NMT Gadgetry

Computer-Camera Interface

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A device using operational amplifiers has been constructed to improve the interfacing of scintillation cameras to a scintigraphic data analysis computer. Advantages of the device are that (A) distortion of pulses is eliminated, (B) the data store/playback unit may be used as a signal source, (C) proper orientation of signals sent to the computer is automatic, and (D) long transmission lines between the computer and scintillation cameras may be used.

A device has been constructed so that scintillation cameras (Searle Radiographics Pho/Gamma HP and Pho/Gamma IV) can be properly interfaced to a computer (Hewlett-Packard 5407A Scintigraphic Data Analyzer).

Before the interface was installed, distortion of pulses from the camera was evident due to the capacitive load presented by the long (about 75 ft) coaxial cables used. Pulses originating from the data store/playback unit attached to the camera were so distorted that this unit could not be used as the source of signals for the computer.

Materials

Figure 1 illustrates the placement of components within the interface. Connection to the camera and computer is done using six coaxial cables (eight would be required if no data store/playback unit is available) and one power supply cable. The cables between the camera and the interface should be kept fairly short (3 ft is acceptable). The unit is contained within a 2- by 5- by 7-in. aluminum box and may be placed into any convenient location within the camera or data store/playback unit.

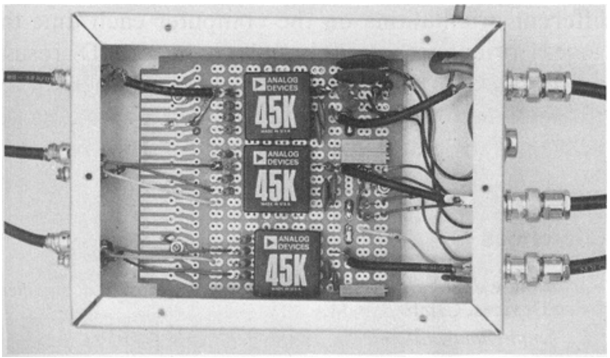

FIG. 1. Layout and components placement within interface. Three input cables enter at left; three output cables exit at right. Top amplifier is for gate pulse; other two are for x and y pulses. Power supply cable at top.

Table 1 itemizes the components necessary for construction. The components are generally not highly critical. The operational amplifiers should be of the fast-settling variety designed for analog-to-digital converters, and should have at least 20-mA output current capability.

Discussion

The interface consists of two identical differential-input operational amplifiers—operating at unity gain—as x and y amplifiers and one noninverting operational amplifier—operating at a gain of about 0.28—as the gate pulse amplifier. All three units (Analog Devices model 45K) are connected as 50-Ω transmission-line drivers *(1)*. Because transmission-line techniques are used, cable capacitance is no longer relevant and does not limit the length of cable connecting the interface to the computer. The only practical limitation is cable attenuation. In our laboratory a RG-174/U cable is used due to its conveniently small size. At the frequencies under consideration, this cable causes about a 20% loss of pulse voltage at the receiving end of the 75-ft-long cable. This is not generally significant since this represents merely a reduction in image size at the computer end and can be compensated for by a readjustment of the image-size (gain) switch at the computer. If it is desired to minimize this loss, lower-loss coaxial cables could be used *(2)*, i.e., RG-58A/U would produce less than 4% voltage reduction at the receiving end of 75 ft of cable.

Most scintigraphic computers will accept pulse amplitudes as produced by the camera. Thus, the unity gain configuration is generally sufficient. The gain of

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TABLE 1. Component Parts Necessary for Interface Construction

Item	Quantity
Phenolic or epoxyglass perforated circuit card, approx. 4 X 5 in.	1
Operational amplifier, AD45J or 45K	3
Cable connector, male, Amphenol 14S-2P	1
Aluminum minibox, 5 X 7 X 2 in. with bottom cover plate, Bud AC-402	1
Resistor, 2 kΩ, ½-W metal film	11
Resistor, 50-Ω, ½-W, carbon (selected from 47-Ω nominal)	3
Trim pot, 1 kΩ	3
Dual ± 15-V tracking regulator, Motorola 1568R	1
Resistor, 4.7-Ω, ½-W, carbon	2
Capacitor, 0.0015-μF, polystyrene	2
Capacitor, 0.1-μF ceramic disk	2
Capacitor, 8.2-μF 35 VDC tantalum electrolytic	2
BNC connector, female chassis mount, Amphenol 31-221, UG-1094/U or equivalent	3
Phone jack chassis mount	5
Phone plug, cable mount	10
RG 58 A/U sufficient to make connecting cables between camera and interface	20 ft
Power cable, three conductors	10 ft

the amplifiers can be adjusted over a moderate range, however, by altering the value of the input and feedback resistors *(3)*. It is evident that, with the proper choice of amplifier gain and coaxial cable, hundreds of feet could separate the computer from the camera.

