

**PHILIPS**

Data handbook



Electronic  
components  
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Semiconductors

Book S14

1987

Liquid Crystal Displays

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Liquid Crystal Displays

S14

1987

## DATA HANDBOOK SYSTEM



## DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

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The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

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- T3**      **Klystrons**
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- T5**      **Cathode-ray tubes**  
Instrument tubes, monitor and display tubes, C.R. tubes for special applications
- T6**      **Geiger-Müller tubes**
- T8**      **Colour display systems**  
Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
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- S4a Low-frequency power transistors and hybrid modules**
- S4b High-voltage and switching power transistors**
- S5 Field-effect transistors**
- S6 R.F. power transistors and modules**
- S7 Surface mounted semiconductors**
- S8a Light-emitting diodes**
- S8b Devices for optoelectronics**  
Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and infrared sensitive devices, laser and fibre-optic components
- S9 Power MOS transistors**
- S10 Wideband transistors and wideband hybrid IC modules**
- S11 Microwave transistors**
- S12 Surface acoustic wave devices**
- S13 Semiconductor sensors**
- \*S14 Liquid Crystal Displays**

\*To be issued shortly.

## INTEGRATED CIRCUITS (PURPLE SERIES)

The NEW SERIES of handbooks is now completed. With effect from the publication date of this handbook the "N" in the handbook code number will be deleted. Handbooks to be replaced during 1986 are shown below.

The purple series of handbooks comprises:

<b>IC01</b>	<b>Radio, audio and associated systems</b> Bipolar, MOS	new issue 1986 IC01N 1985
<b>IC02a/b</b>	<b>Video and associated systems</b> Bipolar, MOS	new issue 1986 IC02Na/b 1985
<b>IC03</b>	<b>Integrated circuits for telephony</b> Bipolar, MOS	new issue 1986 IC03N 1985
<b>IC04</b>	<b>HE4000B logic family</b> CMOS	new issue 1986 IC4 1983
<b>IC05N</b>	<b>HE4000B logic family – uncased ICs</b> CMOS	published 1984
<b>IC06N</b>	<b>High-speed CMOS; PC74HC/HCT/HCU</b> Logic family	published 1986
<b>IC08</b>	<b>ECL 10K and 100K logic families</b>	New issue 1986 IC08N 1984
<b>IC09N</b>	<b>TTL logic series</b>	published 1986
<b>IC10</b>	<b>Memories</b> MOS, TTL, ECL	new issue 1986 IC7 1982
<b>IC11N</b>	<b>Linear LSI</b>	published 1985
<b>Supplement to IC11N</b>	<b>Linear LSI</b>	published 1986
<b>IC12</b>	<b>I<sup>2</sup>C-bus compatible ICs</b>	not yet issued
<b>IC13</b>	<b>Semi-custom</b> Programmable Logic Devices (PLD)	new issue 1986 IC13N 1985
<b>IC14</b>	<b>Microcontrollers and peripherals</b> Bipolar, MOS	published 1986
<b>IC15</b>	<b>FAST TTL logic series</b>	new issue 1986 IC15N 1985
<b>IC16</b>	<b>CMOS integrated circuits for clocks and watches</b>	first issue 1986
<b>IC17</b>	<b>Integrated Services Digital Networks (ISDN)</b>	not yet issued
<b>IC18</b>	<b>Microprocessors and peripherals</b>	new issue 1986

## COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

- C2** Television tuners, coaxial aerial input assemblies, surface acoustic wave filters
- C3** Loudspeakers
- C4** Ferroxcube potcores, square cores and cross cores
- C5** Ferroxcube for power, audio/video and accelerators
- C6** Synchronous motors and gearboxes
- C7** Variable capacitors
- C8** Variable mains transformers
- C9** Piezoelectric quartz devices
- C11** Varistors, thermistors and sensors
- C12** Potentiometers, encoders and switches
- C13** Fixed resistors
- C14** Electrolytic and solid capacitors
- C15** Ceramic capacitors
- C16** Permanent magnet materials
- C17** Stepping motors and associated electronics
- C18** Direct current motors
- C19** Piezoelectric ceramics
- C20** Wire-wound components for TVs and monitors
- C22** Film capacitors





## LIQUID CRYSTAL DISPLAYS

	<i>page</i>
<b>Preface</b> .....	3
<b>Selection guide</b> .....	5
<b>Index</b> .....	7
<b>Optical selection guide</b> .....	9
<b>User guide</b> .....	13
Main features of LCD .....	15
Typical applications .....	15
Principles of LCD .....	15
Viewing characteristics .....	16
Electro-optical characteristics .....	16
Driving methods .....	19
Supertwisted Birefringe Effect (SBE) .....	21
Modules .....	21
<b>Quality</b> .....	23
Quality aspects .....	25
Handling aspects .....	26
Mounting methods .....	27
Reliability .....	27
<b>Custom design</b> .....	29
<b>Type code information</b> .....	33
Type number designations .....	35
Cross reference guide .....	36
<b>General LCD family characteristics</b> .....	37
<b>LCD cell data</b> .....	47
<b>LCD module data</b> .....	115
<b>Brief driver device data</b> .....	167



**PREFACE**

This data handbook is a guide to the use of liquid crystal displays. LCDs are versatile displays with a large number of superior features. These include low power consumption, high legibility (even in bright sunlight), thin outline and flexibility in pattern design. The principles of LCD are outlined in the chapter "User guide" and standard LCD data is contained in the chapter "LCD cell data".

As LCDs are commonly custom designed the handbook contains a custom design guide and brief driver data.



## SELECTION GUIDE

	<i>page</i>
<b>Index</b> .....	<b>7</b>
<b>Optical selection guide</b> .....	<b>9</b>



TYPE NO.	DESCRIPTION	DRIVE*	DIMENSIONS (mm)		PAGE
			length	height	
LTA141-C01/C12	5x7 dot matrix	DD	50,8	80,0	49
LTD101-E01	3½-digit clock	DD	50,8	22,9	51
LTD132-E01	3½-digit + analog clock	1:2	54,8	46,8	53
LTD201-E01	4-digit	DD	23,9	14,0	57
LTD202-C01/C12	2-digit	DD	27,9	30,4	59
LTD203-E01/E12	4-digit	DD	38,0	20,3	61
LTD211-E01/E12	8-digit	1:2	38,0	20,3	63
LTD221-C01/C12	3½-digit	DD	50,8	30,4	67
LTD221-E01	3½-digit	DD	50,8	30,4	67
LTD222-C01/C12	3½-digit multimeter	DD	50,8	30,4	69
LTD222-E01/E12	3½-digit multimeter	DD	50,8	30,4	69
LTD224-E01	3½-digit multimeter	DD	50,8	30,4	71
LTD225-E01	3½-digit multimeter	DD	50,8	30,4	73
LTD226-C01/C12	4-digit	DD	50,8	30,4	75
LTD226-E01/E12	4-digit	DD	50,8	30,4	75
LTD227-C01/C12	4½-digit multimeter	DD	50,8	30,4	77
LTD228-C01	5-digit	DD	50,8	30,4	79
LTD229-C01/C12	6-digit	DD	69,8	30,4	81
LTD231-E01	3½-digit multimeter	1:3	50,8	30,4	83
LTD232-E01	4½-digit multimeter	1:3	50,8	30,4	87
LTD233-E01	16-digit	1:2	69,8	20,3	91
LTD234-E11	16-digit	1:4	69,8	20,3	95
LTD241-C01/C12	3½-digit multimeter	DD	69,8	38,0	99
LTD242-C01/C12	4-digit	DD	69,8	38,0	101
LTD261-C01/C12	1-digit	DD	76,2	101,6	103
LTD262-C01/C12	8-digit	DD	93,8	30,8	105
LTD263-C01 and C11	6-digit	DD	93,8	30,8	107
LTD264-C11 and C12	5-digit till display	DD	114,0	26,0	109
LTD321-C01	bargraph	DD	69,8	30,4	111
LTD351-E01	bargraph	1:2	114,0	26,0	113
LTG201-N01	graph. 240 x 64 dot mod.	1:64	180,0	75,0	117
LTG401-N01	graph. 640 x 200 dot mod.	1:100	256,0	125,0	125
LTM233-N01	16-digit module	1:2	92,5	25,0	133
LTN111-N01	16-char. 5 x 7 dot 1-line mod.	1:16	80,0	36,0	137
LTN211-N01	16-char. 5 x 7 dot 2-line mod.	1:16	84,0	44,0	147
LTN241-N01	40-char. 5 x 7 dot 1-line mod.	1:16	182,0	33,5	157

\* DD: direct drive





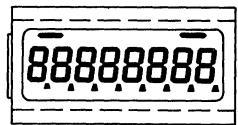
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LTD203



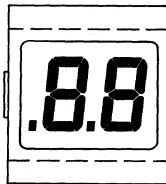
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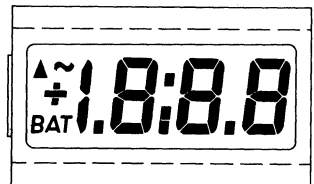
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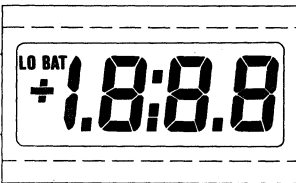
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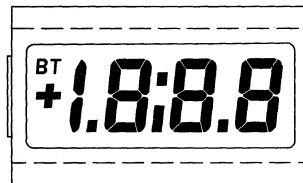
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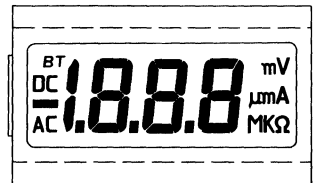
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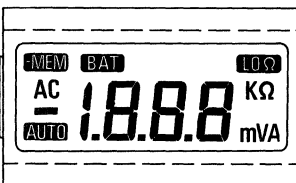
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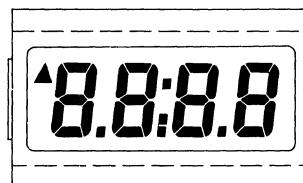
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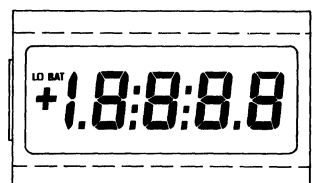
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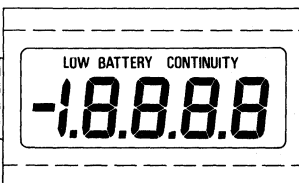
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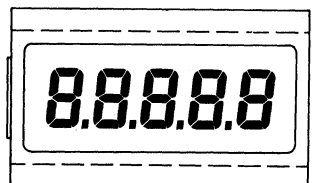
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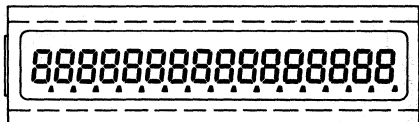


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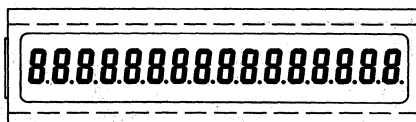


OPTICAL  
SELECTION GUIDE

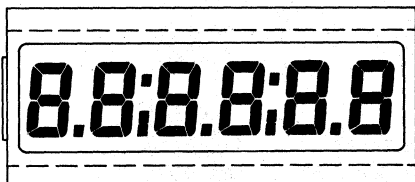
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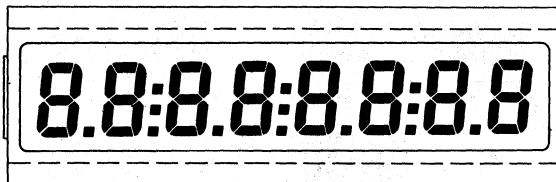
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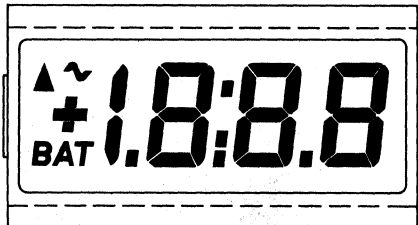
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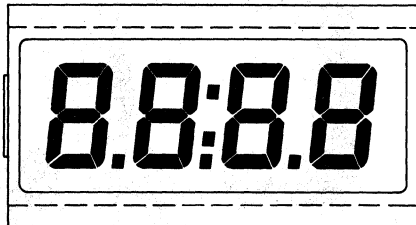
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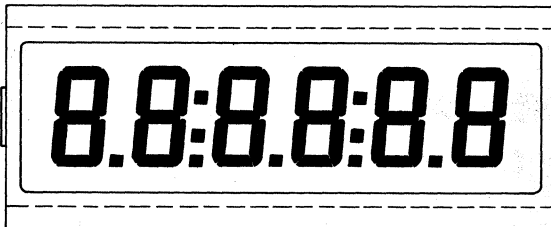
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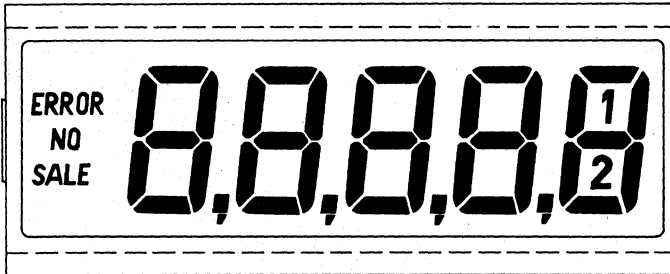
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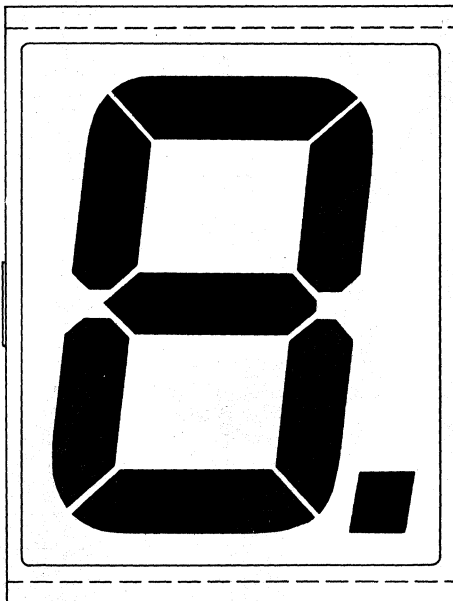
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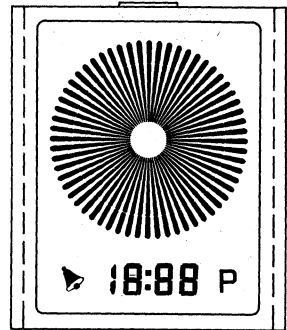
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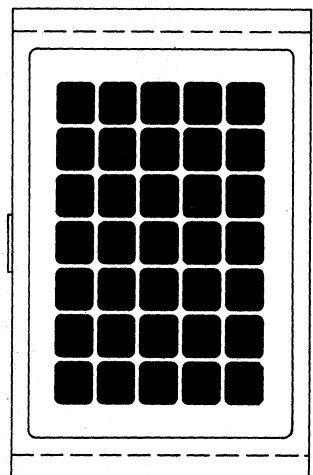
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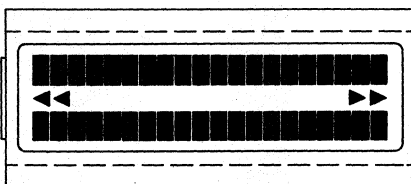
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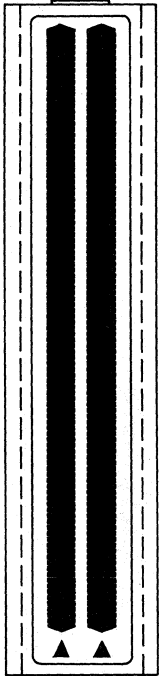


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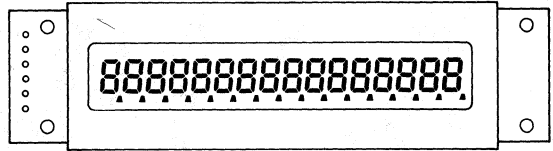


OPTICAL  
SELECTION GUIDE

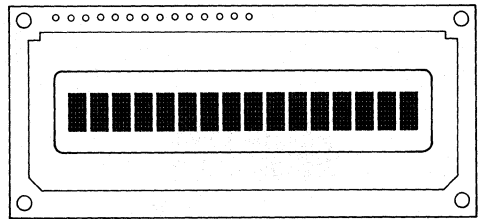
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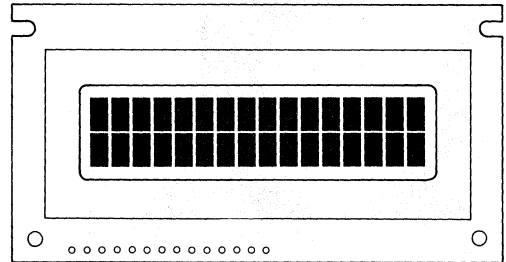
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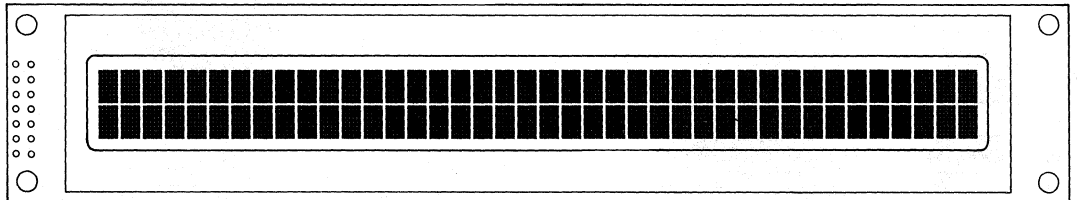
LTN111-N01



LTN211-N01



LTN241-N01



## USER GUIDE

	<i>page</i>
<b>Main features of LCD</b> .....	15
<b>Typical applications</b> .....	15
<b>Principles of LCD</b> .....	15
<b>Viewing characteristics</b> .....	16
<b>Electro-optical characteristics</b> .....	16
<b>Driving methods</b> .....	19
<b>Supertwisted Birefringe Effect (SBE)</b> .....	21
<b>Modules</b> .....	21



USER GUIDE

MAIN FEATURES OF LCD

LCDs are passive displays and are flexible-in both pattern, size and design (from standard 7-segment displays to full dot graphic displays).

LCDs are very legible and unlike active displays, do not suffer from washout even under very bright lighting conditions.

They are thin, consume little power and are CMOS compatible making them ideal for portable applications.

TYPICAL APPLICATIONS

Although initially used almost exclusively in consumer products, such as watch and clock displays, the application areas have expanded enormously. Those application areas which are becoming of increasing importance are computers, automotive, telephony and test and measuring equipment.

PRINCIPLES OF LCD

Liquid crystal

Liquid crystal is an organic material which is in a mesophysical phase between an isotropic liquid state and a crystalline solid state. The molecules are free to move but are grouped together in an orderly manner.

The liquid crystal generally used for display purposes is nematically structured as the cigar shaped molecules are aligned and their optical properties can be influenced by electric fields (see Fig. 1).

Twisted nematic displays (TN)

In an LCD the fluid occupies a space of a few microns between two parallel glass plates. The inner surfaces of the plates have transparent conductive coatings (electrodes) that define the symbols, characters or other pattern to be displayed. The surface of the glass in contact with the fluid is treated to induce the crystals to align in a direction parallel to the plate.

