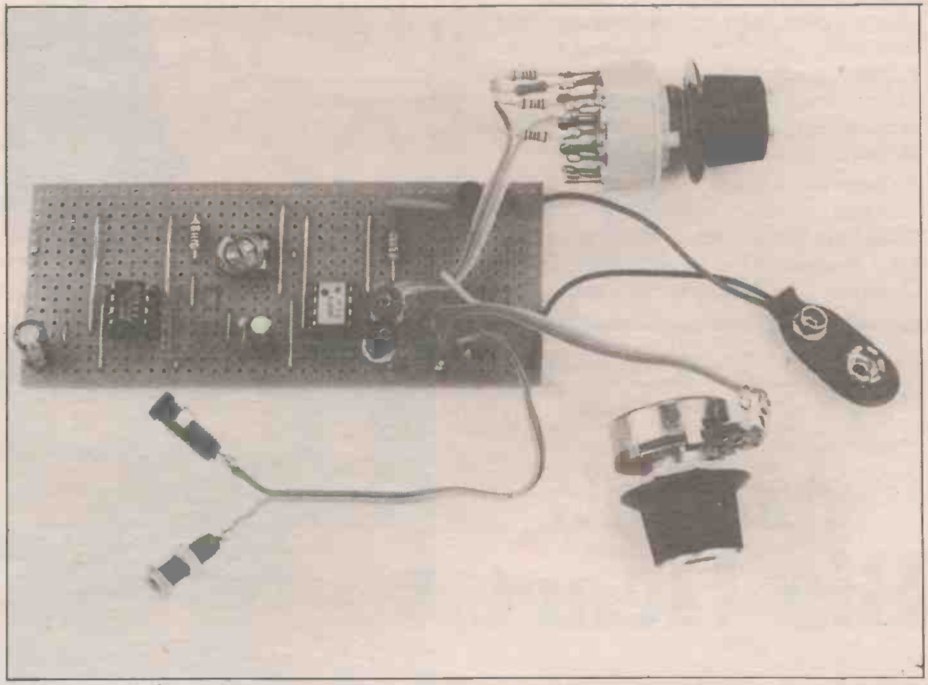
Capacitance Meter Adaptor

A capacitance meter is certainly one of the more useful items of equipment for the home constructor, but even home built instruments tend to be rather expensive. Unfortunately, few multimeters seem to include any capacitance measuring ranges. A low cost but very effective method of capacitance measurement is to use an add-on circuit for an existing multimeter. This avoids the main expense incurred when building a stand-alone unit, which is the cost of the digital display circuit or a good quality panel meter. The capacitance meter add-on described here is primarily intended for operation with a digital multimeter switched to its 1.999 volt range, but it should work quite well with an analogue multimeter having a sensitivity of 20k/volt or more, and a D.C. voltage range of 1 to 2.5 volts full scale. It has four ranges with full scale values (when used with a digital multimeter) of 1.999nF, 19.99nF, 199.9nF, and 1.999μF full scale. High value capacitors are beyond the capabilities of this circuit, but its range is quite respectable for such a simple and inexpensive circuit. Anyway, high value capacitors can usually be given a rough check with a multimeter set to a resistance range. The charge current of the capacitor (or lack of it) will be indicated by the meter, and will show whether or not it is basically functional. At the low end of its range, this unit can check capacitors of values down to a few picofarads.

The circuit is based on two 555 timers (IC1 and IC2) which are used in the astable and monostable modes respectively. IC1 provides a clock signal which is a series of very brief negative pulses. These trigger IC2 which provides output pulses of a duration that is controlled by the values of the switched resistors (R2 to R5) and the capacitor under test. The switched resistors provide the unit with its four measuring ranges. With the frequency of the output signal at a fixed rate, the average output voltage of the monostable depends on the duration of the output pulses, and is proportional to this duration. This is in turn proportional to the value of the test capacitor. The circuit therefore provides the required capacitance to voltage conversion. RV1 is used to calibrate the unit. R2 to R5 have a tolerance of 1% so that consistent results are obtained from one range to the next. Most multimeters have internal smoothing components, but R6 and C3 will smooth the output to a low ripple D.C. signal in the absence of any built-in smoothing.



