Adapting the Grason-Stadler 829 electronic switch for use with solid state programming equipment*

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The Grason-Stadler Type 829 electronic switch is widely used in auditory research for "transient-free" gating of stimulus waveforms. Although the instrument incorporates a repetition-rate generator for self-cycling operation and has a "sync output" through which other apparatus can be activated, external control of the switch by other equipment is less convenient. Signal channels can be turned "on" and "off" by means of contact closures (which ground designated inputs) or by delivering negative pulses to these inputs. For stable operation, these triggers should have an amplitude of about -90 V. Pulses of this size are, unfortunately, not available from such vacuum tube generators as the Tektronix 161 and 162; they are, of course, far greater than those provided by solid state programming units.

We have solved this problem simply and inexpensively by adding two one-stage amplifiers to the 829 switch. Each amplifier is a triode which receives positive pulses from our programming equipment and delivers the larger negative triggers required by the electronic switch.

Operation of the two-channel amplifier is as follows (see Fig. 1): When the two grids are at ground potential—as they would be were the amplifiers connected to Tektronix pulse generators—the triodes are self-biased nearly to cutoff. Quiescent plate currents are 0.6 mA each. Electrode voltages for this condition are shown with the left hand triode of Fig. 1. The cathode resistor and bypass capacitor have a time constant of 1 msec. For positive pulses briefer than this, each state has a gain of about -14 . Input pulses whose amplitude equals $+7$ V yield 100 -V negative triggers. The waveforms of the latter are somewhat degraded by the Miller-capacitance of the triode amplifiers, but this does not affect reliability of switching.

Solid state flip-flops, one-shots, etc. (such as those made by BRS, Coulbourn, Grason-Stadler, Iconix, Lehigh Valley), can also be connected to provide trigger pulses. In the "logic 0" state, the grids are held at -12 V.¹ (The 250 -kilohm grid resistors are negligible loads for the solid state modules.) Electrode voltages for this state are given in parentheses for the right-hand triode in Fig. 1. "Logic 1" assertions raise the grid

Fig. 1. Dual-channel amplifier for triggering the Grason-Stadler 829 electronic switch. Values of resistance are given in kilohms; of capacitance, in microfarads. See text for explanation of electrode voltages.

voltage to 0 V. With a stage gain of approximately -10 , these transitions yield -120 -V triggers.

An octal socket for the dual-triode tube (6SN7GT) is easily mounted on the chassis of the electronic switch. Connections to the heater supply, to $B+$, to ground, and to the two trigger inputs are straightforward.

Although the power supply of the 829 switch can easily provide the additional plate and heater currents required by the 6SN7GT tube, we have improved the performance of the instrument by substituting a regulated power supply (Kepco KR2 M) which delivers 90 mA at 340 V. The $B+$ bus is easily disconnected from the internal power supply and connected instead to the high voltage output of the regulated supply. The results of the substitution are notable: Output hum and noise (measured across a 600 -ohm load) total 0.6 mV peak-to-peak. Powered normally, the switch produces 15 dB more hum and noise.

The stability of the pedestal balance adjustment is markedly improved by the use of a regulated power supply (see Ludwig & Hind, 1955). Monitored at the output of the electronic switch, the balance—set after 10 min of warm-up—exhibits less than 1 mV (peak-to-peak) of drift during the next hour. Without the regulated supply, the drift exceeds 7 mV.

The two modifications described above eliminate the need for frequent resetting of the pedestal balance control, increase the dynamic range of the electronic switch, and update it for use with modern solid state programming modules.

REFERENCE

Ludwig, H. & Hind, J. E. Electronic switch eliminates transients. *Electronics*, 1955, **28** (No. 10), 163-165.

NOTE

1. With Grason-Stadler Series 1200 modules, the "complementary dc signal" must be used.

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