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STATISTICALLY PROGRAMMABLE PULSE DISTRIBUTOR

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The statistically programmable pulse distributor is a device for distributing a series of electrical input pulses among a large number of output terminals in accordance with an equal number of preset probabilities.

The randomizing capability of such an instrument has a number of applications in programming statistical variations of parameters associated with behavioral experiments.

Particular applications of interest include the random selection of stimuli presented in discrimination experiments, and randomization of reinforcement contingencies.

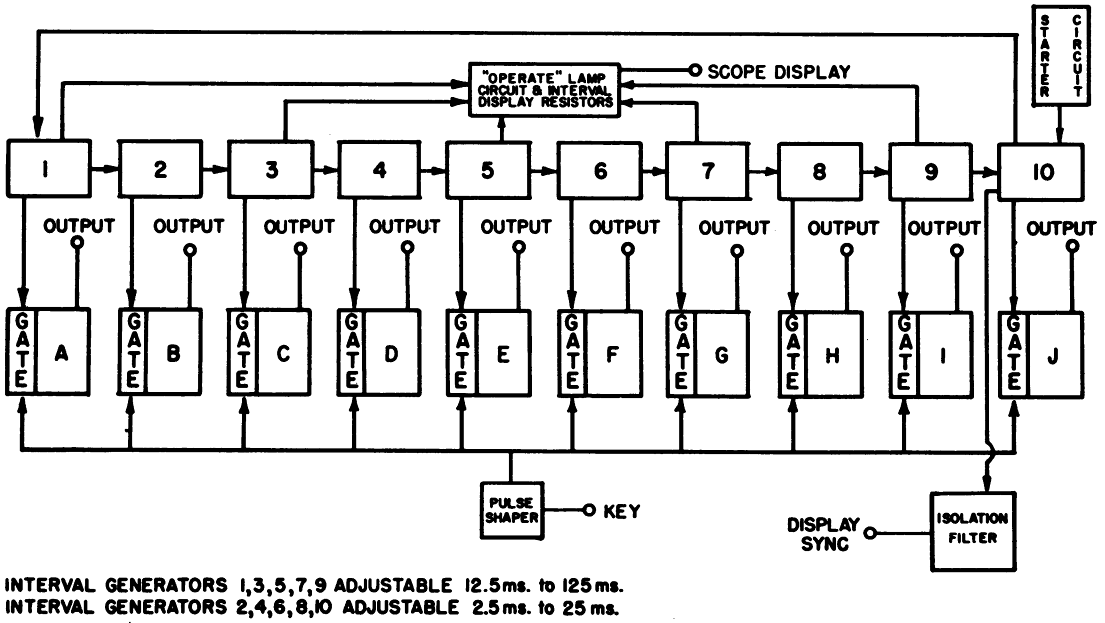
Additional examples of its use, involving a programmable interval timer, include randomization of stimulus intervals, stimulus durations and reinforcement intervals.

The fact that the relative probability of each selection can be varied over a 50:1 range adds significantly to the versatility of the instrument.

The functioning of such a randomizer, having 10 output channels, is shown diagrammatically in Fig. 1. Actually, any number of channels may be employed.

Each ground input pulse is applied simultaneously to gating circuitry in all of the channels through a common shaping circuit. This circuit converts an input contact closure to a 10-μsec spike and will prevent multiple spikes due to contact bounce. Each gate is opened sequentially by a corresponding time interval generator, as shown in blocks 1 through 10 across the top of the diagram. The

BLOCK DIAGRAM OF STATISTICAL PULSE DISTRIBUTOR



INTERVAL GENERATORS 1,3,5,7,9 ADJUSTABLE 12.5ms. to 125ms.
INTERVAL GENERATORS 2,4,6,8,10 ADJUSTABLE 2.5ms. to 25ms.
A-J 50ms. WIDE SQUARE-PULSE GENERATORS

Figure 1

conclusion of each gating interval generates a signal which then fires the next interval generator in the chain and opens its associated gate. Thus, the keyed input pulse always finds just one of the gates "open". Passing through the gate, the pulse fires an associated 50-msec, square-pulse generator capable of supplying control grounds to devices rated to 0.2 amp at 40 v or less.

Five of the interval generators can be set individually for intervals between 2.5 and 25 msec, while the remaining five are adjustable for intervals up to 125 msec. As a result, with maximum settings on all of the generators, a complete cycle of probabilities occurs in ¾ of a second. However, because in most applications only one, or perhaps two, of the generators is set beyond 25 msec, the usual time per cycle of probabilities does not exceed a few tenths of a second. The transition time between interval generators does not exceed ½ μsec.

A starter circuit introduced at the input of one of the interval generators supplies a single triggering pulse to that generator about 1 sec after power is switched 'on'. Meanwhile, this circuit blocks any sequence of intervals initiated by switching transients.

An additional unit on the block diagram includes circuitry for displaying relative gate-generator time intervals, or probabilities, and circuitry for flashing a lamp to indicate that the chain of interval generators is in operation.