In TN displays the direction of the molecules at one plate is at right angles to the direction of the molecules at the other plate, therefore the molecules of the fluid are twisted through a 90° helix. As the LCD's front and backplane polarizers are also at right angles the fluid helix rotates the plane of polarization through 90° which allows light to pass. Provided that no voltage is applied, the light will pass through the display following the helix of the fluid molecules. A suitable voltage between the two electrodes will cause the molecules of the fluid to align themselves parallel to the electric field, so they no longer rotate the plane of polarization. The emergent light beam will then be polarized at right angles to the direction of the output polarizer and will therefore be blocked.

The pattern defined will appear dark on a bright background (positive contrast). The displays will give a negative contrast when the polarizers are applied parallel to each other.

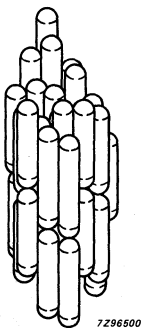


Fig. 1 Nematic phase

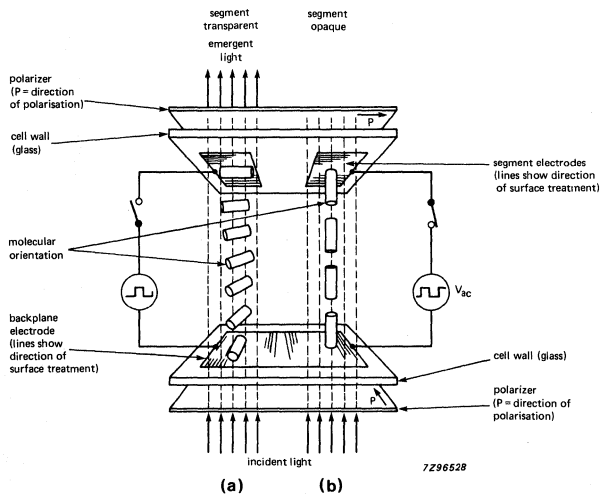


Fig. 2 Operating principles of TN-LCD



**VIEWING CHARACTERISTICS**

**Viewing modes**

LCDs are produced in three main viewing modes.

*Reflective mode*

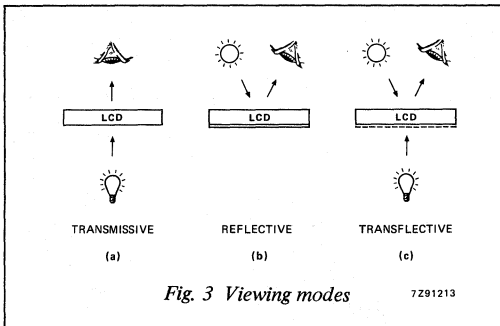
In reflective mode the LCD is backed by a diffuse reflector, such as brushed aluminium foil, that reflects ambient light through the display. This mode gives high contrast and is best used where ambient light is always available. Because no energy is needed for a light source in reflective mode LCDs, this mode is ideally suited to battery-powered applications.

*Transmissive mode*

In transmissive mode the display is lit from behind using artificial light sources. This mode is often used with negative displays (light segments on a dark background) and colour filters.

*Transflective mode*

Transflective mode is a mixture of reflective and transmissive modes and is used where the display is to be viewed under all lighting conditions. The transflector, a partially transmissive reflector, reflects ambient light as well as diffusing back lighting for night use.



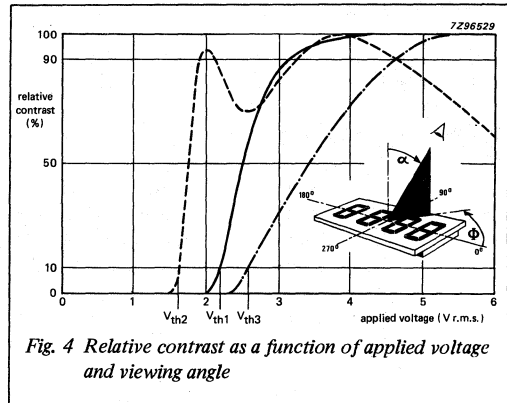
**Contrast and brightness**

LCDs do not generate their own light but modify incident light by controlled absorption and reflection. The brightness of an LCD is expressed as the luminance of reflected or transmitted light as a function of the luminance of incident light (measured on a MgO surface for reflective displays).

The legibility of an LCD depends largely on the contrast ratio ( $CNR = B_l/B_d$  where  $B_l$  is the brightness of the light parts of the display and  $B_d$  is the brightness of the dark parts of the display). For TN displays the maximum contrast ratio is typically between 5 and 50. The limit of legibility in good light is a ratio of about 2 and in bad light it is a ratio of about 3 (for comparison the contrast ratio of a newspaper is about 7).

The ratio of the actual contrast of the display to the maximum contrast obtainable from the display under given conditions is called relative contrast ( $CNR_{rel}$ ); it is usually expressed as a percentage.

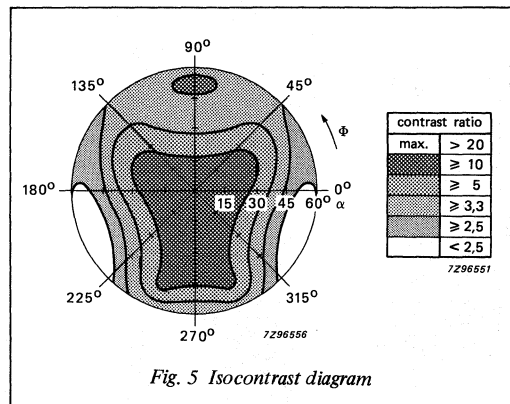
Brightness and contrast both depend on the type of polarizers used.



**ELECTRO-OPTICAL CHARACTERISTICS**

**Voltage and contrast**

The contrast of a TN display depends on the applied voltage and the viewing angle. The voltage at which contrast first appears is known as the threshold voltage ( $V_{th}$ ). As voltage increases, the relative contrast also increases. The voltage at which  $CNR_{rel} = 90\%$  is called the saturation voltage ( $V_{sat}$ ). Both  $V_{th}$  and  $V_{sat}$  vary considerably with viewing angle. Contrast also varies with viewing angle; the alteration is defined in graphical form as an isocontrast diagram (see Fig. 5). The isocontrast diagram shows contrast in relation to azimuth ( $\Phi$ ) and elevation ( $\alpha$ ) angles. The dark area of the diagram shows at which combined angles the optimum contrast is achieved.



**Colour and TN displays**

Colour can be introduced into TN displays in different ways: colour selective polarizers, coloured filters or coloured back lighting. Colour selective polarizers produce coloured segments on a bright background or bright segments on a coloured background. Coloured filters may either be of foil or printed on the display. Coloured filters work better with back lighting and are best used with transmissive, negative image LCDs (light segments on a dark background). Non-energized the segments appear dark like the background, but energized the segments become a window for the coloured light to pass through.

**The guest/host display (GHD)**

In GHDs a dichroic dye is dissolved in the liquid crystal and its molecules align themselves with the long axes of the liquid crystal molecules. Where the molecules are parallel to the display surface (typically the non-energized parts) a part of the incident light is absorbed and the display

appears coloured. When the cell is energized the molecules are perpendicular to the glass surface, light passes through the display and is unaffected by the dye and so the segments appear clear. Generally GHDs have bright segments on a coloured background and are now available in several colours and black.

GHDs are available in two main technologies: the "Heilmeyer" type, with one polarizer for higher contrast, used specifically in transmissive mode, and the "White and Taylor" type, without polarizers for very bright segments in the reflective mode.

The advantages of GHDs are: brighter displays, wider viewing angle and less parallax distortion.

Present disadvantages are: lower contrast (but high legibility due to higher brightness), higher operating voltages and inferior multiplexability. Current development is aimed at overcoming these problems.

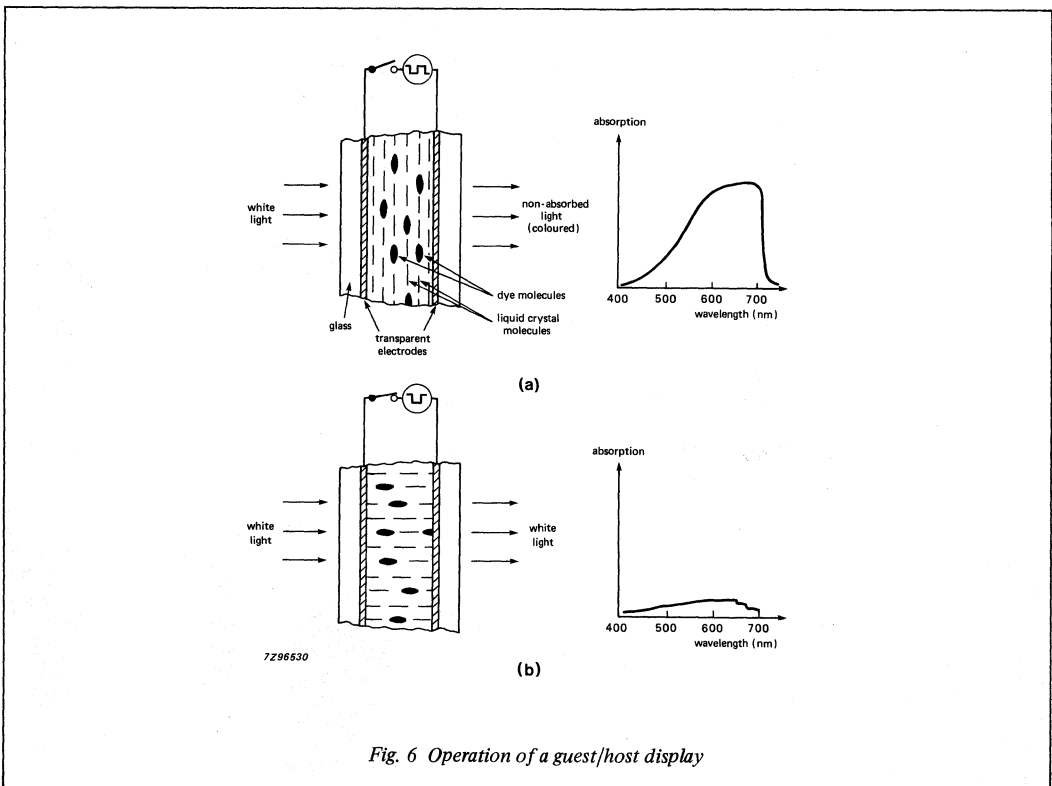
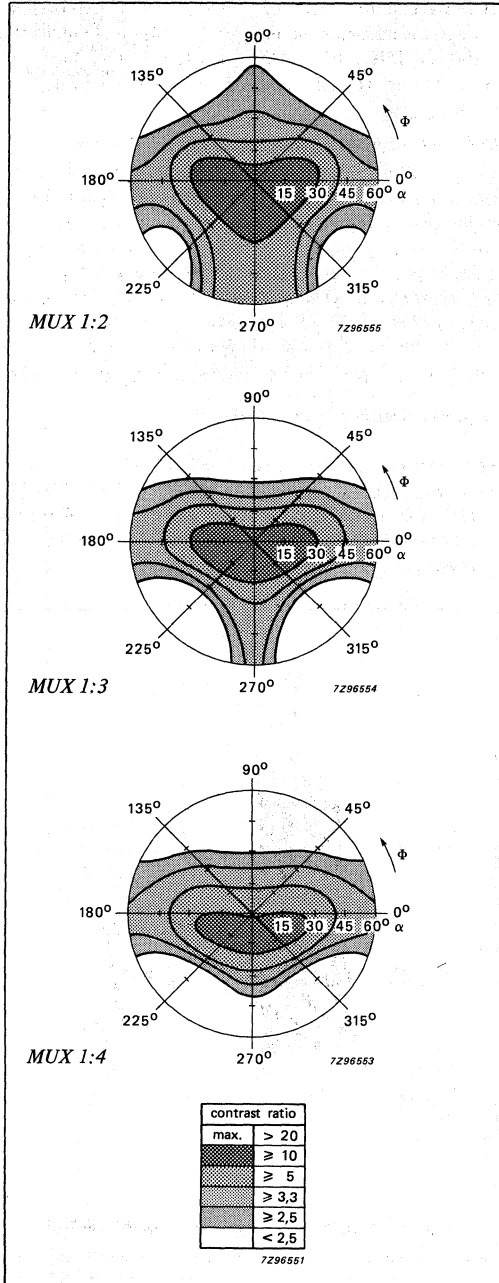


Fig. 6 Operation of a guest/host display

Typical isocontrast diagrams (TN displays)



Temperature dependence of voltage and contrast

Contrast, saturation voltage and threshold voltage are temperature dependent with a negative coefficient; the threshold voltage falls as temperature rises.

On and off response times are also temperature dependent. As a result of the increasing viscosity of the liquid crystal, the on and off response times increase as temperature decreases.

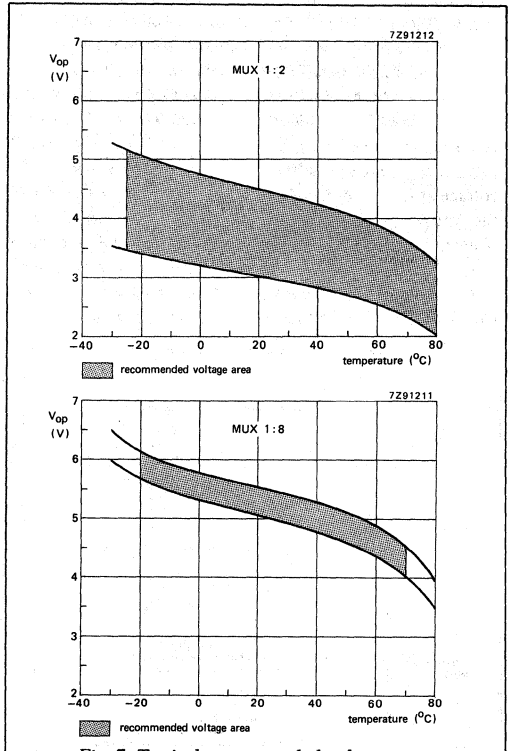


Fig. 7 Typical recommended voltage areas

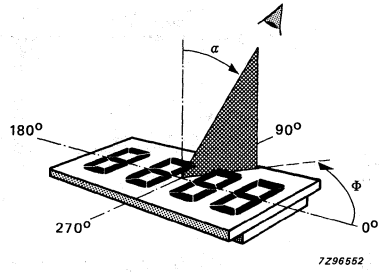


Fig. 8 Azimuth ( $\Phi$ ) and elevation ( $\alpha$ ) angle definitions

Figure 7 shows the typical recommended voltage areas for multiplex ratios of 1:2 and 1:8; the larger the ratio the smaller the recommended voltage area.

**DRIVING METHODS**

**Direct drive**

In a direct drive LCD there is a common electrode on one glass pane and a segment on the other (see Fig. 2). The common electrode is often called the backplane electrode although it can be carried by either the front or rear glass pane. Each display segment is connected directly to a corresponding terminal in the driving circuit. Figure 9 illustrates a phase-switching arrangement commonly used in direct drive LCDs. A square wave is applied to the backplane electrode and to one input of each of the EXCLUSIVE-OR gates controlling the individual segments. The control voltage at the other input of each gate determines whether the gate output is in phase or in antiphase with the backplane voltage. If the control voltage is HIGH the gate output is in antiphase with the backplane voltage and the segment is on; if the control voltage is LOW the output is in phase with the backplane voltage and the segment is off.

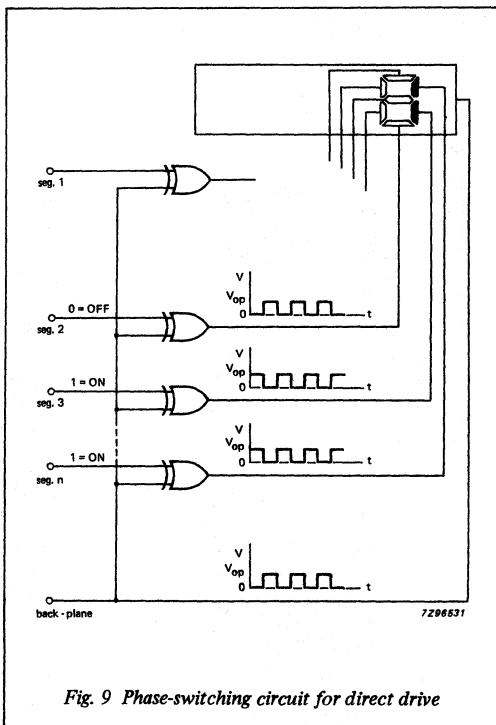


Fig. 9 Phase-switching circuit for direct drive

To avoid electro-chemical reactions that shorten the life of an LCD, the drive voltage must be an alternating one whose effective amplitude is not much greater than the saturation voltage; the maximum permissible d.c. voltage component is 100 mV. Direct drive gives the greatest freedom with regard to drive voltage, operating temperature range and viewing angle.

**Multiplex drive**

Direct drive LCDs with a large number of segments and hence connections are difficult to mount and design. Both the number of connections and driving circuits can be reduced by multiplexing: connecting segments together in groups and addressing them sequentially via multiple backplane electrodes. The number of common electrodes or segments per group determines the multiplex ratio (see Fig. 10). When the number of segments is n and the multiplex ratio is M then the number of connections used,

$$\text{is } \frac{n}{M} + M \text{ against } n+1 \text{ for direct drive.}$$

Fig. 11 shows the drive voltage waveforms of a 1:4 multiplex drive LCD. The common electrodes are activated sequentially and the segment groups are switched on or off simultaneously in accordance with the characters to be displayed.

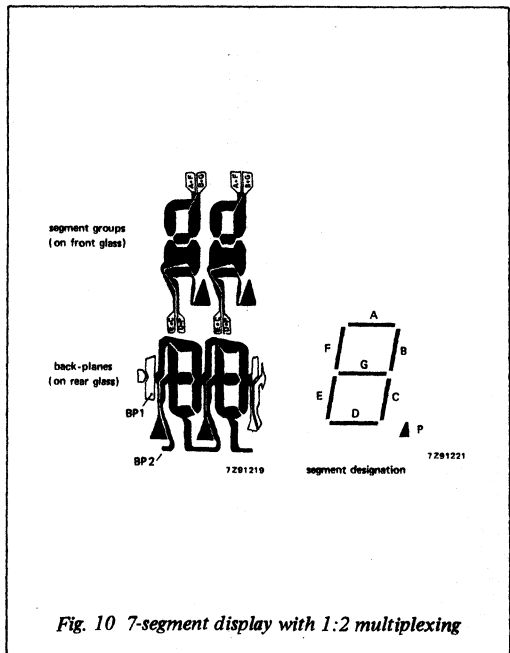


Fig. 10 7-segment display with 1:2 multiplexing

The repetition frequency of the drive waveforms must be at least  $Nf_f$ , where  $N$  is the reciprocal of the multiplex ratio and  $f_f$  is the flicker onset frequency for direct drive (30 Hz). As liquid crystal responds to the r.m.s. value of the applied voltage, the off voltage of a multiplex LCD is not 0, as in direct drive, but a fraction of the on voltage. The ratio of the on to the off voltage (discrimination) depends on the multiplex ratio and the number of voltage levels involved (see Table 1).

Multiplex operation is made possible because of the non-linearity of the contrast/voltage characteristics of the LCD (see Fig. 4).

To obtain optimum contrast and keep the off segments invisible during multiplex drive, the operating voltage has to be such that the off voltage is just below the threshold voltage. The on voltage and contrast are then a function of

the steepness of the  $CNR_{rel}$  versus applied voltage curve (which depends on the liquid crystal) and the discrimination (which depends on the multiplex method). With too high a voltage the off segments become visible and with too low a voltage contrast is lacking (see Fig. 7).

