Another interesting application is in the light pointer as used nowadays on projected images in lectures, film shows, and so on The red-light laser diode is far more suitable than the He-Ne laser for fitting into a reasonably small tubular holder terminated in a convex (focusing) lens Moreover it can be powered by alkaline batteries Such a pointer would cost about a third of the price of an He-Ne laser, and be only a third of the size and weight of an He-Ne laser.

colour	wavelength (nm)
infra-red	1000–740
red	740–620
orange	620–585
yellow	585–575
green	575–500
blue	500–445
indigo	445–425
violet	425–390
ultraviolet	390–5

Use in compact and video disk players?

Believe it or not the price of a compact or video disk player is determined to a larger extent than generally known by the laser it uses. Why this is so will be clear from the following

In Fig 5, light falls on to a convex lens of diameter d The lens concentrates the light at principal focus F, which is a distance f (the focal length) from the optical centre of the lens The ray of light along the principal axis passes unhindered through the lens to F, but most other rays are refracted to F Some rays, however, are refracted to points other than F on the focal plane by an angle, α, with respect to the principal axis. From the curve at the right of Fig 5 it is seen that the light-intensity varies around F Indeed when focusing is poor (normally caused by a cheap lens), light at F is not a sharply defined point, but a disc of diameter a around the principal focus This disc is bright at its centre and becomes virtually dark at the nulls Note that by convention the null below the principal axis is negative and that above is positive.

The angle of aberration, α, is found from

$$\tan\alpha = (a/2)/f, \qquad [2]$$

where a/2 is the distance between the nulls and the principal axis.

The angle is also related to the wavelength of the light in the formula

$$\sin\alpha = 1.22\lambda/d \qquad [3]$$

These two formula can be combined provided α is small (the normal case) into

$$a = 2.44 f\lambda/d.$$

In an ideal lens, $f = d$ so that the diameter of the focal disc is

$$a = 2.44\lambda \qquad [4]$$

To ensure error-free scanning of the pits on the compact or video disc, the focal disc of the light must not be larger than the pits or wider than the tracks between the pits This has two important consequences

First, since the wavelength of the light determines the diameter of the focal disc non-chromatic light will cause several (overlapping) discs Only a laser will thus give one focal disc.

Second, the smaller the wavelength, the smaller the diameter of the focal disc, and the smaller the pits and track-width of the compact or video disk can be.

Currently the wavelength of the laser light in CD players is 780 nm This makes possible a distance of 1.9 µm between tracks and, consequently, about 18 000 tracks on the 33 mm wide recording surface of a CD. If the wavelength of the laser light is brought down to 660 nm, the number of tracks on a CD, and thus the playing time, can be increased by 18% The same applies to video disks and CD-ROM ■

References

"Lasers: an overview"; *Elektor Electronics*, July/August 1987 p. 27

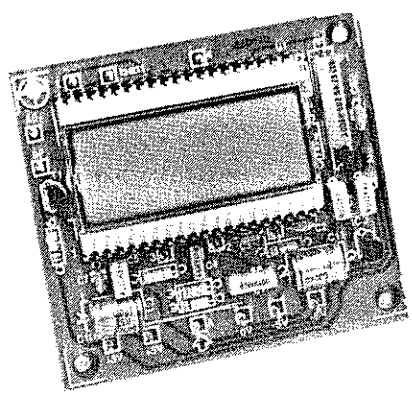
"The compact disc"; *Elektor Electronics* July/August 1987 p 39

LCD FOR INDUCTANCE/CAPACITANCE METER

Design by L. Pijpers

The liquid crystal display described in this article and shown in the photograph below is intended primarily for usewith the indutance-capacitance meter published last month

IN the design of a 3½ digit voltmeter module, IC Type ICL7106 has attained virtually the same status as a 555: universally known and suitable for almost any application It has nearly everything needed on board: an analogue-to-digital (A–D) converter with automatic zero-setting and the required display drivers All that is needed additionally are a reference voltage source and some passive components



The signal that renders the display black must be in anti-phase with the signal at the back-plane (BP) of the display The same is true for that controlling the decimal points and the LoBat indication Unfortunately, the 7106 does not provide these signal and, therefore, transistor T_1 has been added to invert the BP signal By connecting board pins dp_n, dd_p, and bat to BP, the associated parts of the display become visible.

