COMPONENT TEST
General information

Impedance/Z/θ, C, R, L, D & Q

Hewlett-Packard's family of impedance measurement instruments combine the familiar null measurement techniques with digital logic and feedback circuits to achieve simple and rapid operation without a sacrifice in precision. The basic specifications for Hewlett-Packard's impedance family is summarized on the opposite page. Frequency, Q, capacitance, inductance, resistance and basic accuracy can be traded off to select the most suitable instrument. For some instruments, capacitance and inductance are not the principal parameters but are secondary to the primary readout.

Impedance considerations

There are two basic types of impedance measuring instruments: bridges and meters. In general, bridge type instruments have the best accuracy specifications. This type of instrument has found wide application and is the basis for the HP 4260A/4265B Universal Bridge, 4270A Automatic Capacitance Bridge, and 250B RX Meter.

In the past, bridge instruments have required considerable operator skill to obtain consistent results. However, the Universal Bridge was specifically designed to achieve rapid and consistent audio frequency measurements.

The evolution of bridge measurements has created the need for completely automatic instruments to rapidly characterize multi-conductor cables, variable capacitor diodes, and discrete capacitors. To satisfy these customer requirements, the 4270A Automatic Capacitance Bridge was developed. This instrument is completely programmable and displays capacitance and dissipation factor/conductance in digital form. BCD outputs are available for remote processing.

Impedance meters, in general, utilize constant current/voltage sources to excite the unknown impedance. Amplitude and phase sensitive voltmeters detect the real and reactive voltage/current components of the unknown. The display for most impedance meters is an analog meter. Although impedance meters do not have the accuracy of bridge instruments, they are less expensive and easy to use. The 4800A Vector Impedance Meter, and the 4332A LCR Meter utilize this principal. Impedance meters have analog outputs proportional to the displayed function.

The wide measurement ranges of the 4261A allow easy measurements of various kinds of components. This applications area is extended even more by the new HP 4262A with its additional frequency and measurement ranges. The 4271B is particularly useful for measuring microcircuit parameters. The new 4272A and 4273A, with their built-in limit comparators, are especially convenient when measuring small and medium range capacitors respectively.

Integration into HP-IB system

Adding the HP-IB option to a component test instrument enables the instrument to be systemized into an HP-IB system. This permits high speed measurement of many components along with arithmetic processing of the data.

The HP-IB option (Opt 101) for LCR measuring instruments is available for HP models 4271B, 4270A, 4262A, 4272A and 4282A. Two functions are provided: talker (measured data transfer) and listener (measurement remote control). System controller may be an HP model 9830A with bus interface kit (HP 59405A OPT. 021, 030), or an HP model 9825A with HP-IB card (HP 98034A). If other system components such as a plotter, printer, scanner or measurement instrument are added to the system, the integrated system reaches a high level of usefulness. For example, it would provide a component manufacturer with inspection/reliability test capabilities in the quality control or in-process test/inspection departments. In semiconductor device measurements, the combination can process the especially needed complex arithmetic manipulation of the measured data for the various device characteristics.

Figure 1 is the block diagram of a semiconductor device characteristic measurement system using the 4271B Opt 101. This calculator controlled system graphically shows the relationships between either bias voltage (measured with digital multimeter) and capacitance (measured with the 4271B), or between impurity concentration and depletion layer width, on a graphic plotter. Bias is automatically applied to the device capacitance measured as directed by the calculator.

Summary

To help you select an impedance meter suitable to your needs the following guidelines may be used:

(1) For a desired accuracy and cost range, select the instrument with the broadest capability in C, L, R & D or Q.

(2) Bridge instruments will provide the best accuracies (0.1% to 1%). However, only the higher priced bridges offer the speed and convenience in measurement available in meter type instruments.

(3) To obtain meaningful results, a parts user should make measurements at the same frequency and voltage level specified by the manufacturer.

For additional information on component measurements, Hewlett-Packard offers for sale a tutorial RCL video tape. The tape has three parts:

Part 1—Resistance (7 min.)—explains basic resistance measurements.

Part 2—Capacitance (11 min.)—format similar to Part 1—explains capacitance measurements.

Part 3—Inductance (11 min.)—develops the theory of inductors and their functions in circuits.

You may preview this video tape at your nearest HP Sales Office. Please call for an appointment. The tape (ID #90249C/D) is available in ½" EIAJ format (C) or ¾" video cassette (D).

Hewlett-Packard's impedance instruments have been used in numerous diverse applications, from the measurement of the dielectric constant of liquids, to the wing to fuselage continuity of aircraft. If you have an unusual application or need assistance, contact your nearest Hewlett-Packard sales office for application information.

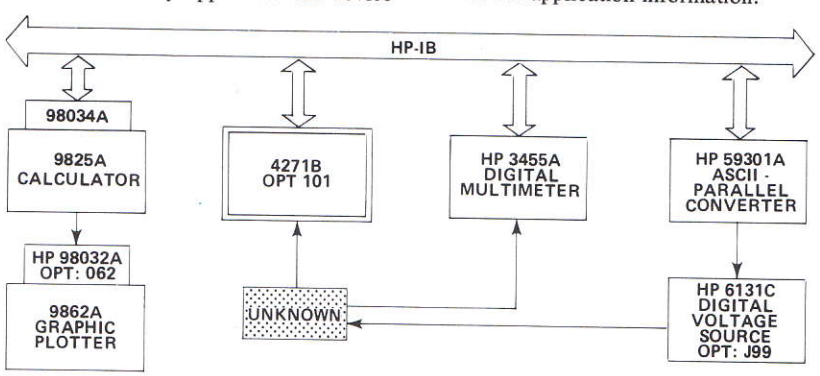

Figure 1. Measuring Semiconductor Characteristics (Typical System)