At low multiplex ratios satisfactory operation over a wide ambient temperature range can be obtained with a fixed value of  $V_{OP}$ . To obtain a constant viewing cone throughout the same ambient temperature range at high multiplex ratios,  $V_{OP}$  has to be temperature compensated to allow for the negative temperature coefficient of the threshold voltage. Besides the effects multiplexing has on operating voltage and ambient temperature ranges it also narrows the viewing angle. The slope of the contrast/voltage curve and the narrowing of the viewing angle sets practical limits to the multiplex ratio. The highest ratio currently

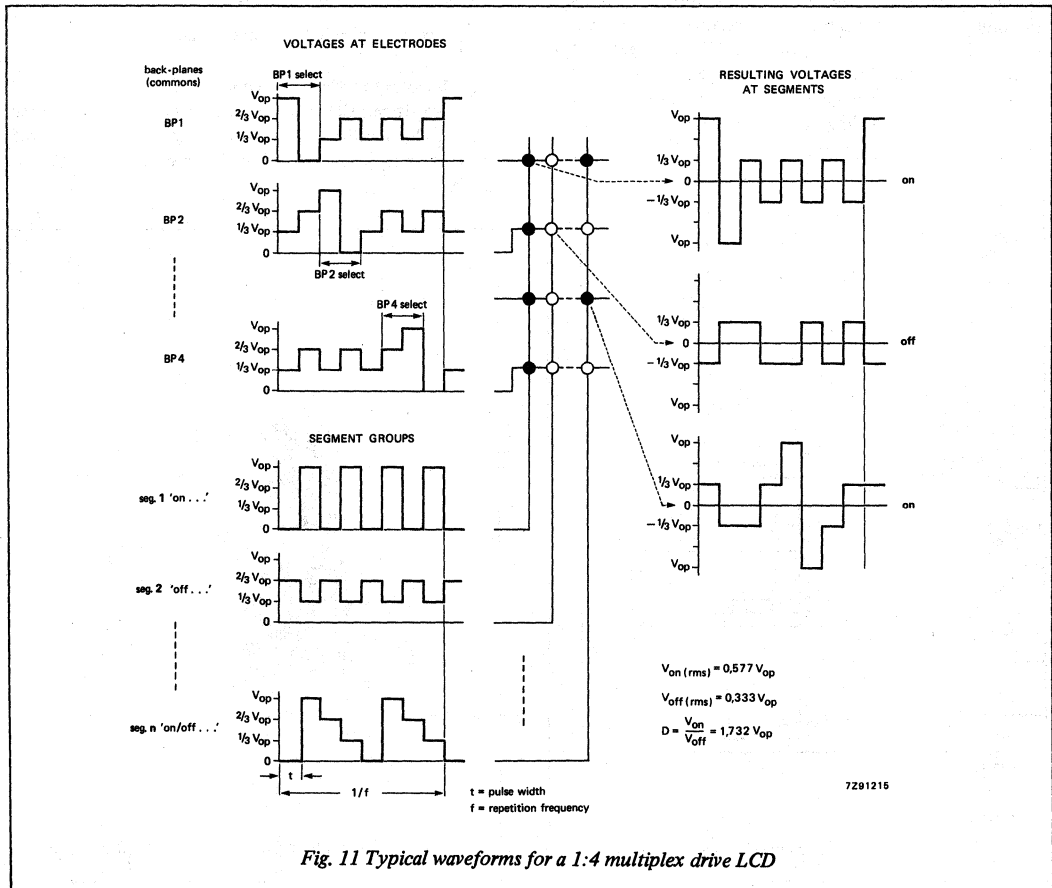


Fig. 11 Typical waveforms for a 1:4 multiplex drive LCD

recommended is about 1:4 for segment displays, 1:16 for dot matrix character displays and 1:64 for dot matrix graphic displays.

**SUPERTWISTED BIREFRINGE EFFECT (SBE)**

SBE is a new LCD technology which is currently being introduced to the market. In SBE the liquid molecules are rotated by 270° compared to the 90° used in twisted nematic displays.

SBE allows very high multiplex rates (over 1:100) with good contrast under wide viewing angles. Such high multiplex rates are required for graphic displays. A typical application is portable computers.

**MODULES**

LCDs are also available in modules complete with driving circuitry, frame or housing, mounting board and connectors (see Fig. 12). Because LCD modules are compatible with microprocessor- or microcontroller-based systems, the equipment designer does not have to concern himself with problems specific to the display.

**Chip-on-glass (COG)**

Further progress in the field of modules is chip-on-glass technology. The drive IC is bonded to the metallization on the glass of the LCD. This method of mounting the driver reduces the external connections drastically to 5 or 6 (including power supply and serial data bus which is directly controllable by most microcomputers).

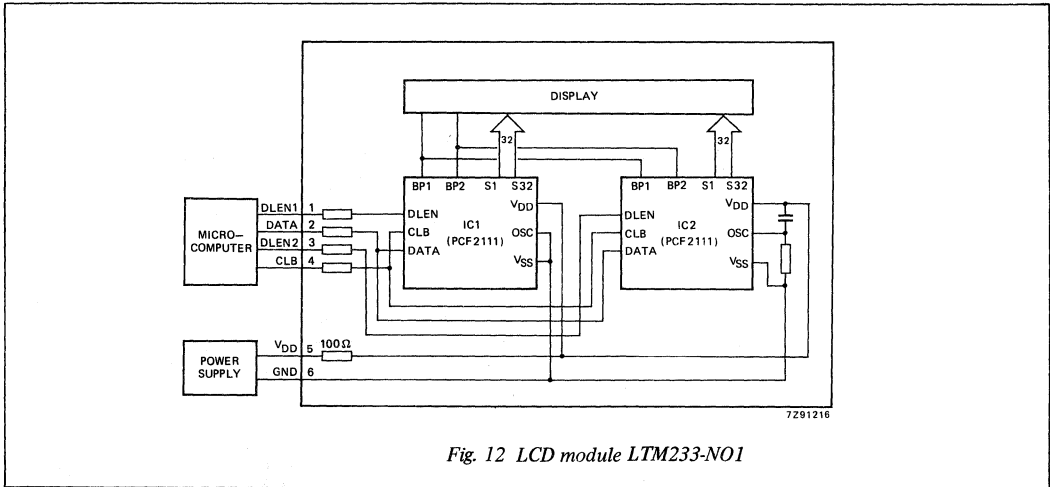


Fig. 12 LCD module LTM233-NO1

Table 1 Operating voltage ratios

multiplex ratio	1:1	1:2	1:3	1:4	1:8	1:16
$V_{off(rms)}/V_{op}$	0	0,35	0,33	0,33	0,30	0,24
$V_{on(rms)}/V_{op}$	1	0,79	0,64	0,57	0,43	0,32
discrimination $\frac{V_{on(rms)}}{V_{off(rms)}}$	$\infty$	2,24	1,92	1,73	1,45	1,29
number of connections required for 16-segment characters	257	130	89	68	40	32



## QUALITY

	<i>page</i>
<b>Quality aspects</b> . . . . .	<b>25</b>
<b>Handling aspects</b> . . . . .	<b>26</b>
<b>Mounting methods</b> . . . . .	<b>26</b>
<b>Reliability</b> . . . . .	<b>27</b>





**QUALITY ASPECTS**

**Quality in design**

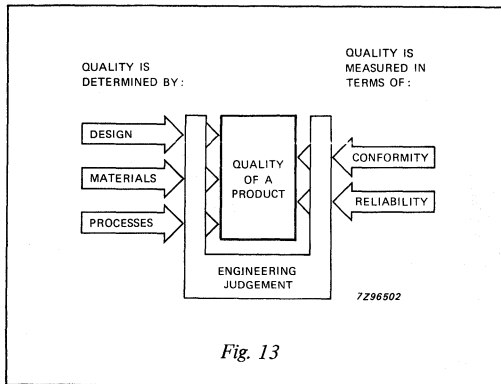


Fig. 13

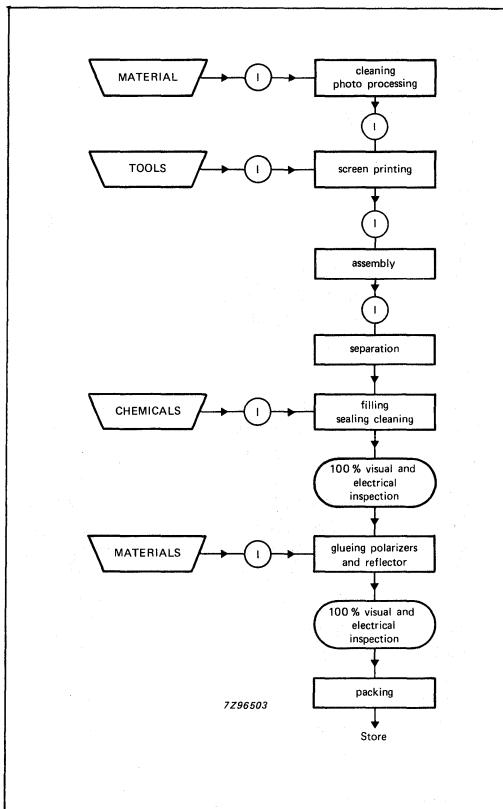
**Internal quality control**

Internal quality control is carried out under four main phases: incoming inspection, fabrication control, functional and final inspection and reliability. It is our intention, using our quality controls, to design in reliability rather than test it out.

**Incoming inspection**

All incoming materials are subjected to incoming inspection.

**Simplified inspection flow diagram**



**Optical defects**

Optical defects are defined as visible irregularities within the viewing area (energized or non-energized display areas according to the display drawing). The limit of the acceptable size of an optical defect depends on the viewing distance and on the contrast of the optical fault. The acceptance criteria for optical defects is established using samples which have been agreed upon by both the customer and by the vendor. These samples represent esthetic borderline conditions of LCDs when mounted in the finished product.

**Inspection method**

The displays are inspected at a maximum viewing distance of 50 cm from the unaided eye. Inspection time per display is a maximum of 5 seconds for the small and medium displays and a maximum of 10 seconds for large displays. Reflective or transmissive mode displays are inspected with front illumination in the blisters. Transmissive displays with positive contrast are inspected with front illumination using a reflective background. Transmissive displays with negative contrast are inspected with rear illumination on a light table.

**Electro-optical defects**

All segments must be visible perpendicular to the display at the specified minimum operating voltage. In multiplex drive non-selected segments must not be visible at the specified off voltage.

Current consumption at 25 °C, specified operating voltage and frequency must not exceed the specified maximum current consumption (see Fig. 14).

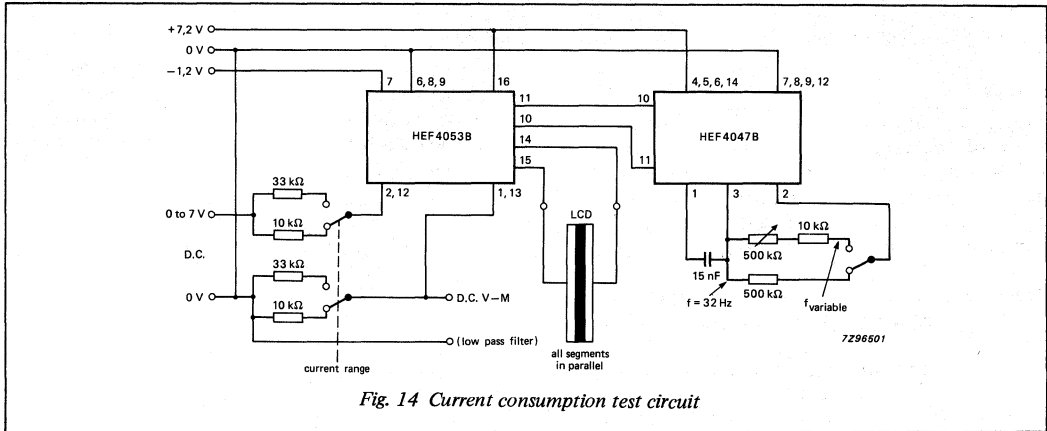


Fig. 14 Current consumption test circuit

Response times at 25 °C, specified operating voltage and frequency must not exceed the specified maximum response times.

For direct drive LCDs the off voltage is zero. For multiplex drive the r.m.s. voltage of the "off" segments is a fixed proportion of the on voltage dependent on the multiplex method.

Each segment has to be individually energizable.

**Operating conditions**

To ensure long term operation of displays the: operating voltage and frequency must not exceed the specified maximum, d.c. voltage must not exceed 0.1 V, ambient operating temperature must not exceed the specified maximum, and relative humidity must not exceed 60%.

**HANDLING ASPECTS**

**Scratching**

Polarizer and reflector foils are neither scratch nor pressure resistant, so avoid touching and treatment with rough or abrasive tools. The conductive stripes on the contacting edges are also sensitive to scratches; treatment of the contacting edges with rough or abrasive tools could lead to scratches on the contacts and to interruptions in the circuit.

**Fingerprints**

Gloves should be worn when handling the displays as fingerprints on the polarizers will reduce the optical performance of the display and fingerprints on the contacting edges will cause connecting problems.

**Cleaning**

To clean a dirty LCD use a soft, clean, lint free, dry tissue. Loose dust may be removed by a clean, soft blower brush. If these methods are not sufficient then a tissue moistened

with lead-free benzene, petrol or freon and applied softly to the surface should be sufficient.

Other solvents or water have to be avoided as they attack the polarizers.

**Unpacking**

Care should be taken that the polarizers are neither scratched nor partly moved whilst the protective foil is being removed.

**Fragility**

LCDs are made of glass. Handle with care to avoid breakage or cracks. If a display is broken use an alcohol- or acetone-soaked tissue to remove the escaped fluid. Avoid direct skin contact. Clean contaminated areas IMMEDIATELY with soap and warm running water.

**Storage precautions**

LCDs should be kept in their original package and in a dust-free environment for long term storage; temperature should not exceed 30 °C and relative humidity should not exceed 40 to 50%.

Keep the protective foil on the polarizers as long as possible after the display has been removed from its original package, ESPECIALLY for temporary storage during manufacture. Ideally the protective foil should only be removed after the display is mounted in its final assembly. Avoid long term storage in direct sunlight: a yellow acrylic box lends itself as a light, shock and dust protecting storage container.

Avoid moving a display from a cold storage area to a humid or hot storage area as it leads to condensation which will attack the polarizers.

**Chip-on-glass and modules**

In the case of LCDs using chip-on-glass or module technology care should be taken to avoid static discharges.

## MOUNTING METHODS

### Housing

Housing and frame dimensions should be well adapted to the size of the display to assure proper mounting in modules and contact frames.

Mechanical pressure should be moderate and should be applied evenly between the frame and the display. No pressure should be exerted on the seal or on the display areas.

Module housings and frames have to be designed in such a way that bending of a display in the mounted position is minimized.

LCDs should be housed with a transparent plate (e.g. glass or non-birefringent acrylic plate) mounted in front of the display to protect it from scratches, humidity and dirt.

### Conductive rubber connections

Mounting instructions from the manufacturers of elastomeric connectors (conductive rubber "zebra") have to be followed. Special attention should be given to the prescribed contact pressure and its even spread over the full length of the contacting edges.

### Soldering

When soldering DIL pin connectors to a display, avoid temperature shocks. Proper protection is necessary in avoiding splashes of flux on the display and its contacting edges. Remaining flux together with humidity will cause corrosion of the contact surface.

### Reliability

Reliability is gauged by the following tests on a sample basis (see Table 2).

### End of life definition

A display fails if:

any visible defects are apparent as described in the chapter "QUALITY ASPECTS",

electro-optical specifications are not met,

total current at 25 °C is more than twice the specified maximum,

the liquid crystal clearing point is less than the maximum ambient operating temperature,

or if the relative contrast is more than 90% of the initial relative contrast.

Table 2 Environmental testing

TEMPERATURE TESTS	COMMERCIAL GRADE	EXTENDED GRADE
High temperature storage (IEC 68-2-2)	+70 °C/3 days	+85 °C/4 days
Low temperature storage (IEC 68-2-1)	-25 °C/3 days	-40 °C/4 days
Temperature, cyclic (IEC 68-2-14)	-25 °C/30 min +25 °C/30 min +70 °C/30 min +25 °C/30 min 10 cycles	-40 °C/30 min +25 °C/30 min +85 °C/30 min +25 °C/30 min 10 cycles
Damp heat, cyclic (IEC 68-2-30)	25 °C/95% RH 40 °C/93% RH 6 cycles every 24 h	25 °C/95% RH 40 °C/93% RH 21 cycles every 24 h
Damp heat, steady state (IEC 68-2-3)	40 °C/93% RH every 4 days	40 °C/93% RH every 21 days

MECHANICAL TESTS		
Low air pressure (IEC 68-2-13)		25 °C/86 to 106 kPa
Vibration (IEC 68-2-6) cells must be mounted on a suitable connector	frequency amplitude duration	10 to 55 Hz 0,75 mm 6 h (2 h in each direction)
Shock (IEC 68-2-27) Half-sine pulse shape	pulse duration peak acceleration number of shocks	11 ms 981 m/s <sup>2</sup> = 100 g 3 shocks in 3 mutually perpendicular axes
Bump (IEC 68-2-29)	pulse duration peak acceleration number of bumps	6 ms 392 m/s <sup>2</sup> ≠ 40 g 1000 ±10

Note: Cells should not be submitted to active ventilation during the described tests.

*page*

**CUSTOM DESIGN ..... 31**



## CUSTOM DESIGN

The advantage of LCD technology over many other technologies is the capability of supplying LCDs to specific customer requirements. We offer a complete custom design service. Custom design projects are handled in four steps: quotation and general specification, technical clarification and design drawing, samples, and volume production.

The prospective customer should contact his local sales office for more details.



