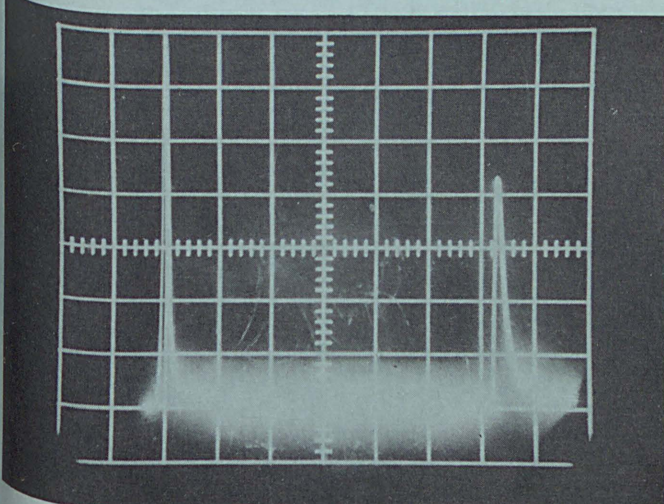
Here the scale is .5 microseconds per cm., or equal to 200 feet per division. This is about 1050 feet of cable with a pressure tap and ending in a two-way splitter. This doesn't mean the splitter isn't good because, as I mentioned earlier, we are limited to physical factors because of the band width of the scope.

NEXT SLIDE PLEASE (#13)



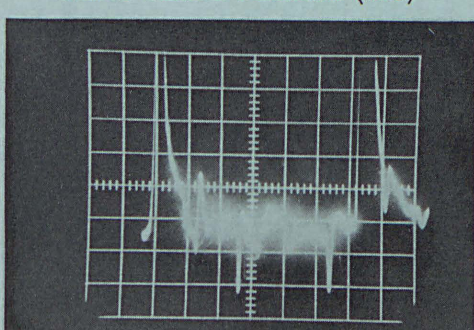
The scale here is .5 microseconds per cm., over 7 divisions or 1500 feet. This is about 1500 feet of cable with taps at 200 feet, 400 feet, 600 feet and another splitter at the end. Probably one or both of the legs of the splitter are not properly terminated.

NEXT SLIDE PLEASE (#14)



Scale is 1 microsecond per cm., or 400 feet per division. This is about 2500 feet of cable with two pressure taps and an amplifier at the end of this 2400 feet. This end looks open but again we are not making conclusions as to frequency.

NEXT SLIDE PLEASE (#15)



This is the same cable with the scope gain at maximum.

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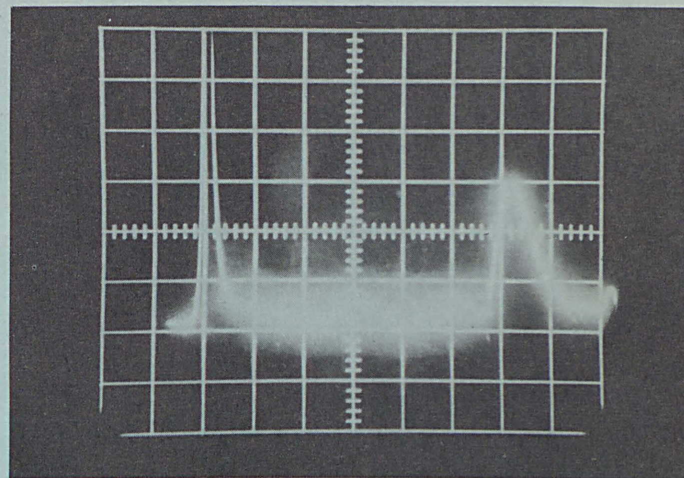
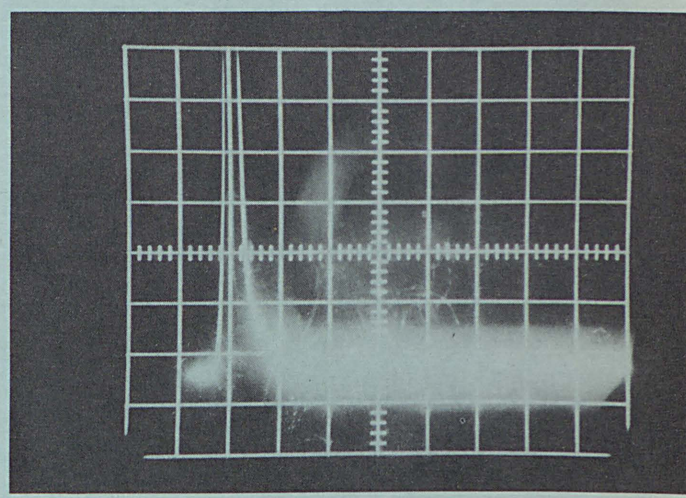


This is .5 microseconds per cm., with 200 feet per division. This is about 1200 feet of cable with two pressure taps and ending in a splitter. The termination of the legs of the splitter appears normal.