The x amplifier is identical to the y amplifier [Fig. 2(A)]. The differential input configuration was chosen to permit use of the camera β+x and γx signals when no data store/playback unit is available. For use with bipolar signals from the data store/playback unit, either the (+) or (−) amplifier input should be grounded. The 2-kΩ input and feedback resistors provide an input impedance sufficiently high so as not to load the camera signals, yet maintain the excellent transient response of the amplifier. The coaxial cable is not terminated with 50 Ω at the receiving (computer) end. Termination at only the sending (amplifier) end is sufficient if the amplifier is of adequate bandwidth. When this is the case, reflected pulses are completely absorbed by the 50-Ω resistor and are not reflected again to the computer. An operational amplifier of marginal bandwidth may be used if the receiving end is also terminated with 50 Ω. In this case, however, only half of the amplifier output voltage is available at the computer end of the cable.

Figure 2(B) shows the driver for the gate pulse. The gate signal at the camera is +18 V in amplitude. The computer requires a signal greater than +2.2 V. The circuit of Fig. 2(B) produces a signal about +5 V in amplitude, providing an adequate margin to reliably gate the computer. A unity gain amplifier in this application would require an output current capability of 180 mA. Such amplifiers are prohibitively expensive. Thus, a differential-input noninverting configuration was chosen to permit a gain of less than unity.

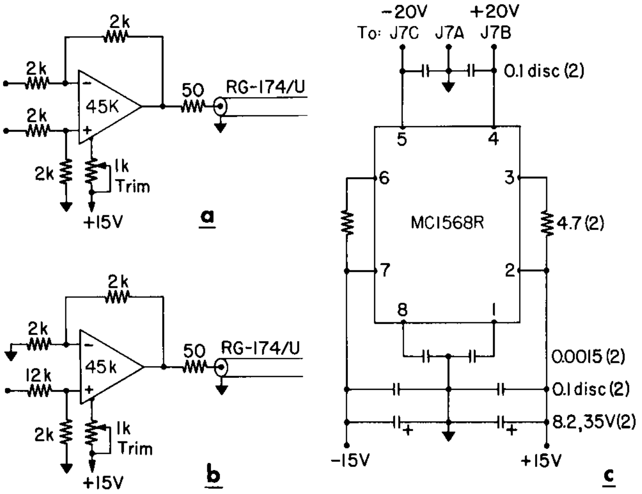

FIG. 2. (A) x and y line drivers. Output resistor (50 Ω shown) must match impedance of coaxial cable used. (B) Driver for gate signal. (C) Dual regulator of ±15 V. Capacitor values are in microfarads.

The trim pots shown in Fig. 1 are adjusted so that the amplifiers have zero dc output when there is no input.

The amplifiers used require a ±15-V regulated supply. These voltages are not available from the camera. Rather than construct a separate power supply, a Motorola MC1568R dual regulator [Fig. 2(C)] was used to reduce, regulate, and current limit the ± 20 V available at connector J7 (marked "Preamp pwr.") on the camera *(4)*. Current limiting on the unit is set at about ± 100 mA by the 4.7-Ω resistors. The quiescent current drawn by the entire interface is ± 24 mA and increases to +50, −42 mA at 50,000 counts/s.

Advantages of the interface include (A) distortion of pulses has been eliminated, resulting in more accurate signals being presented to the camera oscilloscopes and computer; (B) the data store/playback unit may be used as the signal source, making offline as well as online signals available to the computer; (C) orientation of signals sent to the computer is automatically the same as the orientation on the camera oscilloscopes (since bipolar signals available at the camera rear panel do not change with different positions of the H/U orientation switch, it had been necessary to select different orientations on the computer each time the camera orientation switch was changed); (D) results obtained are virtually independent of the length of the cable connecting the computer to the camera; and (E) the cost of the entire unit, assembled, is approximately $200.

References

1. *Analog devices data sheet for model 45 operational amplifier.* Analog Devices, Cambridge, MA

2. *Amphenol Catalog RF-2.* Amphenol Corp, Danbury, CT

3. Graeme HG, Tobey GE, Huelsman LP, eds: *Operational Amplifiers. Design and Applications.* McGraw-Hill, New York, 1971, Chaps 1 and 6

4. *Semiconductor Data Library, Vol. 6.* Motorola, Inc., p 8–342, 1975