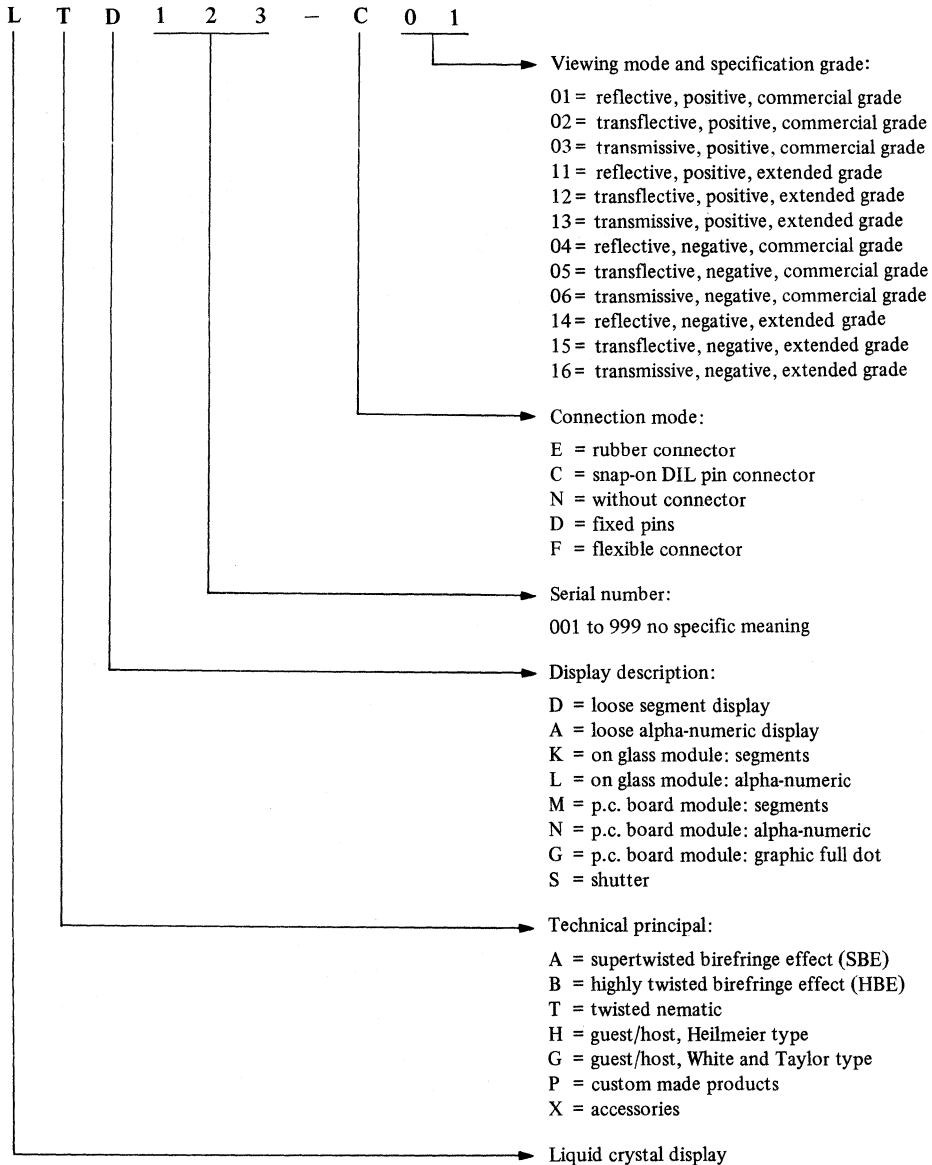


## **TYPE CODE INFORMATION**

	<i>page</i>
<b>Type number designations</b> .....	<b>35</b>
<b>Cross reference guide</b> .....	<b>36</b>



TYPE NUMBER DESIGNATIONS



**TYPE CODE  
INFORMATION**

**CROSS REFERENCE GUIDE**

<b>OLD TYPE NO.</b>	<b>NEW TYPE NO.</b>
LC241440-101	LTD201-E01
LC283020-301	LTD202-C01/C12
LC382040-401	LTD203-E01/E12
LC382080-411	LTD211-E01/E12
LC512332-300	LTD101-E01
LC513031-300	LTD221-C01/C12
LC513031-302	LTD222-C01
LC513031-303	LTD222-E01/E12
LC513031-307	LTD224-E01
LC513031-309	LTD221-E01
LC513031-320	LTD231-E01
LC513031-390	LTD225-E01
LC513040-301	LTD226-C01/C12
LC513040-303	LTD226-E01/E12
LC513041-300	LTD227-C01/C12
LC513041-320	LTD232-E01
LC513050-300	LTD228-C01
LC518000-301	LTA141-C01/C12
LC554731-312	LTD132-E01
LC7020160-412	LTD233-E01
LC7020160-430	LTD234-E11
LC703000-300	LTD321-C01
LC703060-301	LTD229-C01/C12
LC703831-300	LTD241-C01/C12
LC703840-300	LTD242-C01/C12
LC07610110-300	LTD261-C01/C12
LC943080-301	LTD262-C01/C12
LC943860-301	LTD263-C01 and C11
LC11402600-310	LTD351-E01
LC11404650-301	LTD264-C11 and C12
MB 70 20 160	LTM233-N01
LCD-V13-3510A	LTN111-N01
LCD-V13-3511A	LTN211-N01
LCD-V13-3512A	LTN241-N01
LCD-V13-3513A	LTG201-N01
LCD-V13-3514A	LTG401-D02

## GENERAL LCD FAMILY CHARACTERISTICS

*page*

<b>Family characteristics</b> . . . . .	<b>39</b>
<b>Operating characteristics:</b>	
direct drive, commercial temperature . . . . .	<b>39</b>
multiplex drive 1:2, commercial temperature . . . . .	<b>40</b>
multiplex drive 1:3, commercial temperature . . . . .	<b>41</b>
multiplex drive 1:4, commercial temperature . . . . .	<b>42</b>
direct drive, extended temperature . . . . .	<b>43</b>
multiplex drive 1:2, extended temperature . . . . .	<b>44</b>
multiplex drive 1:4, extended temperature . . . . .	<b>45</b>



## FAMILY CHARACTERISTICS

Standard range LCD cells are offered in two main versions. The versions differ, in respect to the ambient operating temperature ranges, when fluid and polarizer combinations are altered. The commercial ambient temperature range is  $-10$  to  $+60$  °C and the extended ambient temperature range is  $-25$  to  $+80$  °C (see section "Temperature dependence of voltage and contrast" in the chapter "User guide").

### OPERATING CHARACTERISTICS

#### Direct drive, commercial temperature range

$T_{amb} = 25$  °C,  $V_{op} = 4,5$  V,  $f = 32$  Hz unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range	$T_{amb}$	$-10$	—	60	°C
Storage temperature range	$T_{stg}$	$-25$	—	70	°C
Operating voltage	$V_{op}$	3	4,5	6	V
D.C. component	$V_{dc}$	—	—	100	mV
Drive frequency	$f_{dr}$	30	—	200	Hz
Current consumption energizable area	$I_{con}$	—	15	30	nA/mm <sup>2</sup>
Turn on time at 25 °C at 0 °C	$t_{on}$ $t_{on}$	— —	40 200	— —	ms ms
Turn off time at 25 °C at 0 °C	$t_{off}$ $t_{off}$	— —	80 400	— —	ms ms
Switching time	$t_{sw}$	—	—	250	ms



**FAMILY  
CHARACTERISTICS**

**OPERATING CHARACTERISTICS**

**Multiplex drive 1:2, commercial temperature range**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $f = 32\text{ Hz}$ ,  $V_{op} = V_{op\ typ}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range with temperature compensation	$T_{amb}$	-10	-	60	$^{\circ}\text{C}$
	$T_{amb}$	-10	-	50	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-25	-	70	$^{\circ}\text{C}$
Operating voltage with temperature compensation	$V_{op}$	3,0	3,1	3,2	V
	$V_{op}$	-	2,8	-	V
External temperature compensation		-	-13	-	mV/K
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	100	Hz
Capacity energizable area	C	-	15	-	pF/mm <sup>2</sup>
Current consumption energizable area	$I_{con}$	-	15	30	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	80	-	ms
	$t_{on}$	-	350	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	90	-	ms
	$t_{off}$	-	450	-	ms
Switching time	$t_{sw}$	-	-	300	ms

**OPERATING CHARACTERISTICS**

**Multiplex drive 1:3, commercial temperature range**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $f = 32\text{ Hz}$ ,  $V_{op} = V_{op\ typ}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range with temperature compensation	$T_{amb}$	-10	-	60	$^{\circ}\text{C}$
	$T_{amb}$	-10	-	50	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-25	-	70	$^{\circ}\text{C}$
Operating voltage with temperature compensation	$V_{op}$	3,2	3,3	3,45	V
	$V_{op}$	-	3,2	-	V
External temperature compensation		-	-14	-	mV/K
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	100	Hz
Capacity energizable area	C	-	15	-	pF/mm <sup>2</sup>
Current consumption energizable area	$I_{con}$	-	22	45	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	120	-	ms
	$t_{on}$	-	700	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	80	-	ms
	$t_{off}$	-	350	-	ms
Switching time	$t_{sw}$	-	-	400	ms

**FAMILY  
CHARACTERISTICS**

**OPERATING CHARACTERISTICS**

Multiplex drive 1:4, commercial temperature range

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $f = 32\text{ Hz}$ ,  $V_{op} = V_{op\ typ}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range with temperature compensation	$T_{amb}$	-10	-	60	$^{\circ}\text{C}$
	$T_{amb}$	-10	-	40	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-25	-	70	$^{\circ}\text{C}$
Operating voltage with temperature compensation	$V_{op}$	3,2	3,3	3,45	V
	$V_{op}$	-	3,25	-	V
External temperature compensation		-	-14	-	mV/K
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	100	Hz
Capacity energizable area	C	-	15	-	pF/mm <sup>2</sup>
Current consumption energizable area	$I_{con}$	-	22	45	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	140	-	ms
	$t_{on}$	-	850	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	80	-	ms
	$t_{off}$	-	350	-	ms
Switching time	$t_{sw}$	-	-	440	ms

**OPERATING CHARACTERISTICS**

Direct drive, extended temperature range

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $V_{op} = 4,5\text{ V}$ ,  $f = 32\text{ Hz}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range	$T_{amb}$	-25	-	80	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-40	-	90	$^{\circ}\text{C}$
Operating voltage	$V_{op}$	3	4,5	6	V
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	200	Hz
Current consumption energizable area	$I_{con}$	-	10	20	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	40	-	ms
	$t_{on}$	-	200	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	80	-	ms
	$t_{off}$	-	150	-	ms
Switching time	$t_{sw}$	-	-	200	ms

**FAMILY  
CHARACTERISTICS**

**OPERATING CHARACTERISTICS**

Multiplex drive 1:2, extended temperature range

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $f = 32\text{ Hz}$ ,  $V_{op} = V_{op\ typ}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range with temperature compensation	$T_{amb}$	-25	-	80	$^{\circ}\text{C}$
	$T_{amb}$	-25	-	60	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-40	-	90	$^{\circ}\text{C}$
Operating voltage with temperature compensation	$V_{op}$	4,2	4,35	4,5	V
	$V_{op}$	-	3,9	-	V
External temperature compensation		-	-13	-	mV/K
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	100	Hz
Capacity energizable area	C	-	11	-	pF/mm <sup>2</sup>
Current consumption energizable area	$I_{con}$	-	10	20	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	40	-	ms
	$t_{on}$	-	150	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	50	-	ms
	$t_{off}$	-	200	-	ms
Switching time	$t_{sw}$	-	-	160	ms

**OPERATING CHARACTERISTICS**

Multiplex drive 1:4, extended temperature range

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $f = 32\text{ Hz}$ ,  $V_{Op} = V_{Op\ typ}$  unless otherwise stated (perpendicular viewing direction)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Operating ambient temperature range with temperature compensation	$T_{amb}$	-20	-	70	$^{\circ}\text{C}$
	$T_{amb}$	-20	-	50	$^{\circ}\text{C}$
Storage temperature range	$T_{stg}$	-40	-	90	$^{\circ}\text{C}$
Operating voltage with temperature compensation	$V_{Op}$	4,45	4,6	4,75	V
	$V_{Op}$	-	4,55	-	V
External temperature compensation		-	-14	-	mV/K
D.C. component	$V_{dc}$	-	-	100	mV
Drive frequency	$f_{dr}$	30	-	100	Hz
Capacity energizable area	C	-	11	-	pF/mm <sup>2</sup>
Current consumption energizable area	$I_{con}$	-	15	30	nA/mm <sup>2</sup>
Turn on time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{on}$	-	80	-	ms
	$t_{on}$	-	350	-	ms
Turn off time at 25 $^{\circ}\text{C}$ at 0 $^{\circ}\text{C}$	$t_{off}$	-	50	-	ms
	$t_{off}$	-	200	-	ms
Switching time	$t_{sw}$	-	-	160	ms



*page*

**LCD CELL DATA . . . . . 49**





**LARGE 5x7 DOT MATRIX DISPLAY****DEVICE DESCRIPTION**

The LTA141-C01/C02/C11/C12 is a direct drive, dot matrix LCD. The cell is available in reflective viewing mode. The LTA141 lends itself to large display applications. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	50,8 x 80,0 mm 54,0 x 85,0 mm*
Viewing area	45,8 x 67,4 mm
Character size	37,2 x 57,3 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

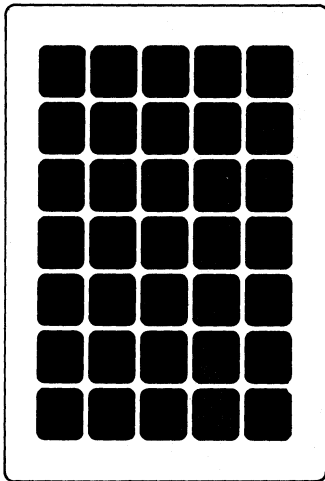
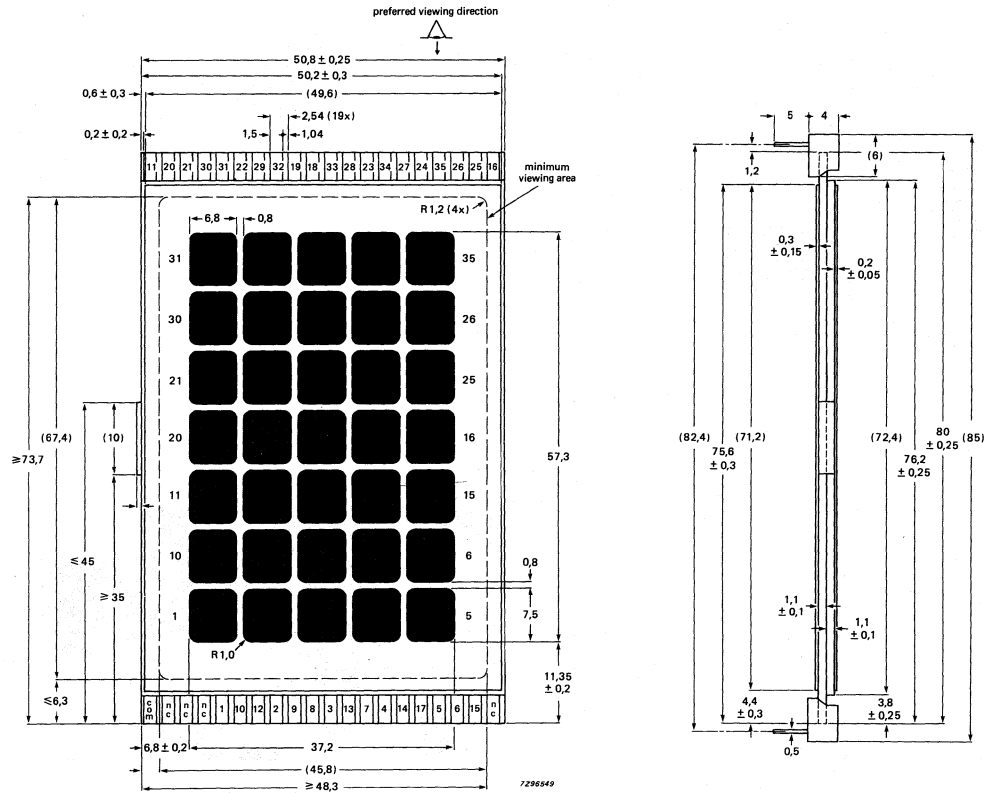


Fig. 1 Universal display

## MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred driver: PCF8576

Fig. 2

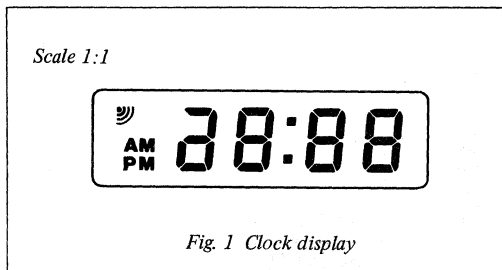
**3½-DIGIT CLOCK LCD****DEVICE DESCRIPTION**

The LTD101-E01 is a direct drive, 3½-digit, 7-segment LCD clock with AM and PM functions. The cell is available in reflective viewing mode. Transflective version is available on request.

**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C — —
Overall dimensions	50,8 x 22,9 mm
Viewing area	46,4 x 13,4 mm
Digit height	8,9 mm

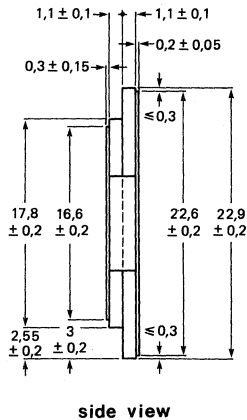
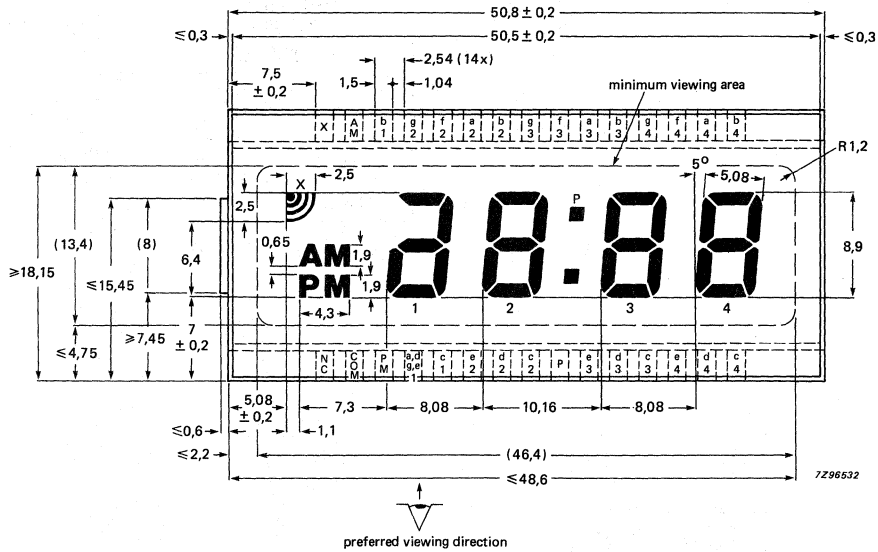
Conductive rubber connection.

**DISPLAY MODE**

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



side view

Clock driver: PCF1171, PCF1172, PCF1174  
Preferred drivers: PCF2112, PCF8577

Fig. 2

### 3½-DIGIT ANALOG CLOCK LCD

#### DEVICE DESCRIPTION

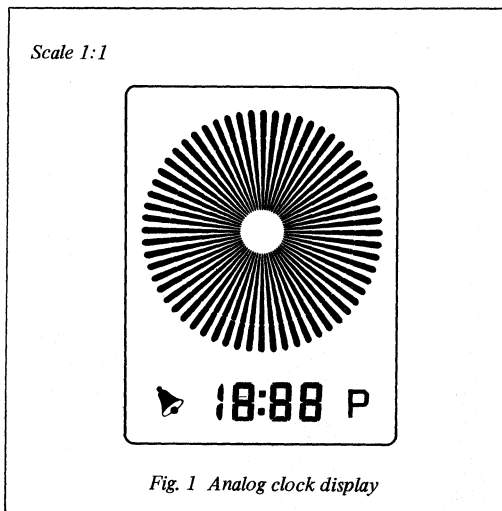
The LTD132-E01 is a 3½-digit, 7-segment LCD analog clock with a 1:2 drive ratio. The cell is available in reflective viewing mode. The display is designed to run from the MSM5015 clock driver.

#### QUICK REFERENCE DATA

$V_{op}$	2,8 to 3,2 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C — —
Overall dimensions	46,8 x 54,8 mm
Viewing area	38,8 x 49,8 mm
Digit height	5,6 mm

Conductive rubber connection.

