

# CURRENT CONTROLLER USES ADJUSTABLE EXPONENT

by Galen W. Ewing\*

In connection with electrochemical studies (variable-current chronopotentiometry), an instrument was required that would control the current  $i$  through a cell as a power of time

$$i(t) = k t^m$$

in which the exponent,  $m$ , can assume a wide range of values of either sign and ranging from perhaps 1/4 to 3.0.

The 433J† has proved to be a highly convenient component for accomplishing this design, using the circuit of Figure 1.

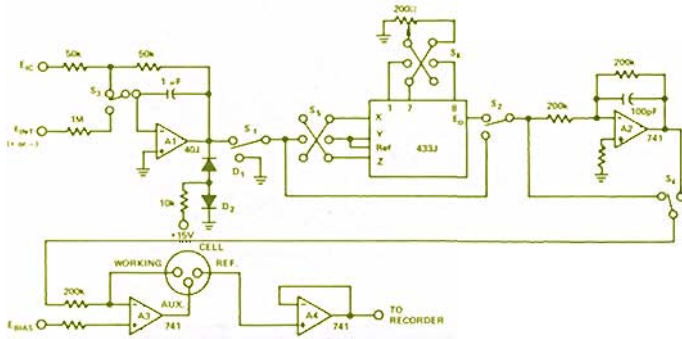


Figure 1. Power-of-time programmable galvanostat. Offset trimming and power-supply circuitry are conventional.

Two DPDT panel switches determine the sign of the exponent ( $S_5$ ) and whether it is greater or less than 1 ( $S_6$ ). The 200Ω 10-turn pot connected to  $S_6$  fixes the numerical value of the exponent, 1000 X dial setting for  $m < 1$ , and 1000 ÷ dial setting for  $m > 1$ . Switched fixed resistors could be used for a limited set of specific  $m$  values.

Two of the inputs to the 433J are fixed: the Y input, and either X or Z, as selected by  $S_5$ . They are connected to the 9-volt reference output at pin 11. The active input is supplied from a conventional ramp generator utilizing a Model 40J FET-input amplifier as the integrator (A1). The integrator output is clamped to ground by diodes D1 and D2, to avoid applying negative inputs to 433 (while not harmful, negative inputs drive the output into saturation). The SPDT panel switch ( $S_3$ ) controls the integrator: *initial conditions* and *run*; *hold* is not needed. The switch is synchronized with the recorder's *remote start* control.

The 433J output (direct or inverted) is taken to a control amplifier (A3), the galvanostat proper, the feedback for which is the electrochemical cell. With the programmed current flowing through the cell, the voltage between the reference electrode and the "working" electrode is unloaded by the follower (A4) and plotted on an X-Y recorder with its X-axis driven by the linear time base. Figure 2 (adjacent column) shows the programmed current, compared with computed points for  $m = 3/4$  and  $4/3$ , using a 200kΩ dummy load to replace the cell for this measurement.



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†See page 14.

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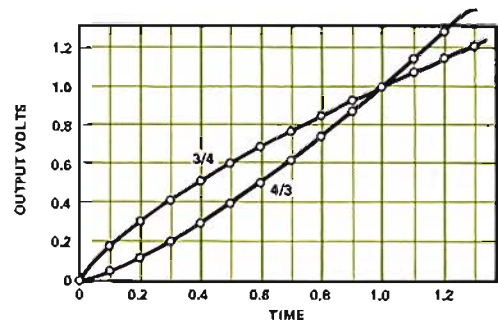


Figure 2. Power of time curves. Output voltage proportional to the 4/3 and 3/4 powers of time. Both scales normalized about the point of intersection. Circled points are calculated.