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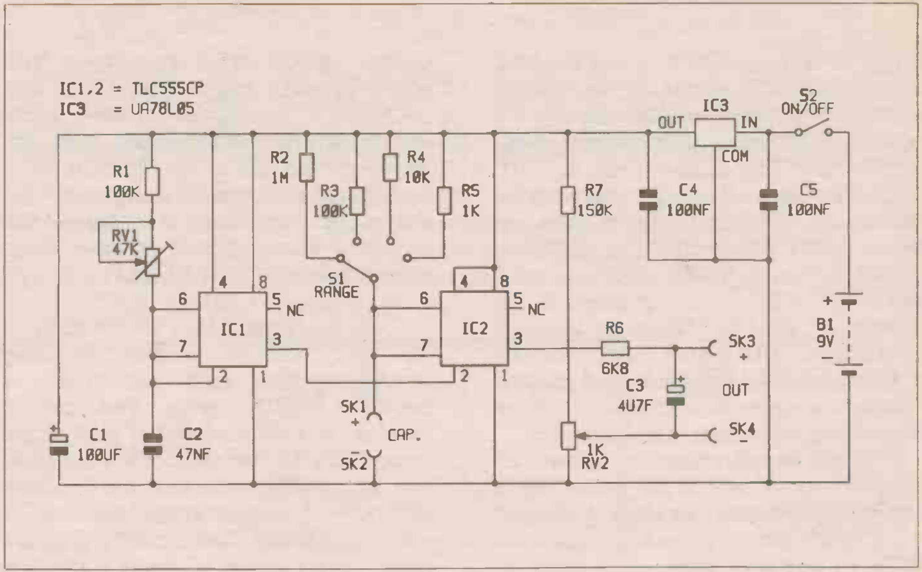
There is a problem with simple capacitance measuring circuits of this type in that there is a certain amount of stray capacitance in the monostable which is in parallel with the test capacitor, and adversely affects accuracy. The problem is insignificant on the higher ranges, but can be quite severe on the lower ranges. In this case the problem is eased by the use of the TLC555CP for IC1 and IC2. This has a higher switching speed and lower internal capacitance than the standard 555, and a quiescent reading of only about 20pF is obtained. The problem is further eased by RV2, which provides a variable offset voltage that can be used to zero the quiescent reading. This enables the unit to measure very low value capacitors.

A stable 5 volt supply is needed, and this is obtained from a 9 volt battery via monolithic voltage regulator IC3. The current consumption of the circuit is only about 4 milliamps.

Reasonable care must be taken with the layout of any circuit of this type, so that the stray capacitance in parallel with test components is kept as low as possible. I originally mounted R2 to R5 on the circuit board, but this boosted the stray capacitance from about 20pF to 80pF. It is much better to mount these resistors on S1. The unit can be calibrated on any range, but for best accuracy use a close tolerance capacitor that has a value which is around 50% to 100% of the full scale value of the range on which the unit will be calibrated. Zero the unit using RV2 prior to connecting the test component, and then adjust RV1 for the correct reading on the multimeter. Note that changing ranges will require some slight readjustment of RV2 in order to re-zero the unit. Note also that the decimal point of the display is in the wrong position on the middle two ranges, but you will soon get used to converting readings into true capacitance values. The unit is quite accurate, but when testing capacitors you must remember to make allowances for small deficiencies in the accuracy of the unit, and the tolerances of the test components (which can often be some 20%, or even more for ceramic types). As with any capacitance meter, do not connect charged capacitors to it! Always discharge test capacitors before connecting them to the unit.



Capacitance Meter Adaptor circuit.

CAPACITANCE METER ADAPTOR PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,3	100k	2	(M100K)
R2	1M	1	(M1M)
R4	10k	1	(M10K)
R5	1k	1	(M1K)
R6	6k8	1	(M6K8)
R7	150k	1	(M150K)
RV1	47k Hor Sub-min Preset	1	(WR60Q)
RV2	1k Lin Pot	1	(FW00A)
CAPACITORS			
C1	100μF 10V PC Electrolytic	1	(FF10L)
C2	47nF Polyester	1	(WW37S)
C3	4μ7F 63V PC Electrolytic	1	(FF03D)
C4,5	100nF Ceramic	2	(YR75S)
SEMICONDUCTORS			
IC1,2	TLC555CP	2	(RA76H)
IC3	μA78L05	1	(QL26D)
MISCELLANEOUS			
SK1	1mm Socket Red	1	(WL60Q)
SK2	1mm Socket Black	1	(WL59P)
SK3	2mm Socket Red	1	(HF47B)
SK4	2mm Socket Black	1	(HF44X)
S1	4-way 3-pole Rotary Switch	1	(FF75S)
S2	SPST Ultra-min Toggle Switch	1	(FH97F)
B1	9V PP3 Battery	1	(FK62S)
	Battery Connector	1	(HF28F)
	8-pin DIL Socket	2	(BL17T)