#### DISPLAY MODE



## MULTIPLEX DUTY FACTOR 1:2

CONTACT NUMBER	COMMON 1	COMMON 2
1	f2	e2
2	comm 1	
3	a2d2	g2
4	b2	c2
5	f3	e3
6	g3	d3
7	b3	c3
8	P	
9	a3	DP1/2
10	X29	Y29
11	X28	Y28
12	X27	Y27
13	X26	Y26
14	X25	Y25
15	X24	Y24
16	X23	Y23
17	X22	Y22
18	X21	Y21
19	X20	Y20
20	X19	Y19
21	X18	Y18
22	X17	Y17
23	X16	Y16
24	X15	Y15
25	X14	Y14
26	X13	Y13
27	X12	Y12
28	X11	Y11
29	X10	Y10
30	X9	Y9
31	X8	Y8
32	X7	Y7
33	X6	Y6
34	X5	Y5
35	X4	Y4
36	X3	Y3
37	X2	Y2
38	comm 1	
39	X1	Y1

CONTACT NUMBER	COMMON 1	COMMON 2
40		comm 2
41	X60	Y60
42	X59	Y59
43	X58	Y58
44	X57	Y57
45	X56	Y56
46	X55	Y55
47	X54	Y54
48	X53	Y53
49	X52	Y52
50	X51	Y51
51	X50	Y50
52	X49	Y49
53	X48	Y48
54	X47	Y47
55	X46	Y46
56	X45	Y45
57	X44	Y44
58	X43	Y43
59	X42	Y42
60	X41	Y41
61	X40	Y40
62	X39	Y39
63	X38	Y38
64	X37	Y37
65	X36	Y36
66	X35	Y35
67	X34	Y34
68	X33	Y33
69	X32	Y32
70	X31	Y31
71	X30	Y30
72		AL
73	a1	h
74	f1	e1
75	g1	d1
76	b1	c1
77		comm 2
78	NC	NC

Preferred driver: MSM5015

MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".

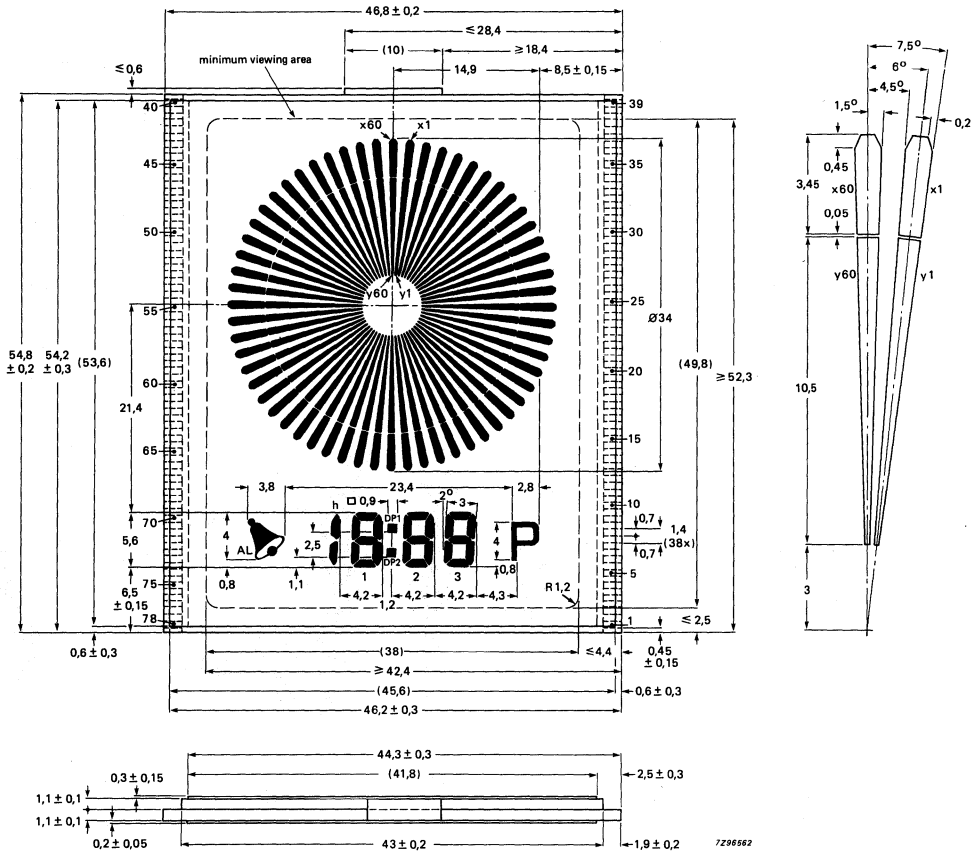


Fig. 2





**SMALL 4-DIGIT LCD****DEVICE DESCRIPTION**

The LTD201-E01 is a direct drive, 4-digit, 7-segment LCD. The cell is available in reflective viewing mode and commercial ambient temperature ranges. The LTD201-E01 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C — —
Overall dimensions	23,9 x 14,0 mm
Viewing area	21,5 x 9,4 mm
Digit height	6,8 mm

Conductive rubber connection.

**DISPLAY MODE**

Scale 1:1

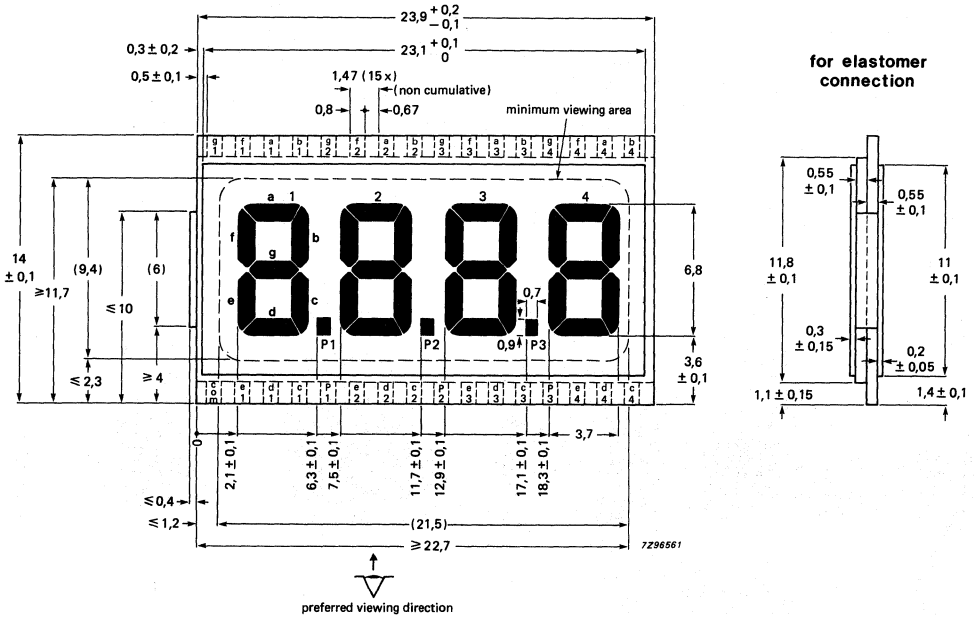


Fig. 1 Universal display

**MECHANICAL DATA**

*Dimensions in mm*

Connect all unused segments to common.



Preferred drivers: PCF2112, PCF8577

Fig. 2

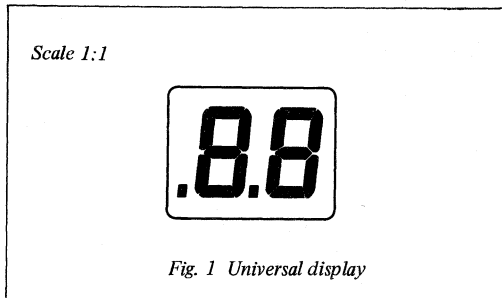
**2-DIGIT LCD****DEVICE DESCRIPTION**

The LTD202-C01/C11/C12 is a direct drive, 2-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD202-C01/C12 is a universal display. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	27,9 x 30,4 mm 31,0 x 35,4 mm*
Viewing area	23,5 x 18,4 mm
Digit height	12,7 mm

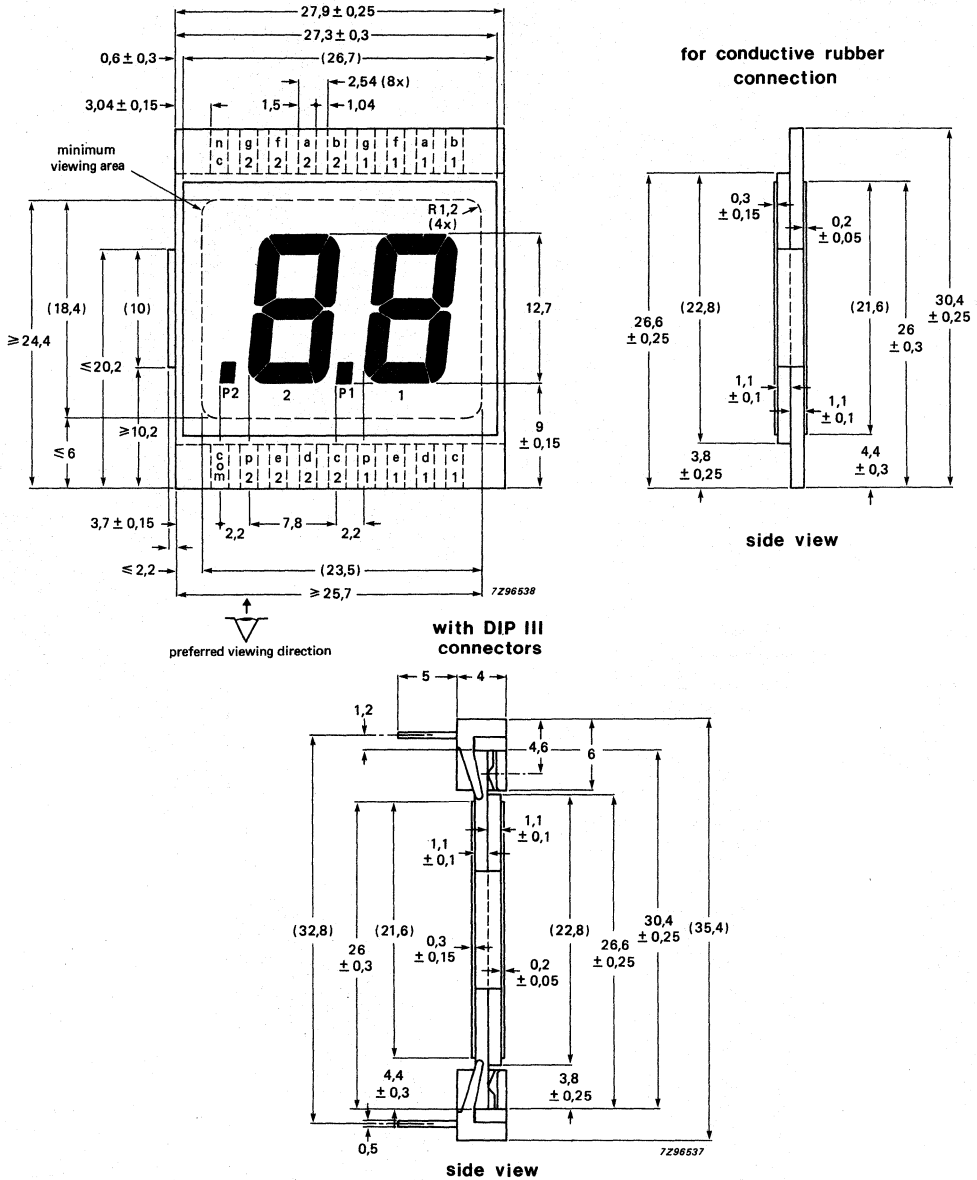
\* With DIL pin connector.

**DISPLAY MODE**

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred drivers: PCF8577, PCF2112

Fig. 2

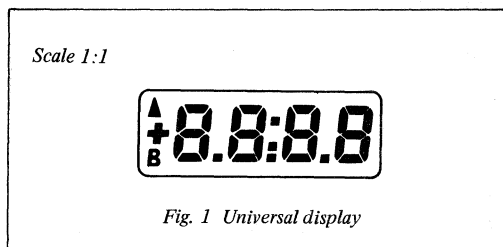
**4-DIGIT LCD****DEVICE DESCRIPTION**

The LTD203-E01/E12 is a direct drive, 4-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD203-E01 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	38,0 x 20,3 mm
Viewing area	34,0 x 11,2 mm
Digit height	8,0 mm

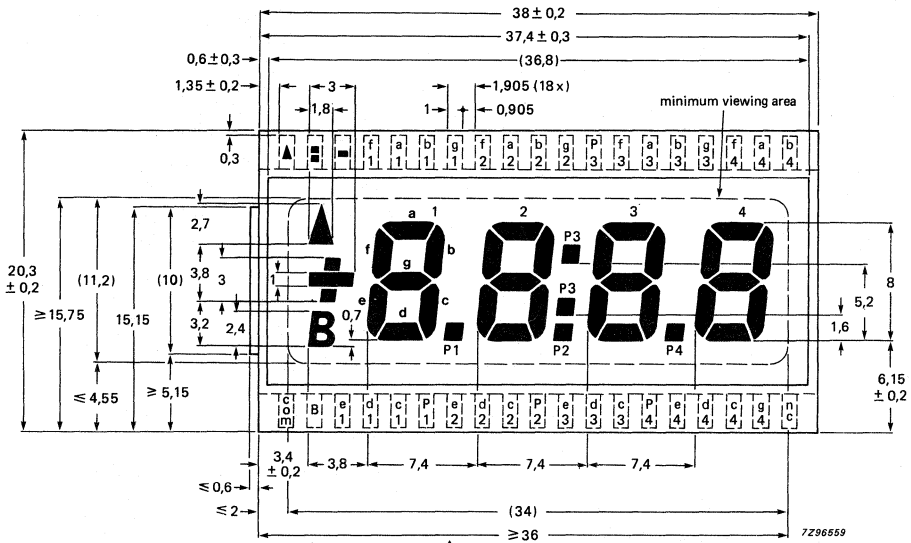
Conductive rubber connection.

**DISPLAY MODE**

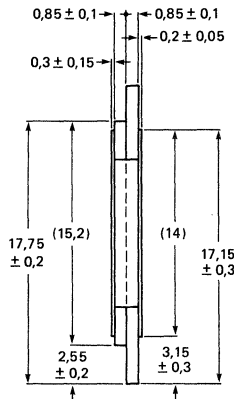
**MECHANICAL DATA**

*Dimensions in mm*

Connect all unused segments to common.



↑  
preferred viewing direction



side view

Preferred drivers: PCF2112, PCF8576

Fig. 2

## 8-DIGIT, MULTIPLEX DRIVE LCD

### DEVICE DESCRIPTION

The LTD211-E01/E11/E12 is an 8-digit, 7-segment LCD with a 1:2 multiplex drive ratio. The cell is available in reflective viewing mode. The LTD211-E01/E12 is typically used in telecom applications. Transflective version is available on request.

### QUICK REFERENCE DATA

V <sub>op</sub>	2,8 to 3,2 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	93,8 x 30,4 mm
Viewing area	34,0 x 11,2 mm
Digit height	6,0 mm

Conductive rubber connection.

### DISPLAY MODE

Scale 1:1 •



Fig. 1 Telecom display



## MULTIPLEX DUTY FACTOR 1:2

CONTACT NUMBER	COMMON 1	COMMON 2
1		comm 2
2	g1	e1
3	c1	d1
4	g2	e2
5	c2	d2
6	g3	e3
7	c3	d3
8	g4	e4
9	c4	d4
10	g5	e5
11	c5	d5
12	g6	e6
13	c6	d6
14	g7	e7
15	c7	d7
16	g8	e8
17	c8	d8
18		comm 2
19	comm 1	

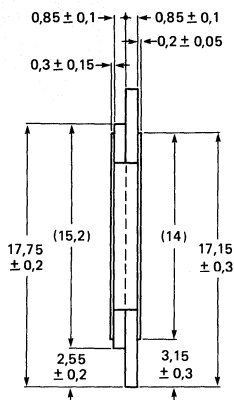
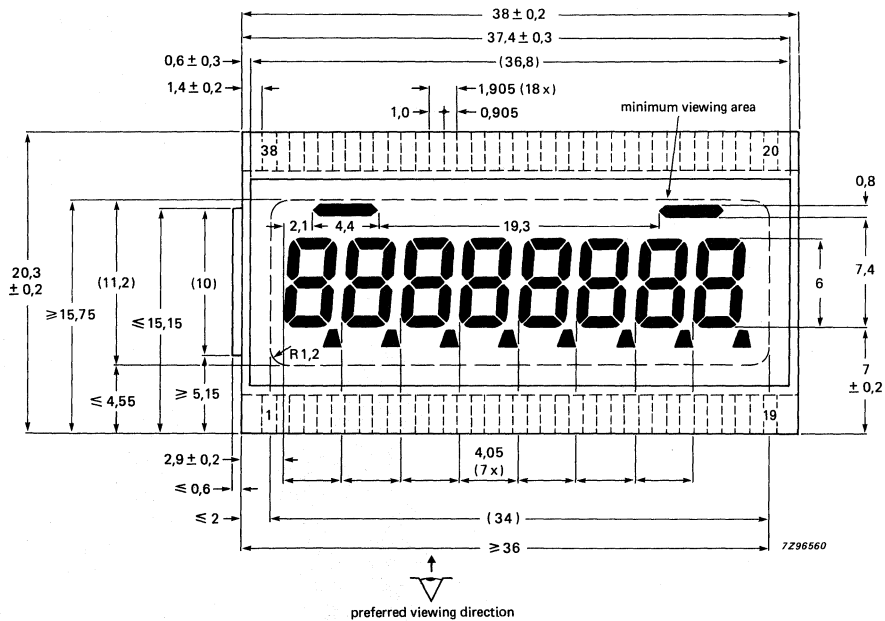
CONTACT NUMBER	COMMON 1	COMMON 2
20	b8	P8
21	a8	f8
22	P10	
23	b7	P7
24	a7	f7
25	b6	P6
26	a6	f6
27	b5	P5
28	a5	f5
29	b4	P4
30	a4	f4
31	b3	P3
32	a3	f3
33	b2	P2
34	a2	f2
35	P9	
36	b1	P1
37	a1	f1
38	comm 1	

Preferred drivers: PCF2111, PCF8576, PCF8577

MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".



side view

Fig. 2



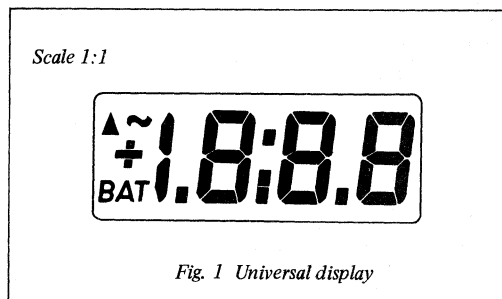
**3½-DIGIT LCD****DEVICE DESCRIPTION**

The LTD221-C01/C02/C11/C12 and E01 is a direct drive, 3½-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD221-C01/C12 is a universal display. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	50,7 x 30,4 mm 54,0 x 35,4 mm*
Viewing area	46,7 x 18,4 mm
Digit height	12,7 mm

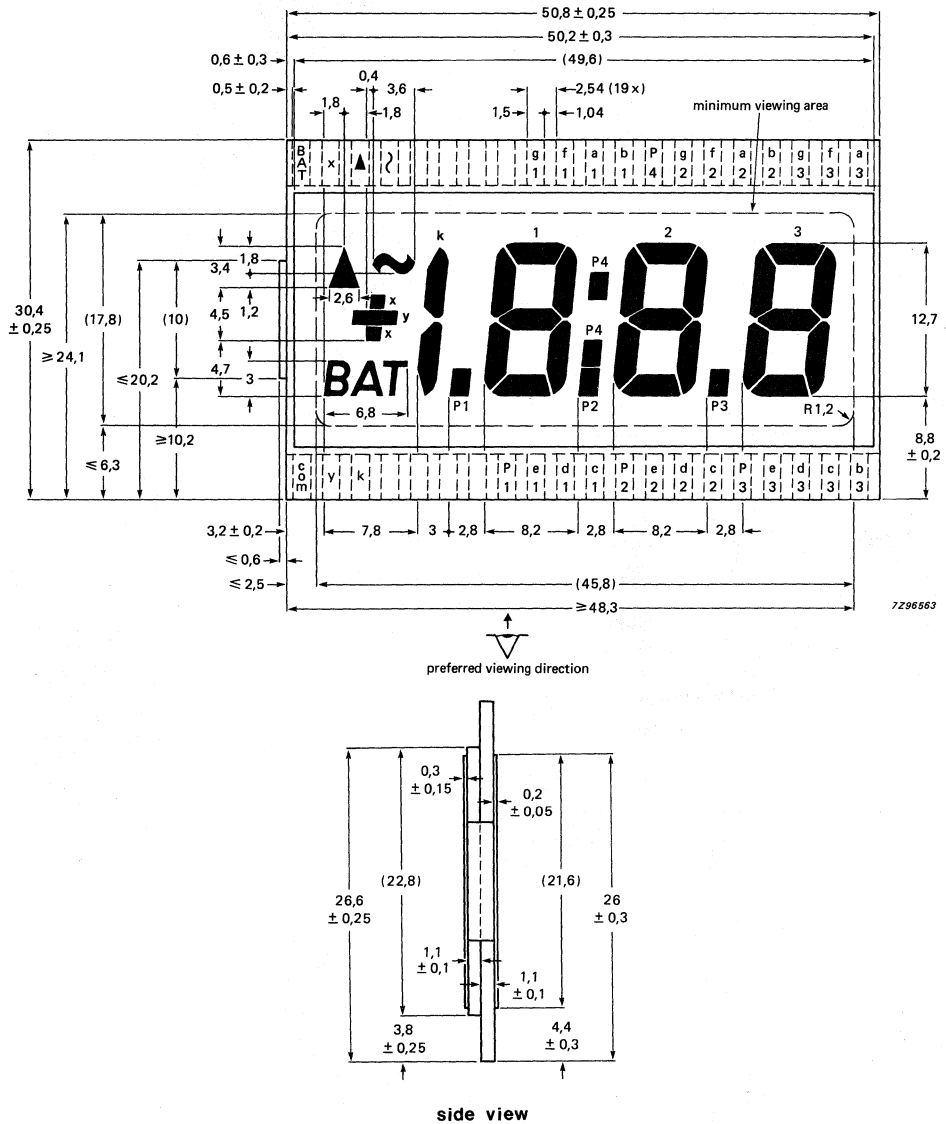
\* With DIL pin connector.