The display circuit mixes, at a single output terminal, signals from alternate interval generators. Thus, an oscilloscope connected at this point will show vertical displacements during these intervals, separated by baseline increments of lengths equal to the other generator times. The displacement corresponding to generator No. 1 has been made somewhat higher than the rest for identification. A triggering pulse for the oscilloscope is available at a separate terminal. The series isolation filter prevents the triggering of interval generator No. 1 by ambient transients picked up on the scope 'sync' lead.

The instrument is completely transistorized, contains no moving parts, and occupies 5⅜ in. vertically in a 19-in. relay rack. The power requirement is small, being plus 12 and minus 6 v, each at 50 ma. As shown, the circuitry is

TYPICAL PLUG IN CHANNEL

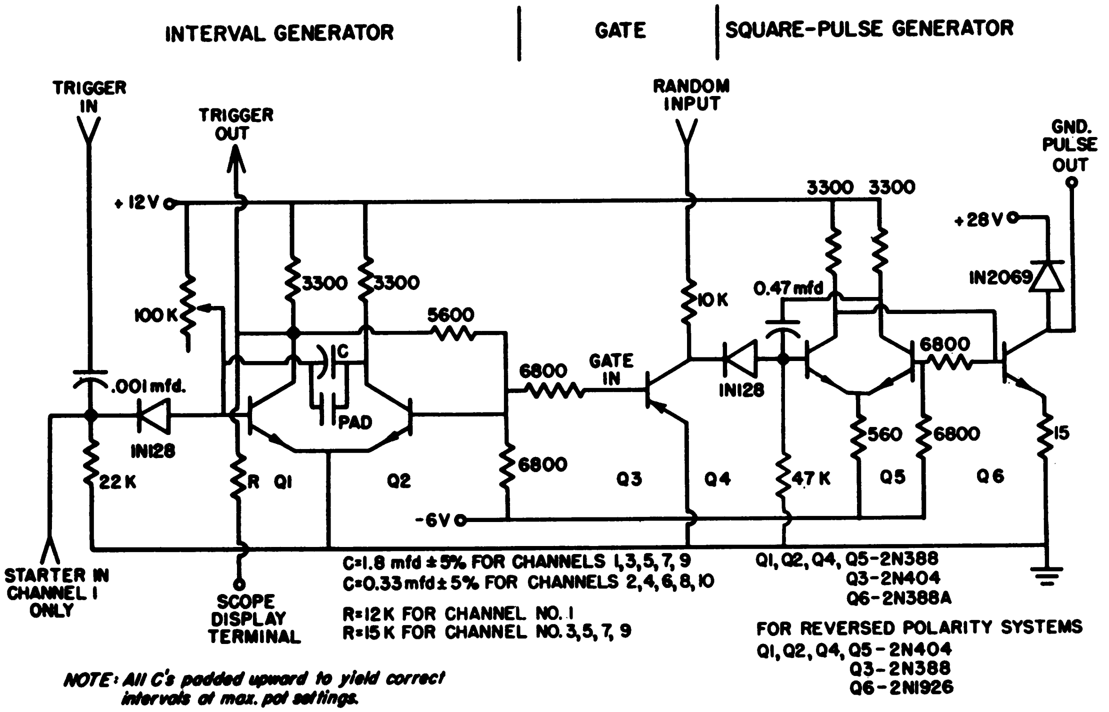


Figure 2

compatible with 28-v, operant conditioning apparatus requiring negative ground for actuation.

Each of the 10 channels, including an interval generator, gate, and square-pulse generator, is built on a small circuit board measuring 4 by 4½ in. A set of 10 such boards, plus an auxiliary circuit board, plug into a substantial mechanical frame. The circuits are shown schematically in Fig. 2 and 3, respectively. The instrument can be made compatible with systems requiring positive grounds for actuation if all of the diodes shown are reversed, and the alternative transistor complements indicated on the schematics are employed.

If the operant conditioning equipment power supply is known to contain large switching transients, an electrolytic condenser of 1000 μf capacity should be connected across it at the instrument. In this laboratory, the effects of 200-v transients observed on the dc power line were completely removed by the application of such a capacitor.

The time intervals generated in the various channels are determined by the capacitors marked "C" on the schematic, in conjunction with the 100-kohm potentiometers. In order that the indexing on standard dial plates correspond to the interval lengths generated, precision potentiometers must be employed. Further, since 10% of the resistance must remain in the circuit at all times for transistor protection, mechanical stops must be provided to limit the rotation. If fixed resistors are placed in series with the potentiometers for this purpose, the simple proportionality between probability interval duration and potentiometer dial setting will be destroyed.

