Figure 1.

THE TYPE 1398-A PULSE GENERATOR

An instrument, no matter how ingeniously designed and efficiently made, is never so good that it can't be improved. That is the story of GR's general-purpose pulse generator, which our engineers designed over 10 years ago and have not been able to leave alone since. Each successive model represented unequalled value for this class of instrument, and customer response has always been excellent. But the campaign continued to squeeze just a few more ounces of performance out of the design, while holding the cost in line.

[1] R. W. Frank, "Improved Performance from the Unit Pulse Generator," *General Radio Experimenter*, December 1964.

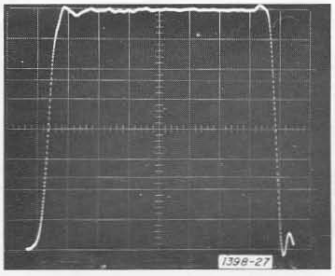


Figure 2. A positive output pulse shown at 10 ns/cm writing speed. The fall time is about 3 ns.

The latest of these pulse generators, the TYPE 1398-A, is most easily described in terms of the popular TYPE 1217-C.[1] The new generator has a shorter rise time and more output power than the TYPE 1217-C and contains its own regulated power supplies. For those who don't need the faster pulse and the extra power and who have their own power supply, the TYPE 1217-C remains available.

To review the general specifications of the TYPES 1217-C and the 1398-A: In both, prf range is 2.5 Hz to 1.2 MHz and duration is 100 nanoseconds to 1 second. In the TYPE 1398-A, transition times have been dropped from 10 to 5 nanoseconds (see Figure 2), and output current has been boosted from 40 to 60 mA, so that the open-circuit output is 60 volts behind 1 kilohm.

Circuit

Figure 3 is a block diagram. In the timing and output circuits, vacuum tubes are used for their high input impedance and ruggedness; the pulse-control circuits are transistorized for maximum switching speed. In the TYPE

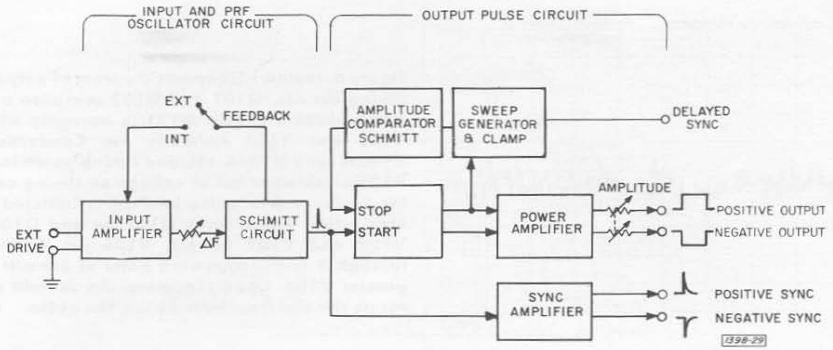


Figure 3. Block diagram of the pulse generator.

1398-A, new silicon npn transistors and double-frame-grid power output tubes further extend the capabilities of the hybrid arrangement.

The input circuits, shown in Figure 4, require only three active devices, which are switched into operation as either a prf oscillator or an aperiodic trigger circuit, depending on whether internal or external drive is desired. Equivalent input noise (as measured by the techniques described in the preceding article) is about 50 μV, rms (see Figure 5), which is much lower than that of many trigger-type input systems. This low input noise leads to very low prf jitter with external drive.

The push-pull output circuit (Figures 6 and 7) offers many advantages: It presents a constant load to the power supply; it delivers both positive-going and negative-going pulses simultaneously; the pentodes used are linear current sources, which produce the same source impedance for either polarity; the output is short-circuitable, and there are no duty-ratio restrictions; and finally, since the output terminals are direct-coupled to the output stage plates, there is never any rampoff.

Another characteristic of this circuit is that it retains a dc component negative with respect to chassis ground. A feature of the new generator is provision

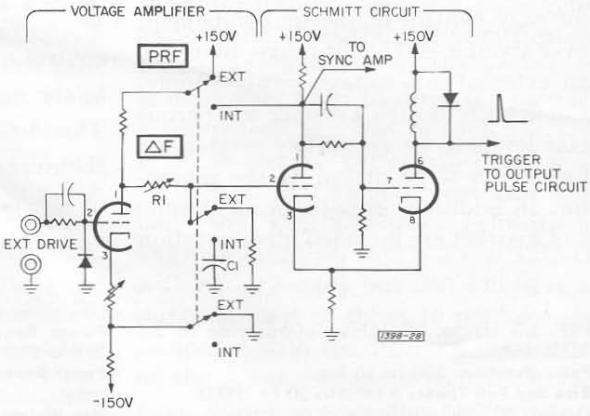


Figure 4. Schematic diagram of input circuits. Switched as shown, for external operation, the Schmitt circuit is driven by the input dc amplifier and is a fast 2-MHz-to-dc trigger circuit. When the PRF control is set for the internal mode, the same components are switched into a stable oscillator that can be injection-synchronized from the external-drive terminals. The input tube becomes a current source to translate the left-hand plate swing to center on the Schmitt circuit. The circuit oscillates within its hysteresis region. C1 establishes frequency range, R1 gives continuous frequency adjustment.