**DISPLAY MODE**

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred drivers: PCF2112, PCF8577

Fig. 2

### 3½-DIGIT LCD MULTIMETER

#### DEVICE DESCRIPTION

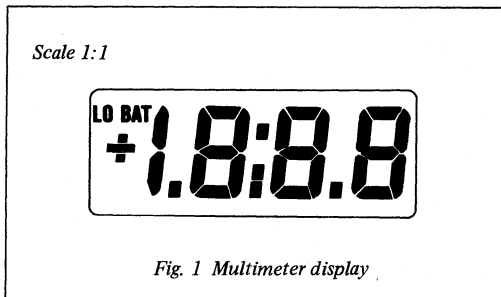
The LTD222-C01/C02/C11/C12 and the LTD222-E01/E11/E12 are direct drive, 3½-digit, 7-segment LCD multimeters with a LOW BATTERY indicator. The cells are available in reflective viewing mode. Transflective version is available on request.

#### QUICK REFERENCE DATA

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	50,7 x 30,4 mm 54,0 x 35,4 mm*
Viewing area	46,7 x 18,4 mm
Digit height	12,7 mm

\* With DIL pin connector.

#### DISPLAY MODE



**MECHANICAL DATA**

*Dimensions in mm*

Connect all unused segments to common.

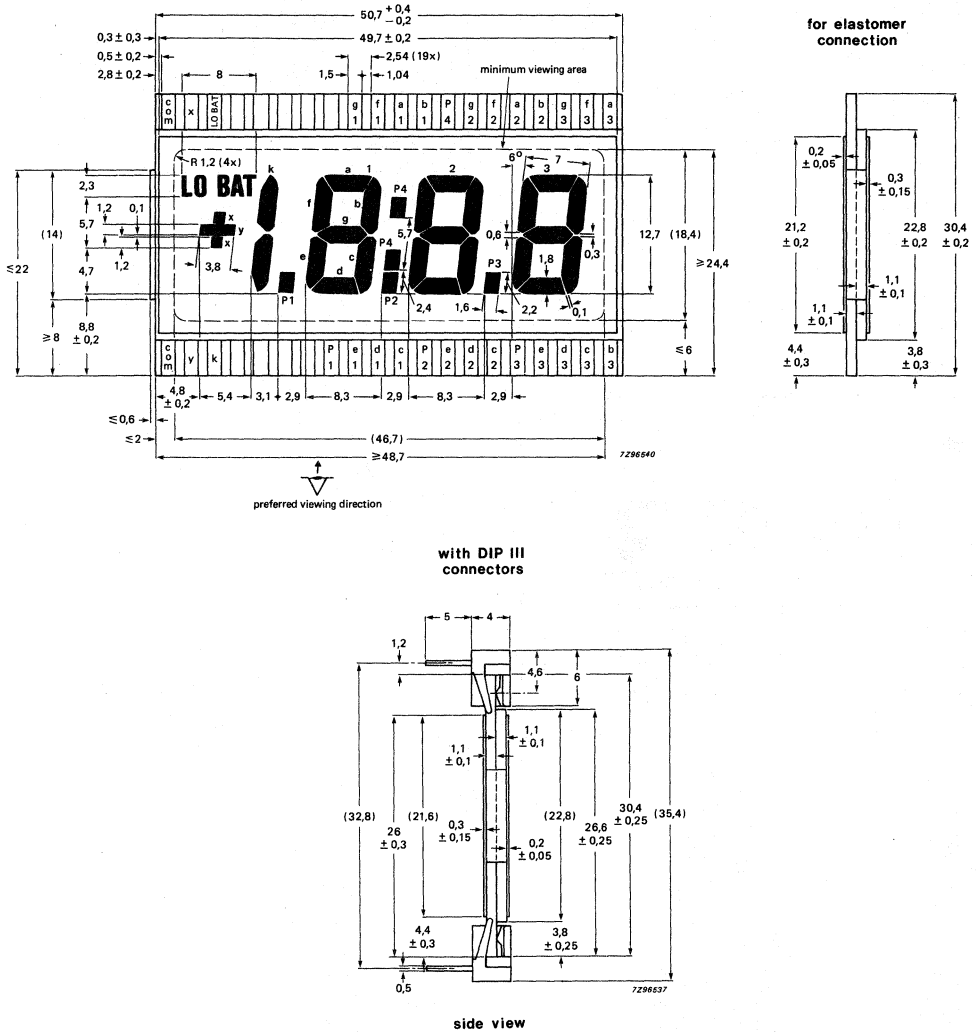


Fig. 2

Preferred drivers: PCF2112, PCF8577

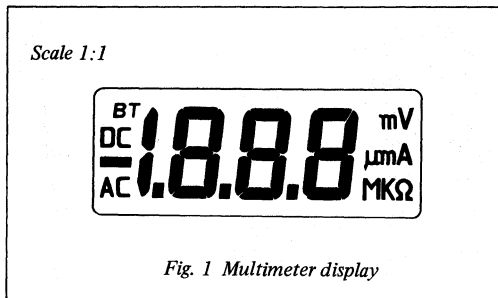
**3½-DIGIT LCD MULTIMETER****DEVICE DESCRIPTION**

The LTD224-E01 is a direct drive, 3½-digit, 7-segment LCD multimeter with various additional indicators. The cell is available in reflective viewing mode. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	50,8 x 30,4 mm
Viewing area	45,8 x 17,8 mm
Digit height	12,7 mm

Conductive rubber connection.

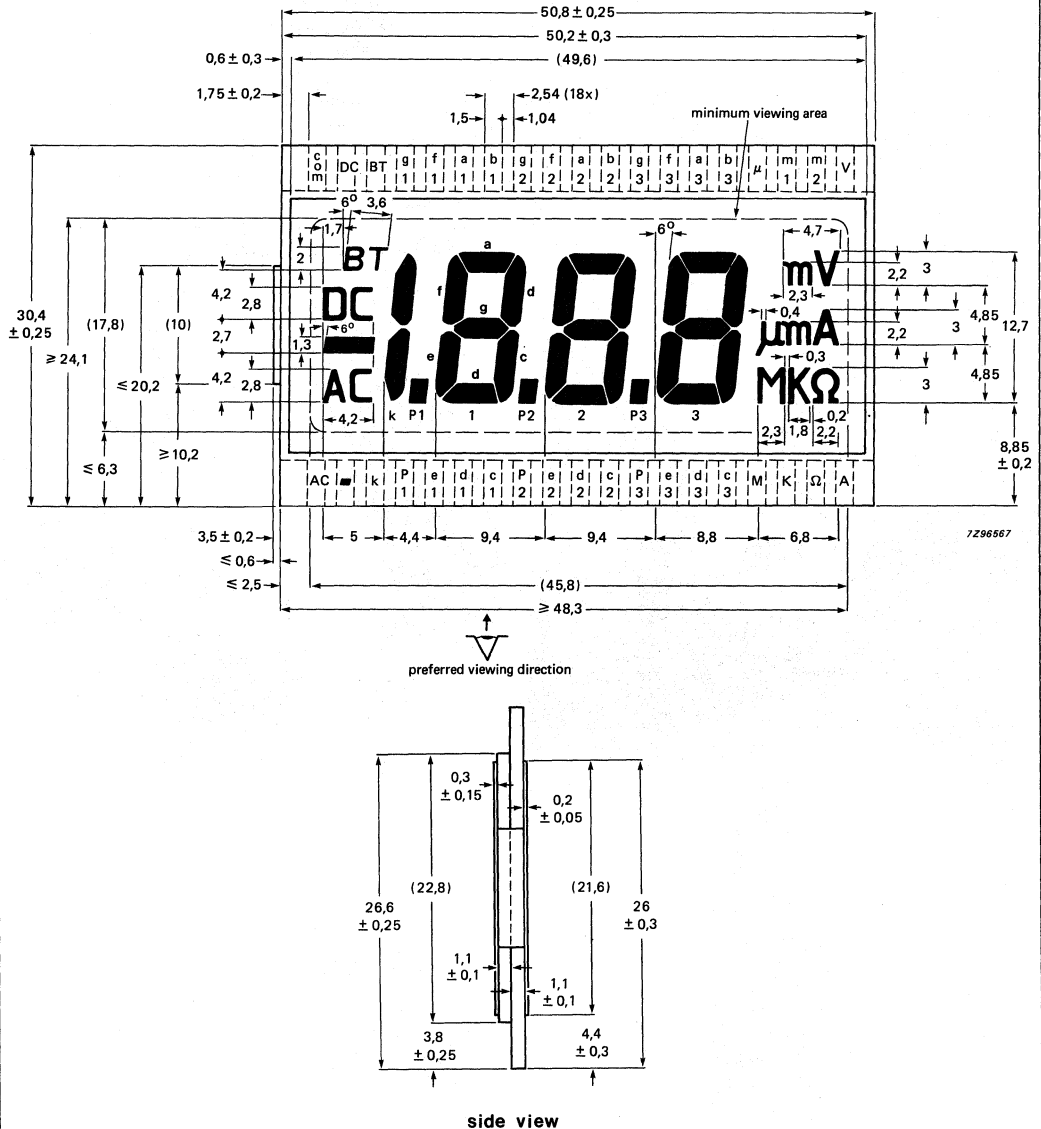
**DISPLAY MODE**



MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred drivers: PCF8576, PCF2111 (x2)

Fig. 2

**3½-DIGIT LCD MULTIMETER****DEVICE DESCRIPTION**

The LTD225-E01 is a direct drive 3½-digit, 7-segment LCD multimeter with LOW BATTERY indicator. The cells are available in reflective viewing mode. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60°C —
Overall dimensions	50,8 x 30,4 mm
Viewing area	45,8 x 17,8 mm
Digit height	12,7 mm

Conductive rubber connection.

**DISPLAY MODE**

Scale 1:1

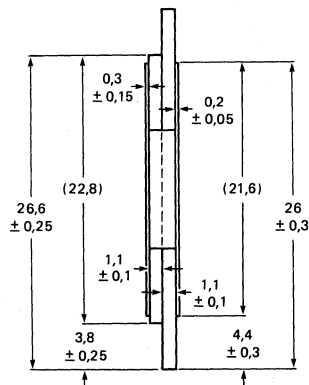
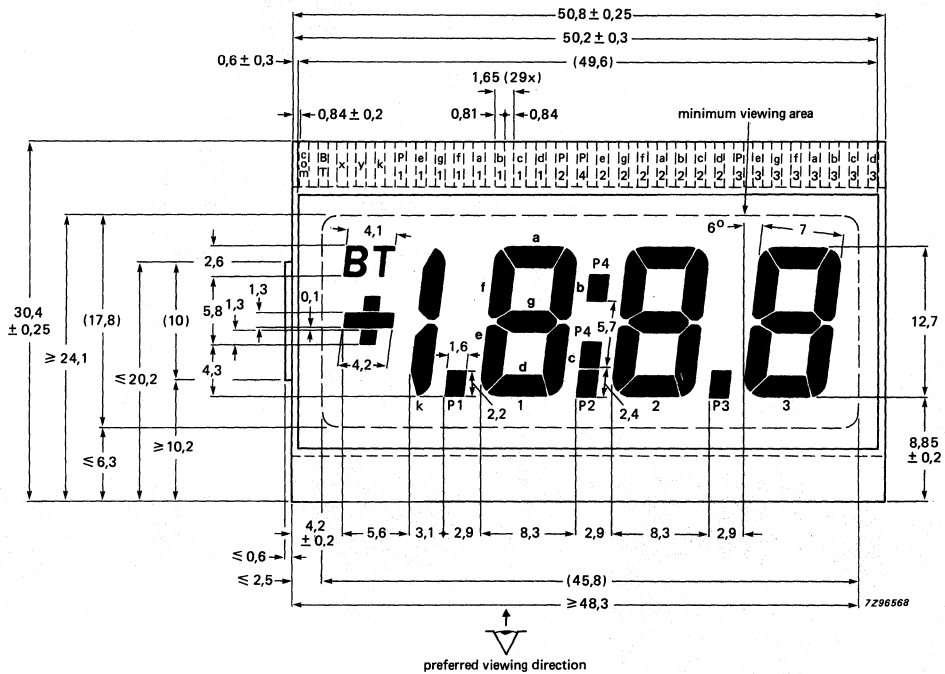


Fig. 1 Multimeter display

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



side view

Preferred driver: PCF8577

Fig. 2

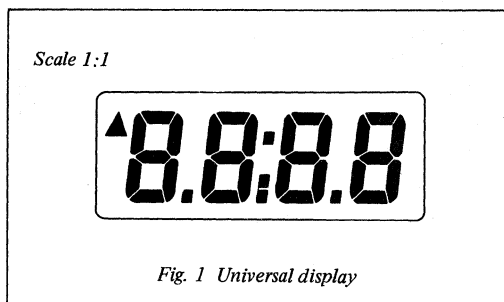
**4-DIGIT LCD****DEVICE DESCRIPTION**

The LTD226-C01/C02/C11/C12 and the LTD226-E01/E11/E12 are 4-digit, direct drive, 7-segment LCDs. The cells are available in reflective viewing mode. The LTD226 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	50,7 x 30,4 mm 54,0 x 35,4 mm*
Viewing area	46,7 x 18,4 mm
Digit height	12,7 mm

\* With DIL pin connector.

**DISPLAY MODE**

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.

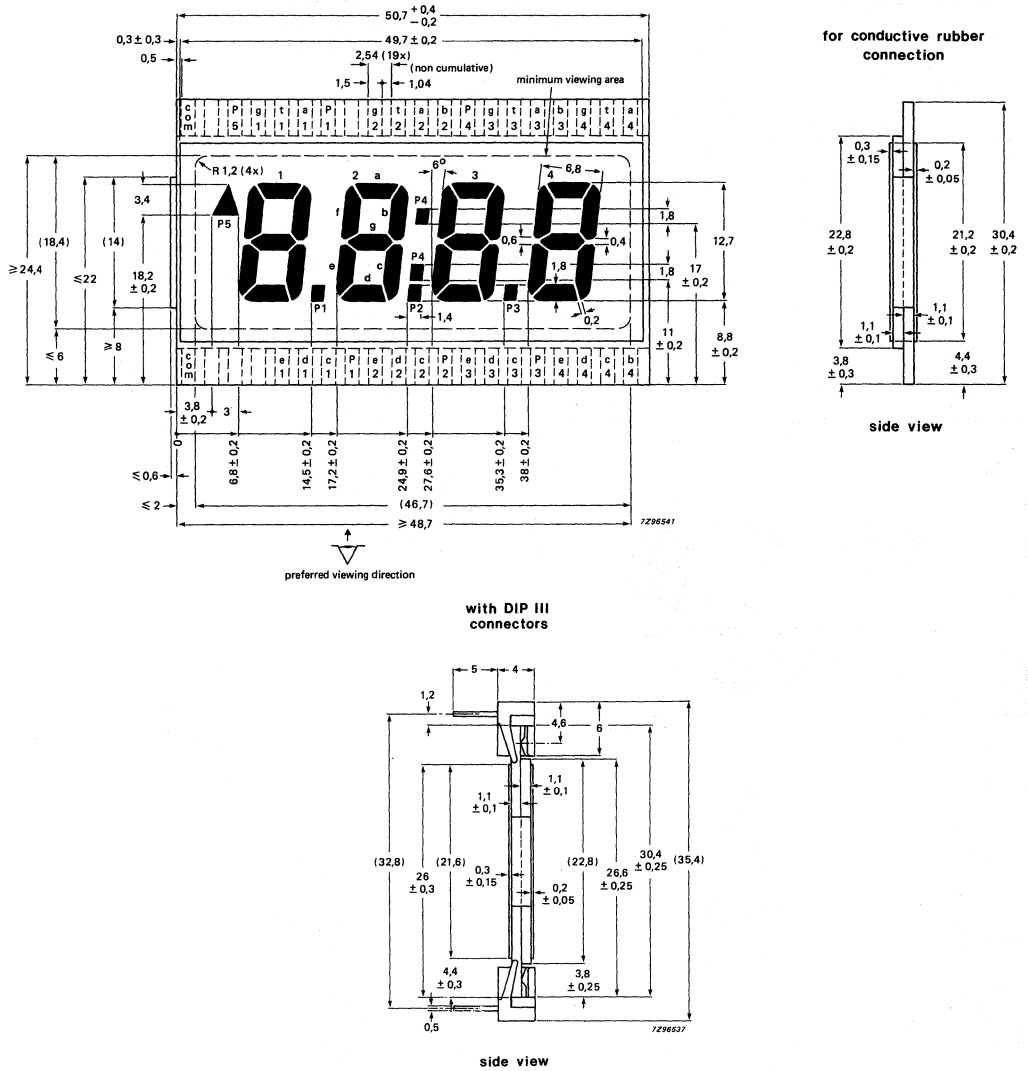


Fig. 2

Preferred drivers: PCF2112 (x2), PCF8577

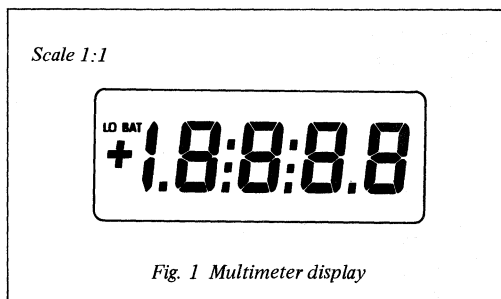
**4½-DIGIT LCD MULTIMETER****DEVICE DESCRIPTION**

The LTD227-C01/C11/C12 is a direct drive, 4½-digit, 7-segment LCD multimeter with LOW BATTERY indicator. The cell is available in reflective viewing mode. The LTD227-C01/C12 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	50,7 x 30,4 mm 54,0 x 35,4 mm*
Viewing area	46,7 x 18,4 mm
Digit height	10,0 mm

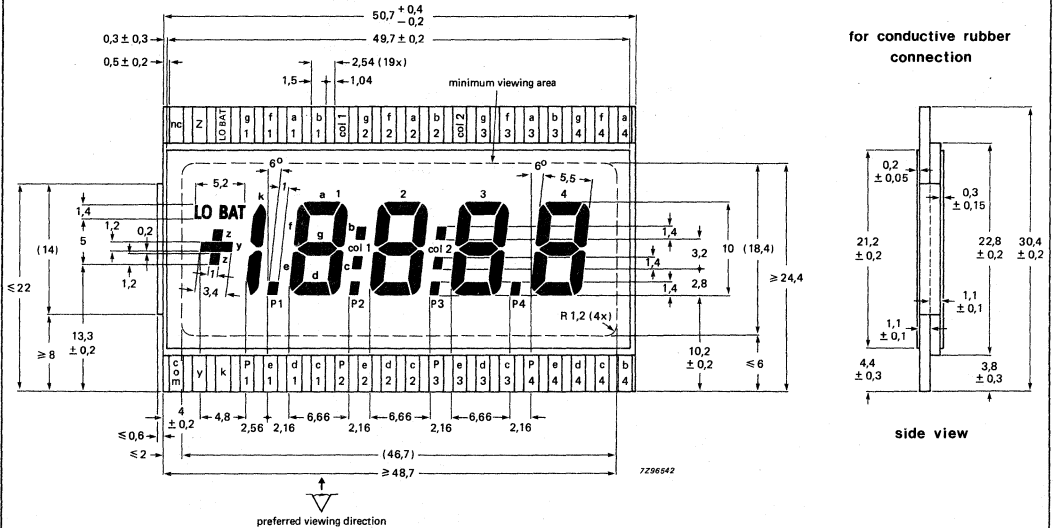
\* With DIL pin connector.