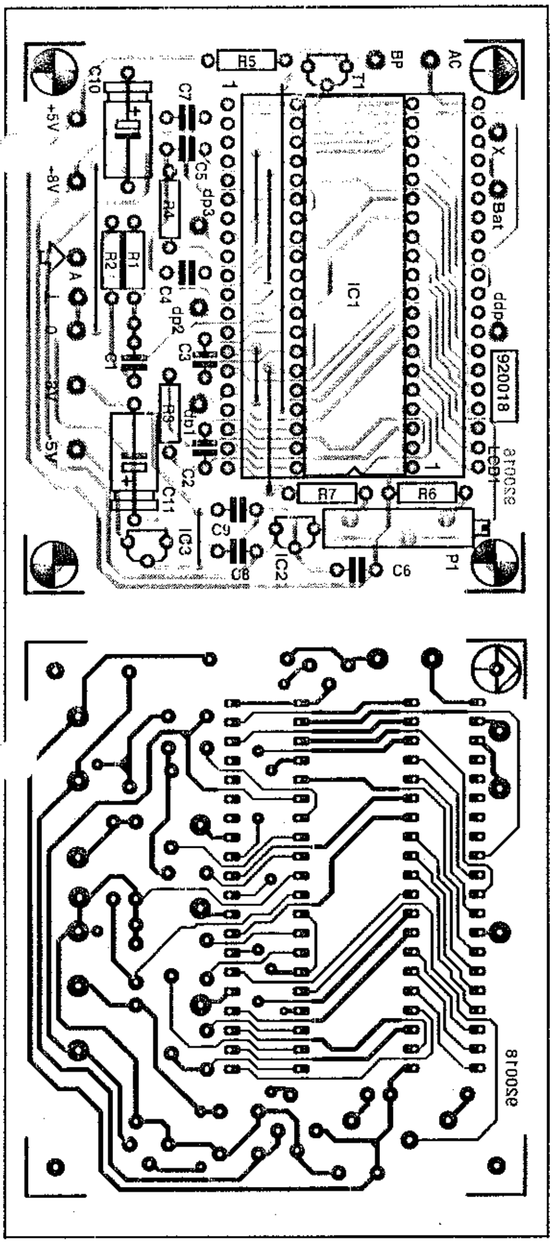
If non-connected pins or the LoBat indication pick up noise that cause the relevant information to become visible, the former can be linked to pin 40 (AC) direct and the latter via a 10 MΩ resistor

The input circuit is a low-pass filter with a cut-off frequency of 16 Hz that refrains any noise at the input from reaching the A–D converter

The clock that 'motivates' the 7106 has a frequency determined by C_2, that makes two measurements per second possible

Resistor R_4 and capacitors C_3–C_5 form part of the A–D converter circuit

The supply voltage is high enough to ensure that the reference voltages, connected



PARTS LIST

Resistors:
R1 = 22 MΩ
R2, R5 = 1 MΩ
R3 = 100 kΩ
R4 = 470 kΩ
R6 = 18 kΩ
R7 = 10 kΩ
P1 = 10-turn preset, 4.7 kΩ

Capacitors:
C1 = 10 nF
C2 = 150 pF
C3, C6, C7 = 100 nF
C4 = 47 nF
C5 = 220 nF
C8, C9 = 330 nF
C10, C11 = 100 μF, 25 V, radial

Semiconductors:
T1 = BS170
IC1 = ICL7106
IC2 = 78L05
IC3 = 79L05

Miscellaneous:
LCD1 = 3½ digit display
40-pin low-profile IC holder
2 off 20-pin terminal strip
PCB 920018

to V+ and Comm of IC_1, are sufficiently stable for the A–D conversation to be accurate to 1 digit. This assumes, of course, that the reference voltages, REF HI and REF LO, have been preset correctly with P_1. The voltage between REF HI and REF LO must be half the full-scale value, that is, here 1 V. Presetting is easiest by applying a voltage of 1.9 V to the input and adjusting P_1 till the display indicates the same value as the meter with which the input voltage is measured. Do not make the input voltage much higher, because if P_1 is then turned a little too far, IC_1 will indicate an 'overload' which complicates the setting.

To make the circuit suitable for supply voltages of ±8–±20 V, it has been provided with two voltage regulators, IC_2 and IC_3, which provide a supply of ±5 V. If such a supply is already available, IC_2, IC_3 and C_8–C_{11} may be omitted.

The circuit is best built on the printed-circuit board shown in Fig. 2. Start the construction with the wire links and end with placing the display into its holder. Since the display is mounted over IC_1, it is important that the 7106 is fitted in a low-profile holder. If the display does not fit properly on to the two terminal strips, plug another pair of terminal strips into the first and then the display into the second pair.

It is, perhaps, interesting to note that the type of display specified is also suitable for (diffused) back lighting. ■

PARAMETERS

Metering range	±2 V with respect to earth
Accuracy	±1 digit (see text)
Supply voltage	Regulated: ±5 V
	Unregulated: ±8–±20 V
Display connections	dp1–dp3; ddp (:); LoBat