ESR Meter Circuit Description/theory of Operation

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ESR METER INSTRUCTIONS & SERVICE INFORMATION

INTRODUCTION

The ESR Meter is basically an AC Ohmmeter with special scales and protective circuitry. It provides a continuous reading of series resistance in electrolytic capacitors. It operates at 100 kHz to keep the capacitive reactance factor near zero. The remaining series resistance is due to the electrolyte between the capacitor plates and indicates the state of dryness. Capacitor termination problems also show up plainly due to the continuous ohmic reading.

INSTRUCTIONS FOR ESR METER

Check every electrolytic you see. Your judgement of ESR increases with experience. You'll notice that capacitors usually check very good or very bad. Marginal capacitors accelerate their own failure.

Variable ESR when wiggling leads: Capacitor is unreliable. Replace. (Be sure test clips are tight and direct to capacitor leads; don't use chassis ground.)

Over 50 Ohms: It should be replaced. Even if it works today, it will probably fail within a year. You're doing the customer a favor by replacing it now and may be saving yourself a recall.

50-20 Ohms: OK for 1 to 50 MFD in medium or high impedance
circuits like signal coupling or timing circuits.

For capacitors over 50 MFD, we have established a general limit which is based on manufacturer's data, circuit theory, and experience:

C X R = 1000

(MFD) (OHMS) (MAXIMUM)

Examples: 100 MFD : 10 Ohms Max.
1000 MFD : 1 Ohm Max.
10,000 MFD : 0.1 Ohm Max.

Capacitors smaller than 1.0 MFD can be checked by comparison with an out-of-circuit capacitor of equal type & capacitance. This will show approximate capacitance, opens, shorts (usually zero ohms), and intermittent terminations, Tt1s always been a problem trying to attach a copper or steel lead to aluminum foil~

With marginal capacitors, try paralleling or substituting with a known good one and re-check equipment performance. Circuit requirements for ESR vary somewhat.

The ESR Meter can monitor ESR in live circuits up to 600 volts, provided the circuit ripple doesn't change the reading from what you had with the circuit off. The ESR Meter will ignore about 10 volts p-p at 120 Hz; less at higher frequencies.

We don't recommend testing live circuits because of the shock hazard and because we haven't found it necessary.

Change batteries when the Zero Adjust setting changes drastically. Battery changing instructions are inside the ESR Meter.

Keep solvents and sprays away from the plastic meter cover.

ADDITIONAL INSTRUCTIONS

1. A shorted electrolytic will check good on the ESR Meter, but is rare. Less than 1% of all field-failures are shorted.
2. Non-Polarized electrolytics check the same as Polarized.
3. Directly parallel led electrolytics must be separated for ESR testing.
4. Your one year warranty excludes breakage & batteries.

CIRCUIT DESCRIPTION

The ESR meter uses 8 operational ainplifiers. An op-amp is an idealized basic amplifier with two inputs. The non-inverting input (+) has an in-phase relationship with the op-amp output, and the inverting input (-) an out-of-phase relationship. Op-amps are usually used with negative feedback and reach a stable operating condition when their two inputs are equal in voltage.

Op-amps IA & 1B form a regenerative 100 kHz oscillatnr circuit. Capacitor C1 is the basic tiining capacitor and RI is selected to set frequency. Diodes D2 & D3 clip the bottom and top of the output waveform so that the output level and frequency are resistant to battery voltage changes.

The oscillator output of op-amp 1B drives 10-ohm source resistor R8F. The test-capacitor, thru the test leads, couples this 100 kllz signal to 10-ohm load resistor R9F. The amount of voltage developed here is indicative of the capacitors ESR value. (The 10-ohm resistors determine the basic iieter scaling.)

Capacitor C3 blocks any DC voltage present on the test-capacitor. Diodes D4 & D5 protect the ESR Meter from any initial charging current to C3. Resistor R7 discharges C3 after test.

A DC operating bias of 0.55 V is established by diode D1 for the oscillator stage and for all subsequent stages, which are DCcoupled and operated class A. DC bias from D1 and ESR signal from R9F are combined at the input of op-amp 1D. Both voltages are amplified by 1D, 1C, & 2A. Each of these three stages has an amplification factor of abou*t* 2.8 due to the ratio of output-voltage to feedback~voltage at the (-) input, which is determined -by feedback resistors R13F & R14F, etc.

Op-amp 2D is configured as a peak-to-peak detector. when the in-corning AC signal goes more positive than the normal bias level of about 0.77 Volt, the output of 2D also goes positive. But it must go positive enough to overcome the voltage drop across diode D6 before a fully equalizing positive voltage can be fed back to the -(-) input thru R20 to stabilize the op-amp.

-Capacitor C4 is charged to the peak value of the AC signal and accurately represents the peak of the incoming AC signal. The voltage drop across the diode becomes almost inconsequential due to the feedback process, and the circuit works down to a few mV.

A similar action occurs during the negative peak, using D7 & C5.

Resistor R21 provides a constant minimum amount of negative feed--back around op-amp 2D. The negative feedback increases the op-amp bandwidth which, most importantly, keeps the amplifier input-to-output phase-shift low enough for proper circuit operation.

The two outputs from the peak-to-peak detector are connected to two high-input-impedance unity-gain DC amplifiers, which drive the 1 mA meter movement differentially.

FAILURE MODES

Our ESR Meter has proven to be a very reliable instrument in field use. The very few failures that have occurred were simple electrical or mechanical problems. Component failures have been ZERO. In one unit, a resistor lead appeared to take solder but didn't. In another unit, battery electrolyte leaked onto the PCB. After THOROUGHLY cleaning the PCB, the unit worked fine. Two units were intermittent due to loose meter-terminal nuts. If intermittency appears, make sure these nuts are TIGHT and the PCB nuts SNUG. If the PCB nuts are tighter than the meter-terminal nuts, the meter nuts "float" on the screw threads and produce a poor connection to the PCB. Problems? Our expert 1-day service is usually free.

1. ICI & 1C2 are National LM324N or equivalent.
2. "F" resistors are 1% tolerance; all others 5%
3. R7 must be 0.5 W; all others 0.5 W or less.
4. IC1 selected for 100 kHz oscillation capability.
5. R1 sets frequency: 1K to 3.3K ohms.
6. R10 optional, selected improves scale linearity.
7. R15 optional; assists IC output pul1-down in some units.
8. R21 sets linearity at mid-scale: 330 to 2.2K~ ohms.
9. R24 optional; corrects DC offset at infinity ESR.
10. R26 helps set zero (full-scale): 68 to 240 ohms.
11. D6 & D7 selected for correct reading at 50 ohms ESR.
12. Calibrate at 75F. Wait 20 minutes after soldering PCB.

Values some have had trouble reading:

R6F=150 ohms
R12F=681 ohms

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