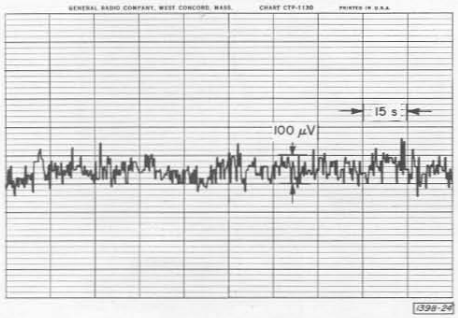
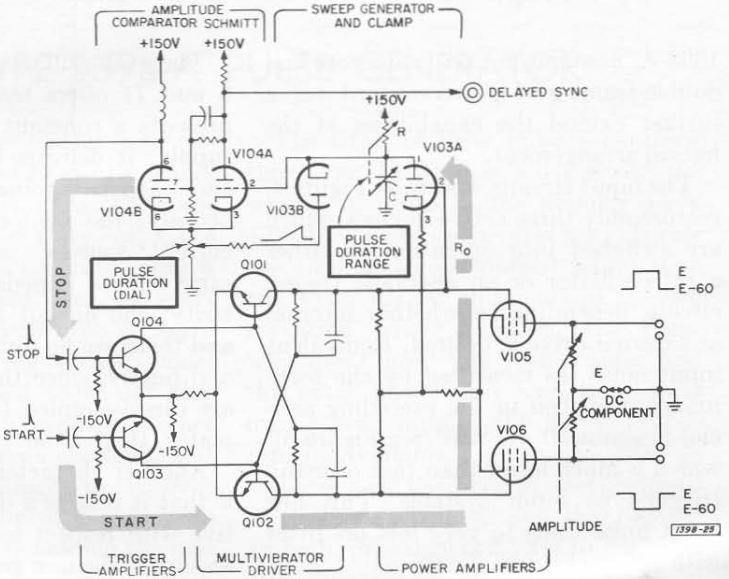


Figure 5. (Above) Plot showing noise generated in input circuit.

Figure 6. (Below) Schematic diagram of output and timing circuits. Q101 and Q102 comprise a transistor bistable circuit. Q101 is normally off and V105 and V103 normally on. Conduction of V103A keep V104A off, and timing potentiometer R125 establishes initial voltage on timing capacitor C. The active pulse interval is initiated by a start pulse, which turns Q101 on and Q102 off. V103 and V105 go off, V106 on. C charges through R to the triggering point of Schmitt comparator V104. Upon triggering, the Schmitt circuit resets the flip-flop, terminating the pulse.



for easy control of the dc component, over about a ± 15-volt range, by use of an external low-voltage power supply. Connection of such a supply will permit bias levels to be accurately established for devices to be driven by the generator. In addition, signal-sensing circuits and a socket are included for connection to a to-be-announced dc-component control unit, which will attach directly to the right-hand side of the generator. This unit will automatically control the average value or either peak value of the positive or negative pulse over a ± 15-volt range.

ABRIDGED SPECIFICATIONS

PRF: 2.5 Hz to 1.2 MHz, internal; dc to 2.4 MHz, external.
Pulse Duration: 100 ns to 1 s.
Rise and Fall Times: 5 ns into 50 or 100 Ω.
Output: 60 mA, positive and negative.
Power Required: 105 to 125, 195 to 235, or 210 to 250 volts, 50 to 60 Hz, 90 W.
Panel Dimensions: 12 × 5¼ inches (305 × 135 mm).
Net Weight: 14½ lb (7 kg).

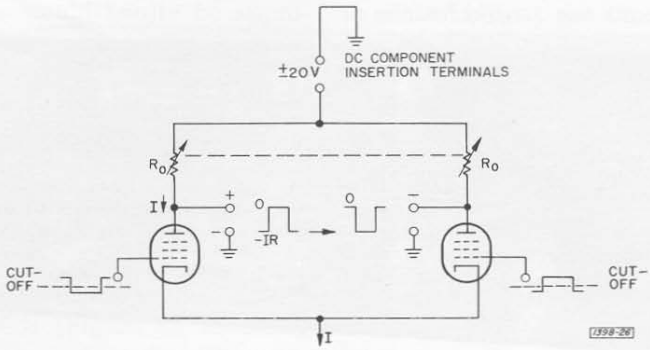


Figure 7. A closer look at the output circuit. The system includes a pair of switched current sources, V1 (normally on) and V2 (normally off). When the active pulse interval switches V1 off, the output voltage at the positive pulse terminal goes from −IR to 0, while the voltage at the negative terminal goes from 0 to −IR. Output impedance is adjusted to control open-circuit output voltage and is unaffected by switching circuits. The dc-component insertion terminals permit use of an external low-voltage power supply to translate the reference from 0 volts to the external supply voltage.

Catalog Number	*Description*	*Price in USA*
1398-9701	**Type 1398-A Pulse Generator**	**$535.00**
0480-9632	**Type 480-P312 Rack-Adaptor Set**	**6.50**

U.S. Patent No. 2,548,457.

For complete specifications, see the current General Radio catalog or write to your nearest GR sales office.

THE TYPE 1397-A PULSE AMPLIFIER

A new pulse amplifier, the TYPE 1397-A, has been designed as a companion not only for the TYPE 1398-A Pulse Generator described in this issue but for the TYPE 1217-C Unit Pulse Generator and the TYPE 1395-A Modular Pulse Generator[1] as well. The new amplifier increases the relatively low output power available from these instruments to a healthy 50 watts peak.

Why have pulse generator and pulse amplifier in separate packages, anyway? The separation, a long-standing GR practice, makes excellent sense. Why, for instance, saddle a pulse generator with a costly and complicated high-power amplifier if the generator is most often used to drive the base of a transistor? The cost of such overkill is measured in performance as well as dollars. A 1-ampere generator not only will generally cost more than twice as much as, say, a TYPE 1217-C with power supply but also will have a duration limit of about 10 milliseconds compared with the 1-second maximum of the lower-cost pulse source. Moreover, since few generators producing an

[1] Gordon R. Partridge," Pulses to Order," *General Radio Experimenter*, May 1965.