NEXT SLIDE PLEASE (#17)



.5 microseconds per cm. Here is about 700 feet of feeder line that is pretty bad. If you were to cut into this piece you would probably find the outer conductor black and drops of water all through the foam.

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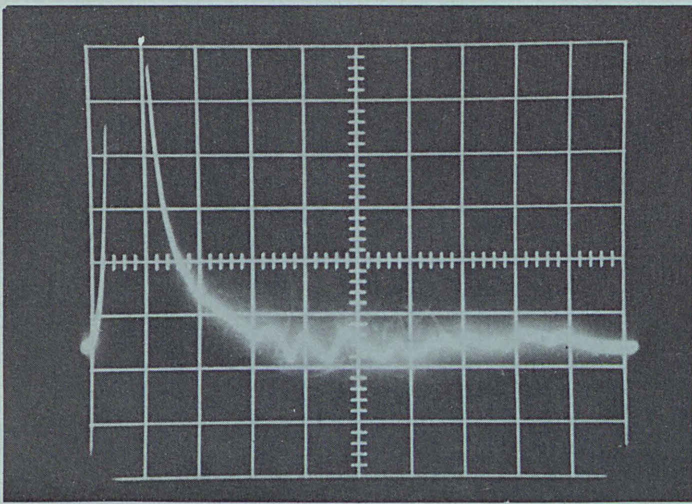


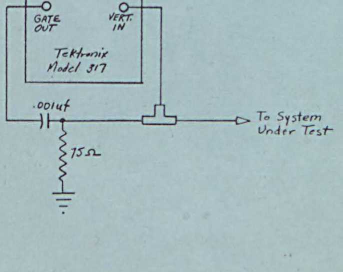
This is the same cable with the time base of the scope changed to .2 microseconds per division and the gain increased to .05 volts per division. At this setting of the scope, each division is worth about 80 feet of cable and you can see it is well riddled with reflections.

You have seen a few examples of what this type of testing can produce and with practice you can evaluate what is seen on the trace. We use this almost daily on our system, if not on the lines - in the shop for measuring partial reels of cable or displaying video wave forms from our microwave terminals.

For those interested in photography, the slides were taken using a 35 mm camera with a set of three portrait lenses attached. The lens opening of F4 and a shutter speed of 1/15 of a second and Ektachrome high speed type B film. We also take Polaroid pictures of wave forms using an old model 95 Polaroid camera and high speed film. Our total investment, including the "custom" mount for the scope is $100.00.

CHAIRMAN TAYLOR: Thank you very much. Are there any questions?

MR. SCHERPENSEEL: Somebody asked me to draw the diagram of the differentiating circuit, and I had better do that.



CHAIRMAN TAYLOR: Are there any other questi

Don't you have a tendency to do a lot of unnecess work of checking equipment when this doesn't check fr quency?

MR. SCHERPENSEEL: No, we are looking for fa This is a fault finder. We know and we check both end and you can see what is going on in between.

CHAIRMAN TAYLOR: Are there any other questi

This is not a question, but we have a lot of system that cannot afford a TDR or something similar, and the use the same technique on a television set for ghosting conditions. What they do is look at the output of the amplifier with a "T" monitor and by taking a ratio between the ghost and the width of the screen they can determine the location.

CHAIRMAN TAYLOR: Thank you very much. Do y have any other questions or contributions?

From your title it seems to me it is "A Low Cost TDR," but when I look at the picture you have a fairly high priced scope. I wonder where the saving is?

MR. SCHERPENSEEL: It is relative. The TDR is around $3,000. It is all relative.

CHAIRMAN TAYLOR: Are there any other questio If not, we will take a short break for a moment.

(A short recess was taken.)

CHAIRMAN TAYLOR: It is always a pleasure at these functions to have guests from our Sister Country o Canada. Our next speaker, I. Switzer, was born and educated in Calgary, Alberta. He received his B.Sc. degree in physics from the University of Alberta in 1949 and spent three additional years in post graduate study in physics.

His professional experience includes a number of years in electronic instrumentation and mathematical problems in petroleum geophysics, several years in applications analysis and programming in the electronic computer field, and association with the CATV field since 1954.

Mr. Switzer was a charter member of the Board of Directors of the Computing and Data Processing Society of Canada. He has been a director of National Communi Television Association of Canada for a number of years. He is a member of I.E.E.E., S.M.P.T.E., and the British Society of Relay Engineers.