The instrument described has been in daily use for several months without requiring service. In an experiment to check its functioning, a random time distribution of 4650 pulses, supplied by an animal being trained in op-

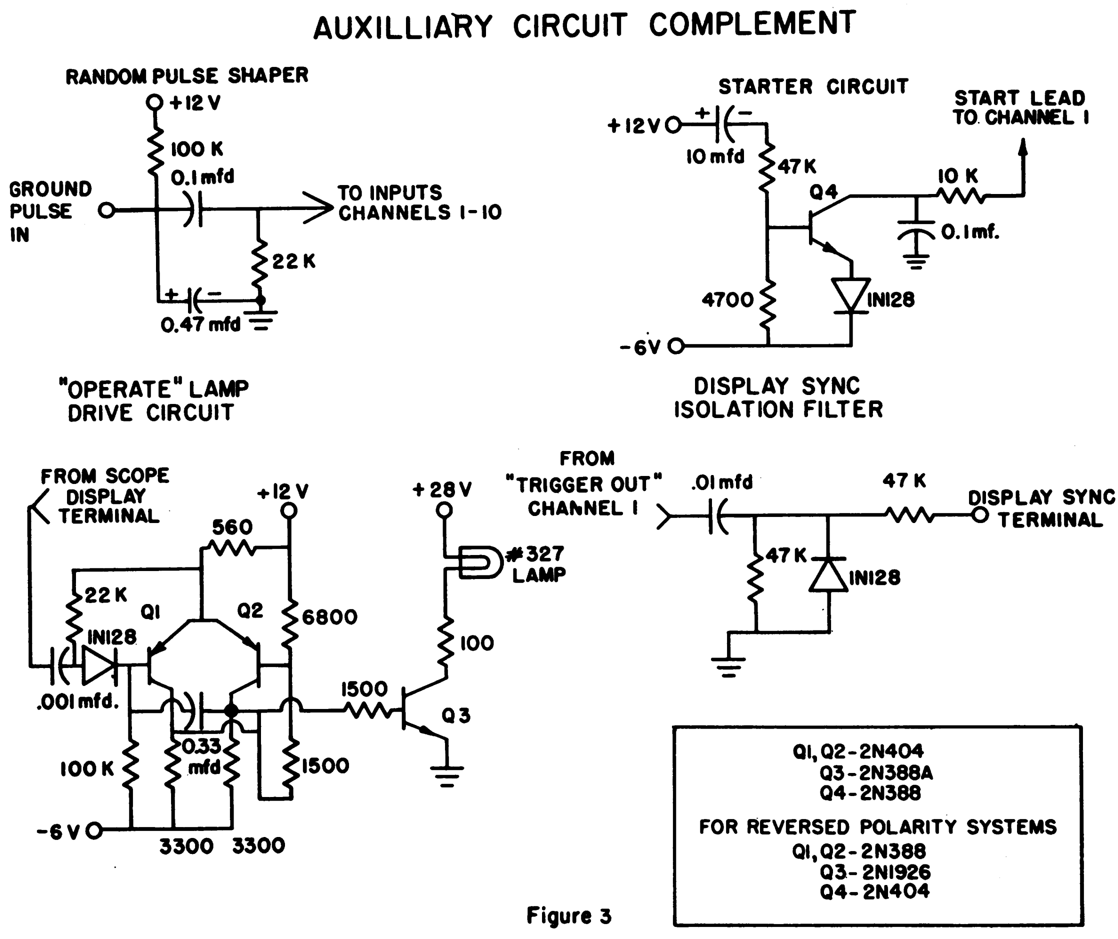


Figure 3

erant conditioning apparatus, was applied to its input. The number of counts accumulated at each of the 10 outputs is plotted in Fig. 4 against the duration of the corresponding probability interval. The linearity of the observed data attests to the validity of the concept.

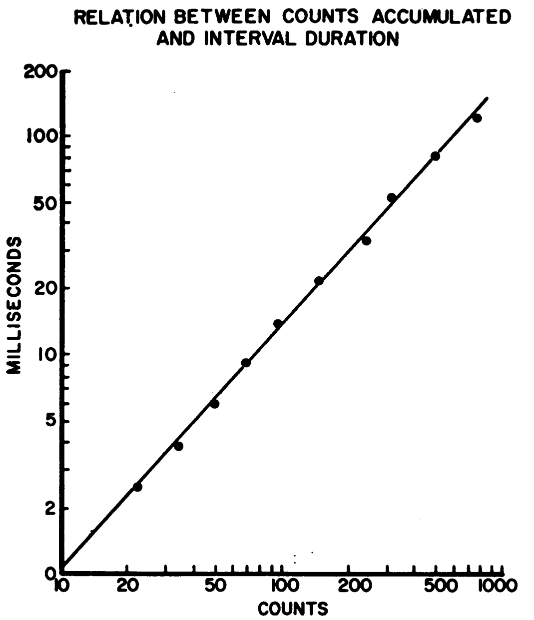


Figure 4.

Two additional units now being fabricated will be modified to facilitate reducing the number of active channels when fewer than 10 outputs are to be programmed. The modification will involve the addition of switches in channels 2 through 10. Thus, the trigger output pulse from any one of these channels may be removed from the input of the channel following and returned to the input of channel 1. The channels beyond the thrown switch are then excluded.

The instrument as described requires a parts expenditure of $350.00. However, if one is willing to set interval durations with an oscilloscope or an electronic period meter, the $150.00 expenditure for precision potentiometers can be avoided. The total time required for fabrication and checkout by a technician somewhat familiar with basic digital transistor circuitry should be three-to-four weeks.