**DISPLAY MODE**

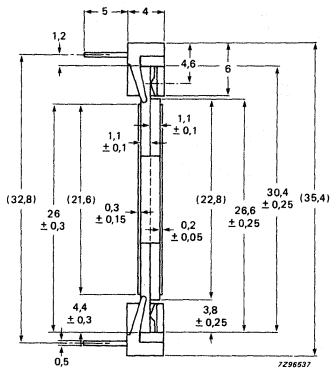
MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



with DIP III connectors



side view

Fig. 2

Preferred driver: PCF8577

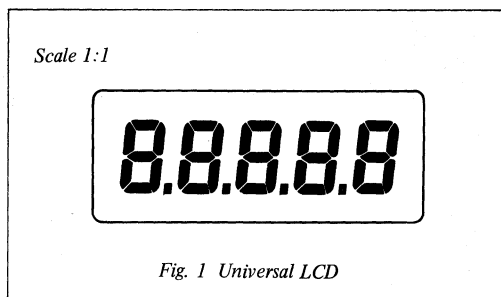
**5-DIGIT LCD****DEVICE DESCRIPTION**

The LTD228-C01 is a direct drive, 5-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD228 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	50,7 x 30,4 mm 54,0 x 35,4 mm*
Viewing area	45,8 x 17,8 mm
Digit height	10,0 mm

\* With DIL pin connector.

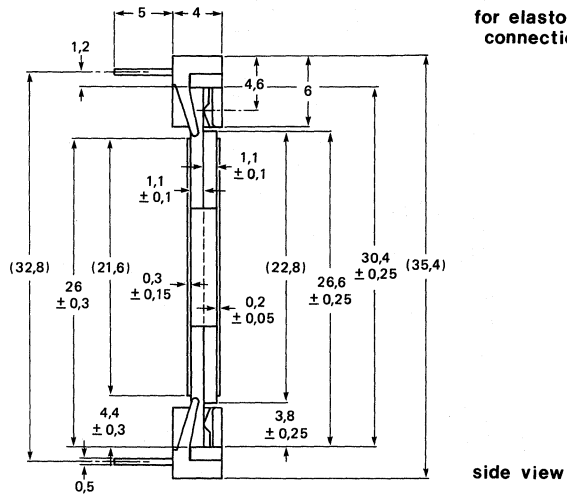
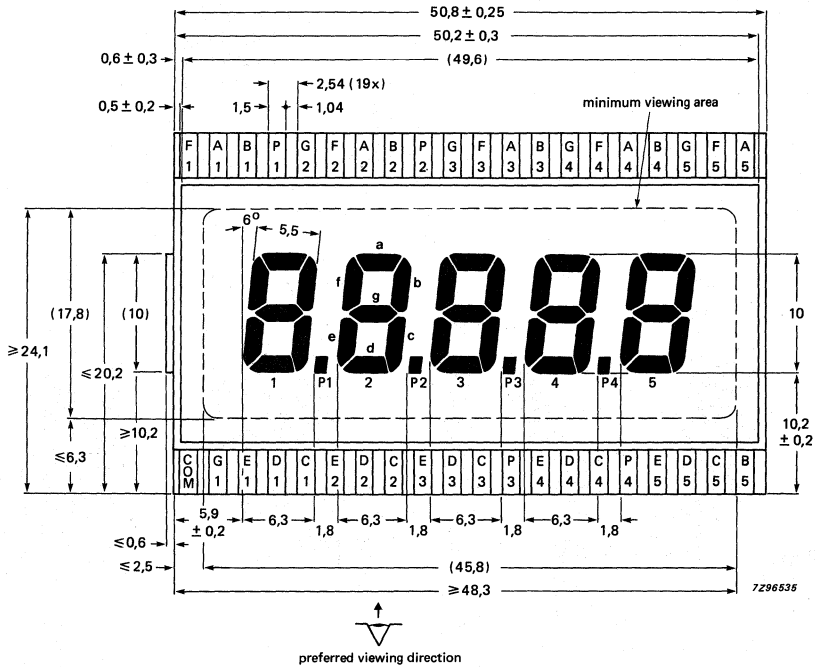
**DISPLAY MODE**



MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred drivers: PCF8576, PCF2112 (x2)

Fig. 2

**6-DIGIT LCD****DEVICE DESCRIPTION**

The LTD229-C01/C11/C12 is a direct drive, 6-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD229 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	69,8 x 30,4 mm 65,8 x 18,4 mm*
Viewing area	73,0 x 35,4 mm
Digit height	12,7 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

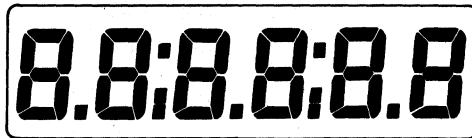
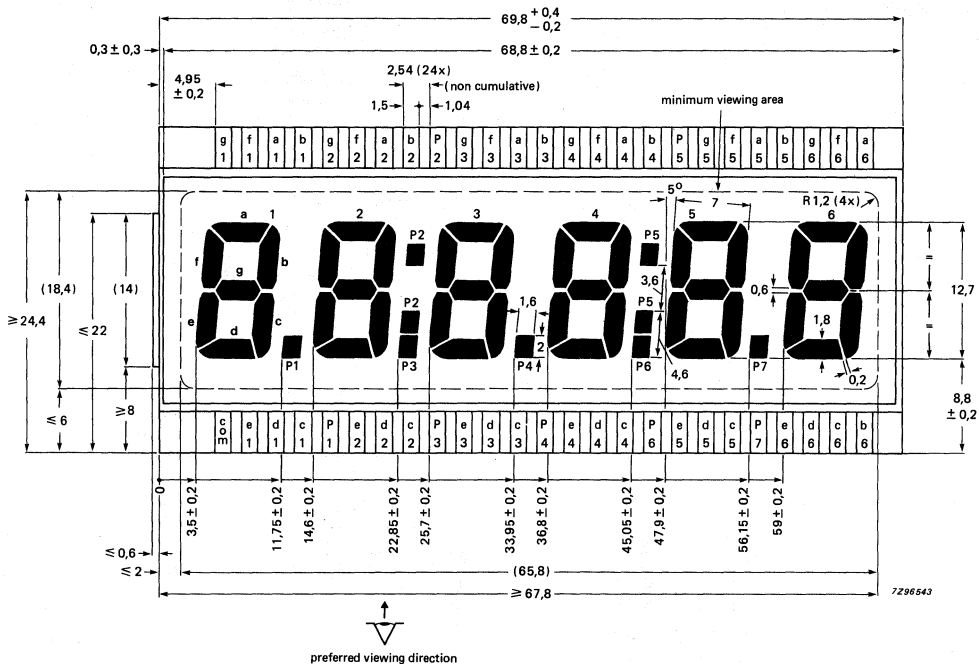


Fig. 1 Universal display

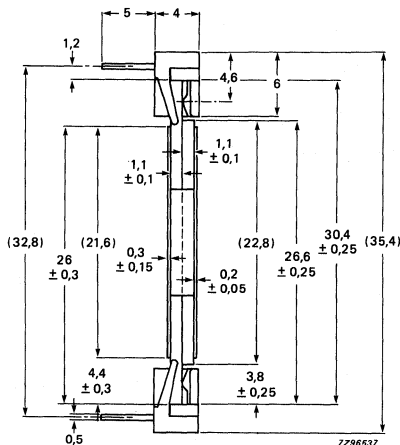
MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



↑  
preferred viewing direction



with DIP III connectors

side view

Preferred drivers: PCF2112 (x2), PCF8577 (x2)

### 3½-DIGIT MULTIPLEX DRIVE LCD MULTIMETER

#### DEVICE DESCRIPTION

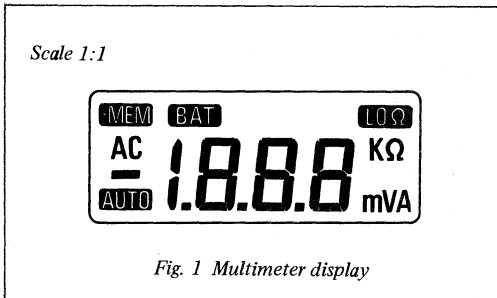
The LTD231-E01 is a 1:3 multiplex drive, 3½-digit, 7-segment LCD multimeter with MEMORY and LOW BATTERY indicators. The cell is available in reflective viewing mode and is compatible to the Teledyne TSC805 analog-digital-converter.

#### QUICK REFERENCE DATA

$V_{op}$	3,2 to 3,45 V
Ambient operating temperature range	-10 to +60 °C
commercial grade	-
extended grade	-
Overall dimensions	50,8 x 30,4 mm
Viewing area	45,8 x 17,1 mm
Digit height	17,1 mm

Conductive rubber connection.

#### DISPLAY MODE



## MULTIPLEX DUTY FACTOR 1:3

CONTACT NUMBER	COMMON 1	COMMON 2	COMMON 3
1	comm 1		
2		comm 2	
3			comm 3
4		LO $\Omega$	A
5		$\Omega$	V
6		K	m
7	b1	c1	
8	a1	g1	d1
9	f1	e1	
10	b2	c2	P2
11	a2	g2	d2
12	f2	e2	
13	b3	c3	P3
14	a3	g3	d3
15	f3	e3	
16	b4	c4	P4
17	AC	■	AUTO
18	BAT	MEM	

Preferred drivers: TSC805, PCF8576

MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".

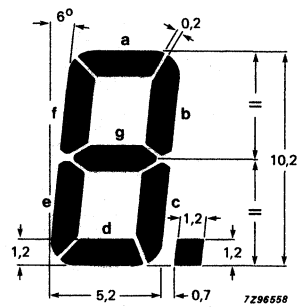
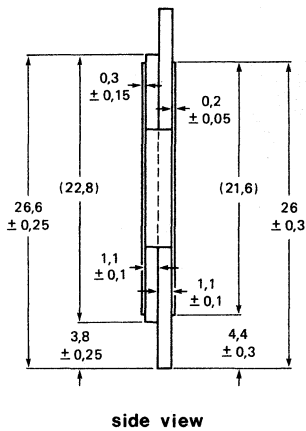
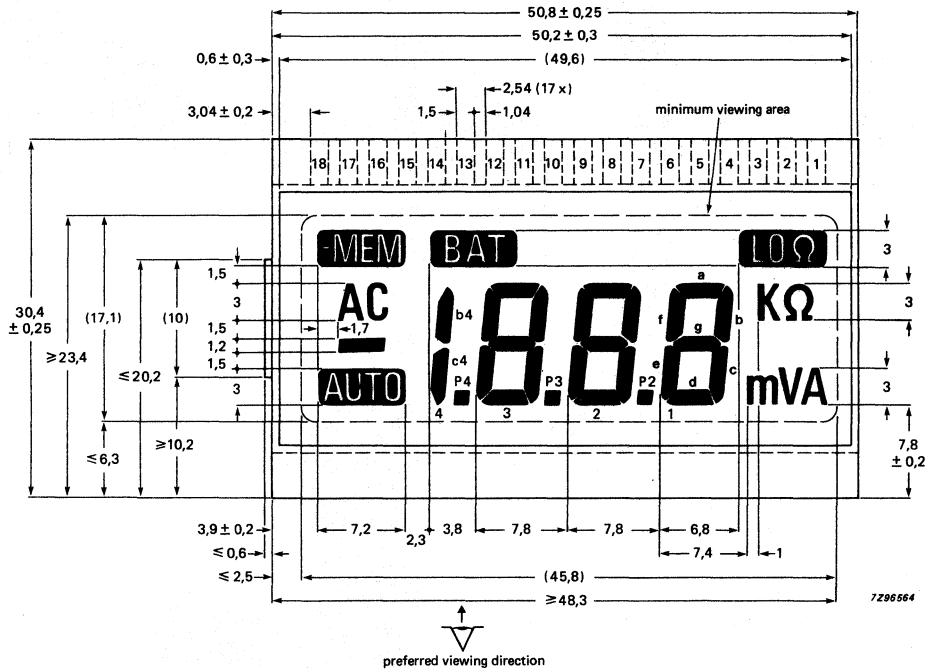


Fig. 2



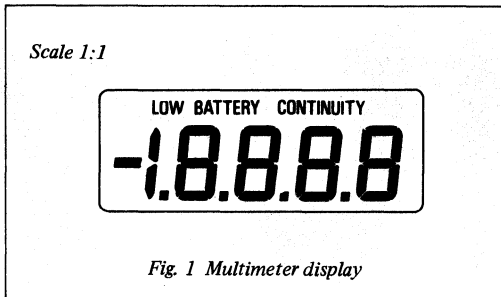
**4½-DIGIT MULTIPLEX DRIVE LCD MULTIMETER****DEVICE DESCRIPTION**

The LTD232-E01 is a 4½-digit, 7-segment LCD with a 1:3 multiplex drive ratio. The LTD232 is a multimeter with LOW BATTERY and CONTINUITY indicators. The cell is available in reflective viewing mode. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,2 to 3,45 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	50,8 x 30,4 mm
Viewing area	44,8 x 16,8 mm
Digit height	11,0 mm

Conductive rubber connection.

**DISPLAY MODE**



## MULTIPLEX DUTY FACTOR 1:3

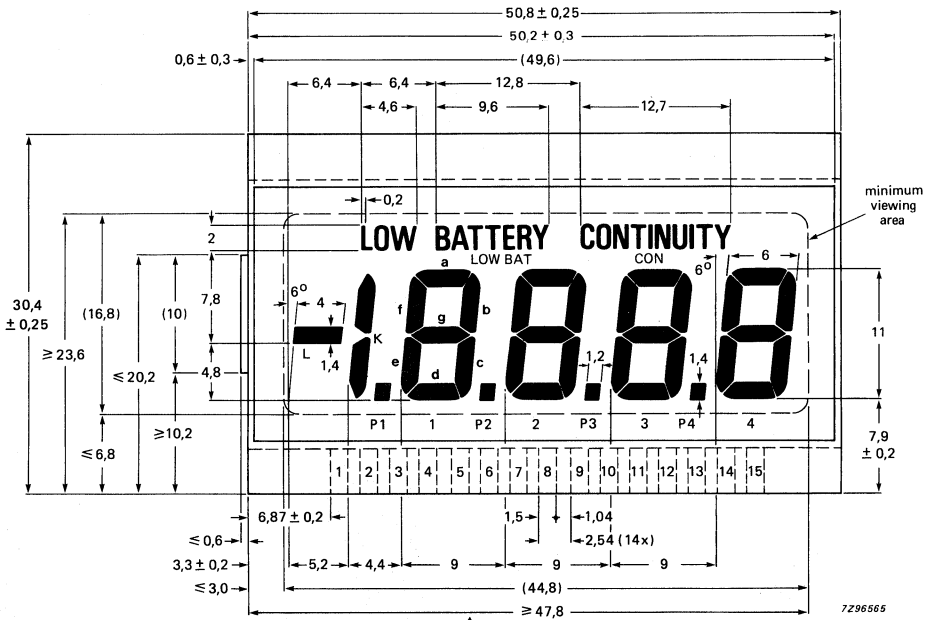
CONTACT NUMBER	COMMON 1	COMMON 2	COMMON 3
1	f1	e1	P1
2	a1	g1	d1
3	b1	c1	K
4	f2	e2	P2
5	a2	g2	d2
6	b2	c2	L
7	f3	e3	P3
8	a3	g3	d3
9	b3	c3	LOW BAT
10	f4	e4	P4
11	a4	g4	d4
12	b4	c4	CON
13	comm 1		
14		comm 2	
15			comm 3

Preferred driver: PCF8576

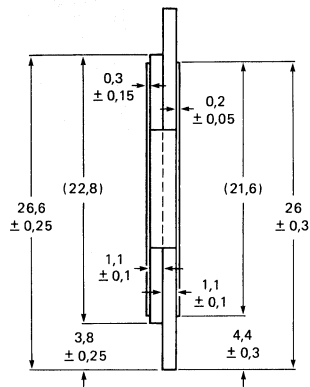
MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".



↑  
preferred viewing direction



side view

Fig. 2



**16-DIGIT MULTIPLEX DRIVE LCD****DEVICE DESCRIPTION**

The LTD233-E01 is a 16-digit, 7-segment LCD with a 1:2 multiplex drive ratio. The cell is available in reflective viewing mode. Typically included in telecom applications. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	2,8 to 3,2 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	69,8 x 20,3 mm
Viewing area	65,8 x 11,2 mm
Digit height	6,0 mm

Conductive rubber connection.

**DISPLAY MODE**

Scale 1:1



*Fig. 1 Telecom display*

## MULTIPLEX DUTY FACTOR 1:2

CONTACT NUMBER	COMMON 1	COMMON 2
1		comm 2
2	g1	e1
3	c1d2	d1
4	g2	e2
5	c2	d2
6	g3	e3
7	c3	d3
8	g4	e4
9	c4	d4
10	g5	e5
11	c5	d5
12	g6	e6
13	c6	d6
14	g7	e7
15	c7	d7
16	g8	e8
17	c8	d8
18	g9	e9
19	c9	d9
20	g10	e10
21	c10	d10
22	g11	e11
23	c11	d11
24	g12	e12
25	c12	d12
26	g13	e13
27	c13	d13
28	g14	e14
29	c14	d14
30	g15	e15
31	c15	d15
32	g16	e16
33	c16	d16
34		comm 4
	comm 3	comm 4

CONTACT NUMBER	COMMON 1	COMMON 2
35	comm 3	
36	b16	P16
37	a16	f16
38	b15	P15
39	a15	f15
40	b14	P14
41	a14	f14
42	b13	P13
43	a13	f13
44	b12	P12
45	a12	f12
46	b11	P11
47	a11	f11
48	b10	P10
49	a10	f10
50	b9	P9
51	a9	f9
52	b8	P8
53	a8	f8
54	b7	P7
55	a7	f7
56	b6	P6
57	a6	f6
58	b5	P5
59	a5	f5
60	b4	P4
61	a4	f4
62	b3	P3
63	a3	f3
64	b2	P2
65	a2	f2
66	b1	P1
67	a1	f1
68	comm 3	
	comm 3	comm 4

Preferred drivers: PCF2111 (x2), PCF8577 (x2)

# MECHANICAL DATA

*Dimensions in mm*

Unused segments to be controlled "off".

