MULTIPLE OSCILLOSCOPE TRACE GENERATION FOR ANALOG COMPUTERS

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In many training and simulation situations, which utilize analog computers, it is desirable to have the option of viewing multiple, independent displays on a single cathode ray tube. However, most small analog computers are equipped only with a single trace capability oscilloscope and the added expense of purchasing a multitrace unit often cannot be justified. Furthermore, general purpose multitrace oscilloscopes are limited in the number of traces which can be produced and do not usually permit one to generate simultaneous X-Y and X-t displays.

At Florida Technological University the analog computer system consists of an Applied Dynamics Corp. model AD-5 computer equipped with four remote, time shared terminals, each of which is equipped with a single trace storage oscilloscope for display. While investigating a manual tracking problem we found that at least three independent traces were required at each of the four terminals. Therefore, a multitrace display system operating under computer control and utilizing the existing single trace oscilloscopes was designed. The main design requirements for the system were first, that it provide maximum applications flexibility since the computer is used by a number of individuals for research as well as instruction. Second, the tracking problem being studied called for a minimum of three traces, each to be independent of the others with respect to amplitude, position, and timing. Third, the limited computing power of the machine necessitated a design which would not decrease the machine's computing capability significantly. The figure depicts the system which was finally chosen. This system is completely under machine control and requires neither external circuitry nor machine integrators.

The six input signals, which can be either internally generated by the machine or externally generated, are brought to the inputs of six individual summing amplifiers, as shown in section 1 of figure 1. The potentiometer at the second input of each amplifier is used as a positioning control.

In section 2 the outputs of these amplifiers lead to a device peculiar to the AD-5 computer, the switching amplifer. The switching amplifier is a standard summer amplifier whose inputs can be switched off independently by a standard TTL logic signal. Such a signal can be generated elsewhere in the computer.

The switching amplifiers in section 3 merely collect the various switched inputs and route them to the appropriate oscilloscope axes.

In principle the amplifiers in sections 2 & 3 of the schematic could be consolidated into a single amplifier having four switched inputs.

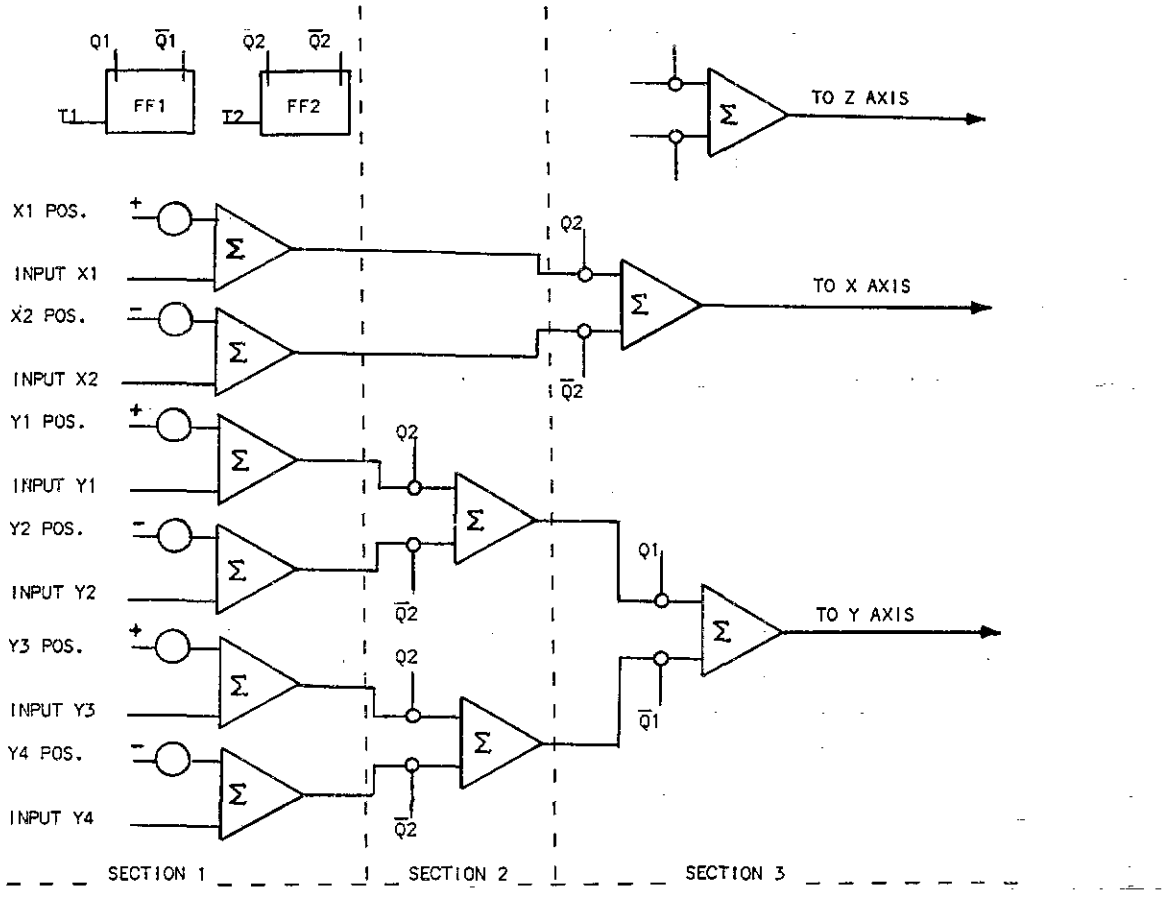

Figure 1. Schematic of the Multiple Trace Generating System

At present, the switching signals are derived from the timing generator of the computer, however, they could be externally generated or program controlled. The flip-flops shown in section 1 of the figure condition the timing signals to the required TTL levels.

It can be seen from the figure that the maximum number of signals that can be displayed depends only upon the number of available inputs on the switched amplifiers.

Now in use, the display control system has proved to be an invaluable aid in generating displays which were previously unattainable with the equipment on hand. At present it is possible to show simultaneously an X-Y plot, a waveform plotted versus time, and an illuminated spot showing the position of a joystick controller.

Although only three signals are presently being displayed, the system is capable of generating quite a few more. The two main limitations on the ultimate number of displays so generated are the number of switching amplifiers available and the resolution of the oscilloscope screen.

The possible applications of this system are only limited by the imagination of the user. Current applications at Florida Technological University include such diverse areas as speech sound analysis, ecological limit cycle simulations, and human operator performance studies.