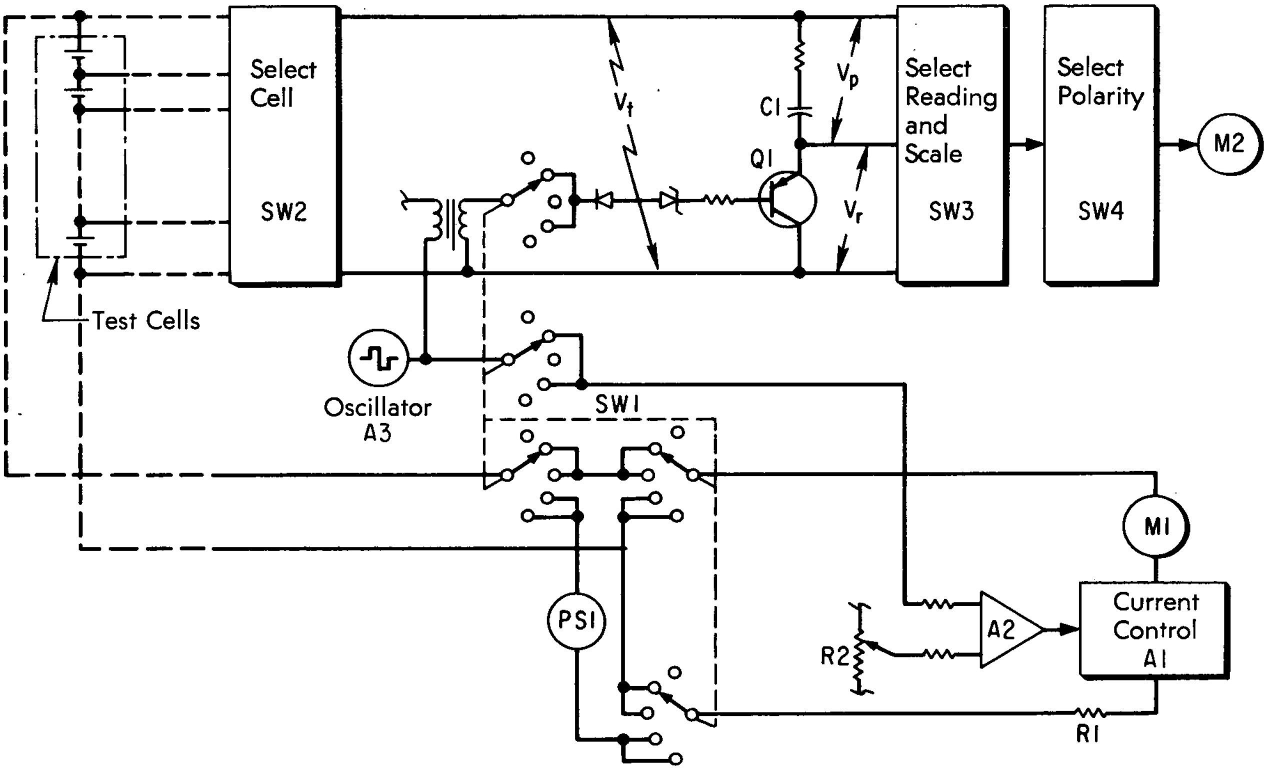
NASA TECH BRIEF

Ames Research Center

Improved Device Measures Performance of Batteries under Load



An improved Kordesch-Marko interrupter bridge circuit for measuring the IR-drop and IR-free voltage of electrochemical cells under load conditions has been developed and constructed. New features include the capability of varying the frequency of interruption in steps from 60 Hz to 2000 Hz, the extension of range to handle stacks of 10 or more cells in series, and the addition of operating modes to allow the instrument to serve as a steady DC constant-current source or load, or as a source of interrupted constant current. It is normally used as an interrupted constant-current load.

The basic principle of the bridge is to sample periodically the terminal voltage of a cell under test the instant the load is removed, before it can recover from polarization. The voltage thus sampled is stored on a capacitor to provide a continuous level to a voltmeter. Sampling and loading are alternated on

(continued overleaf)

a 50-percent duty cycle at a frequency high enough to give a representative "IR-free" measurement. Simultaneously, the average terminal voltage and average current are measured to yield the ohmic characteristics of the cell.

In the original Kordesch-Marko design, the test cell was switched by 60-Hz line power delivered through a variable transformer, a stepdown transformer, a half-wave rectifier, and a variable resistor. Thus, the cell was alternately blocked and loaded at line frequency. Sampling was accomplished through a gating circuit using a small center-tapped line transformer and a double diode bridge to switch the "IR-free" voltmeter into the cell circuit only during the nonconducting half of the cycle. Appropriate choice of phase and a common reference source enforced synchronization.

In the improved version, the load and the current control are isolated from the 60-Hz line, and do not depend on it for waveform, frequency, or duty cycle. Current is controlled through a transistor amplifier, A1, in series with a load resistance, R1, and an ammeter, M1 (see diagram). An operational amplifier, A2, ahead of A1, regulates the current to a constant level and frequency, as determined by a potentiometer, R2, and a square wave oscillator, A3.

The voltage to be sampled is connected across capacitor C1 through transistor Q1. This gate is closed only when A1 is not conducting, as synchronized by oscillator A3, so that C1 assumes the "IR-free" voltage, V_p, of the cell being monitored. The instantaneous terminal voltage V_t appears across the monitored line, and the voltmeter, M2, will read its average value. This is the terminal voltage of a cell or stack under load. The IR drop, V_r, is the difference between V_p and V_t, appearing across Q1, and can be read directly on M2.

When a current source mode is used to serve an external nongenerating load, power supply PS1 is switched into the circuit. Amplifier A1 continues to control the current.

Convenient switching simplifies use of the instrument. The frequency of A3 can be selected by switching capacitors. The operating mode is determined by SW1. The particular cell to be monitored may be selected from the stack during test by SW2. The voltmeter M2 can read directly the "IR-free" voltage, the terminal voltage under load, or the IR drop as selected by SW3. Meter scale is interlocked through SW2 and SW3. Polarity is set by SW4.

Notes:

1. The instrument can be used for production testing; it gives continuous readings, and its operation does not require great skills.
2. The circuit can be readily modified for a variety of electrochemical applications.
3. Requests for further information may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP72-10051

Patent status:

No patent action is contemplated by NASA.

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