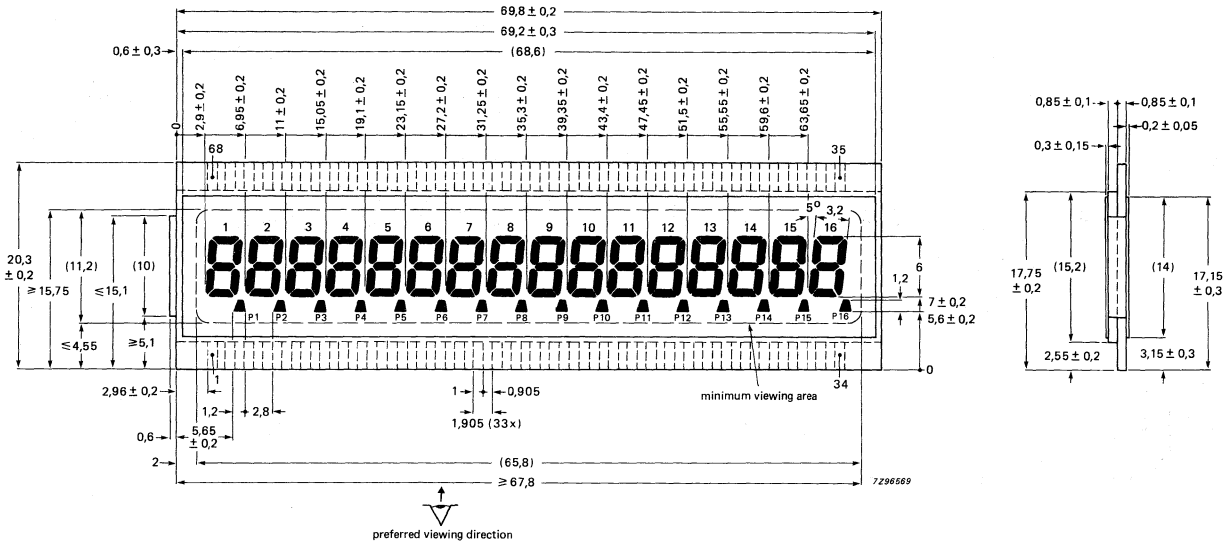


Fig. 2



**16-DIGIT MULTIPLEX DRIVE LCD****DEVICE DESCRIPTION**

The LTD234-E11 is a 16-digit, 7-segment LCD with a 1:4 multiplex drive ratio. The cell is available in reflective viewing mode. The LTD234 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

$V_{op}$	4,45 to 4,75 V
Ambient operating temperature range commercial grade extended grade	— — -20 to +70 °C
Overall dimensions	69,8 x 20,3 mm
Viewing area	65,8 x 11,2 mm
Digit height	6,0 mm

Conductive rubber connection.

**DISPLAY MODE**

Scale 1:1

8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.

Fig. 1 Universal display



## MULTIPLEX DUTY FACTOR 1:4

CONTACT NUMBER	COMMON 1	COMMON 2	COMMON 3	COMMON 4
1	comm 1			
2	comm 1			
3	e1	d1	g1	f1
4	e2	d2	g2	f2
5	NC			
6	e3	d3	g3	f3
7	NC			
8	e4	d4	g4	f4
9	NC			
10	e5	d5	g5	f5
11	NC			
12	e6	d6	g6	f6
13	NC			
14	e7	d7	g7	f7
15	NC		NC	
16	e8	d8	g8	f8
17	NC			
18	NC			
19	e9	d9	g9	f9
20	e10	d10	g10	f10
21	NC			
22	NC			
23	e11	d11	g11	f11
24	NC			
25	e12	d12	g12	f12
26	NC			
27	e13	d13	g13	f13
28	NC			
29	e14	d14	g14	f14
30	NC			
31	e15	d15	g15	f15
32	e16	d16	g16	f16
33		comm 2		
34		comm 2		

## MULTIPLEX DUTY FACTOR 1:4 (continued)

CONTACT NUMBER	COMMON 1	COMMON 2	COMMON 3	COMMON 4
35		comm 2		
36		comm 2		
37	c16	p16	b16	a16
38	c15	p15	b15	a15
39	NC			
40	NC			
41	c14	p14	b14	a14
42	NC			
43	c13	p13	b13	a13
44	NC			
45	c12	p12	b12	a12
46	NC			
47	c11	p11	b11	a11
48	NC			
49	c10	p10	b10	a10
50	NC			
51	c9	p9	b9	a9
52	NC			
53	c8	p8	b8	a8
54	NC			
55	c7	p7	b7	a7
56	NC			
57	c6	p6	b6	a6
58	NC			
59	c5	p5	b5	a5
60	NC			
61	c4	p4	b4	a4
62	NC			
63	c3	p3	b3	a3
64	NC			
65	c2	p2	b2	a2
66	c1	p1	b1	a1
67				comm 4
68				comm 4

Preferred driver: PCF8576

**MECHANICAL DATA**

*Dimensions in mm*

Unused segments to be controlled "off".

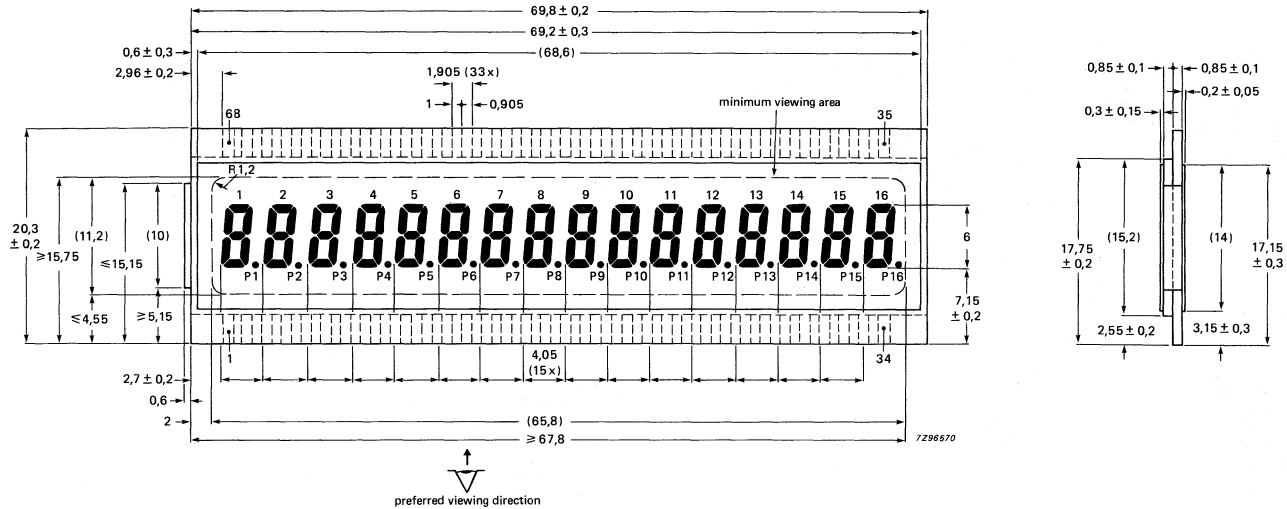


Fig. 2

**3½-DIGIT LCD MULTIMETER****DEVICE DESCRIPTION**

The LTD241-C01/C11/C12 is a direct drive 3½-digit, 7-segment LCD multimeter. The cell is available in reflective viewing mode. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	69,8 x 38,0 mm 73,0 x 43,0 mm*
Viewing area	65,8 x 26,0 mm
Digit height	17,8 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

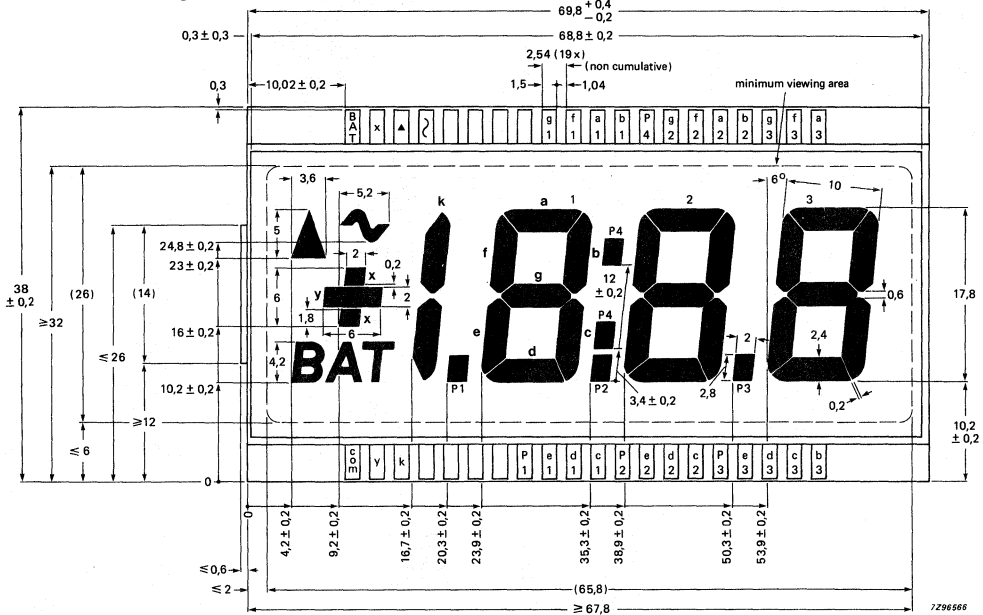


Fig. 1 Multimeter display

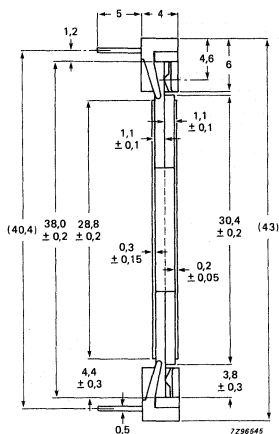
MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



↑  
preferred viewing direction



with DIP III connectors

side view

Preferred driver: PCF2112

Fig. 2

**4-DIGIT LCD****DEVICE DESCRIPTION**

The LTD242-C01/C11/C12 is a direct drive, 4-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD242 is a universal LCD. Transflective version is available on request.

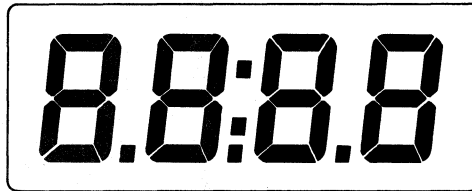
**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	69,8 x 65,8 mm 73,0 x 26,0 mm*
Viewing area	65,8 x 26,0 mm
Digit height	17,8 mm

\* With DIL pin connector.

**DISPLAY MODE**

*Scale 1:1*

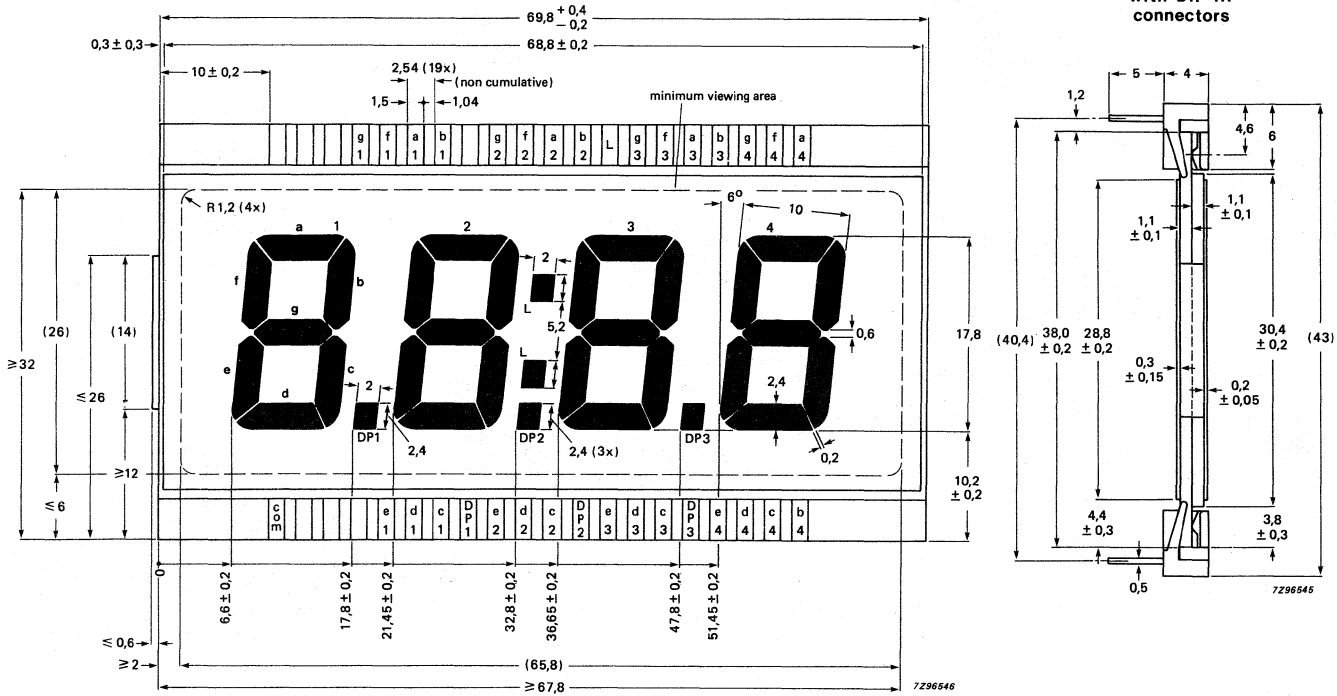


*Fig. 1 Universal display*

**MECHANICAL DATA**

*Dimensions in mm*

Connect all unused segments to common.



Preferred drivers: PCF2112, PCF8577

Fig. 2

**1-DIGIT LCD****DEVICE DESCRIPTION**

The LTD261-C01/C11/C12 is a direct drive, 1-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD261 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	76,2 x 101,6 mm 76,2 x 106,6 mm*
Viewing area	71,2 x 89,0 mm
Digit height	76,0 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

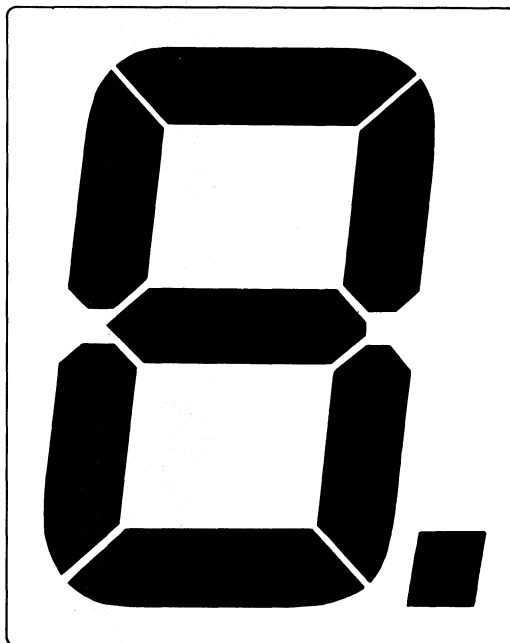


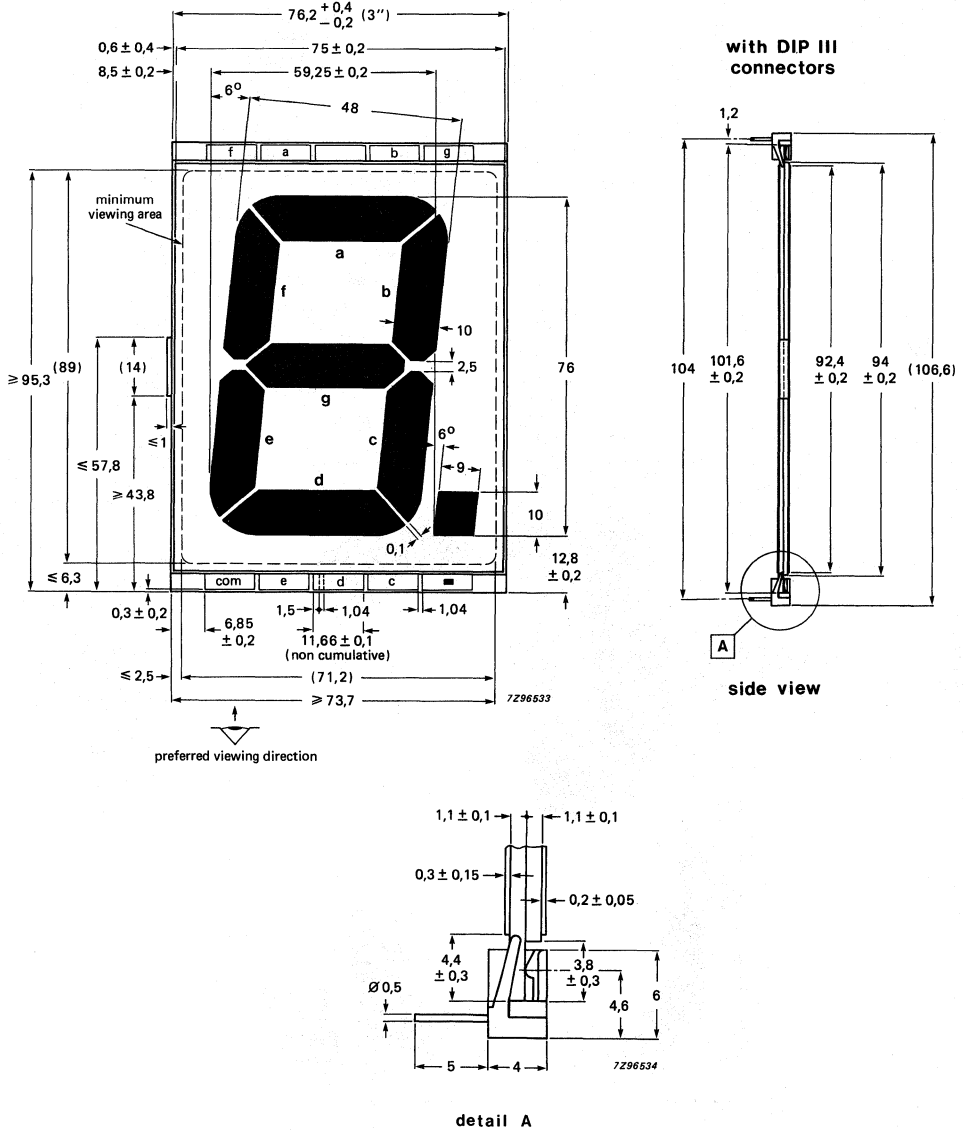
Fig. 1 Universal display



MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



Preferred drivers: PCF2112, PCF8577

Fig. 2

**8-DIGIT LCD****DEVICE DESCRIPTION**

The LTD262-C01/C11/C12 is a direct drive, 8-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD262 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	93,8 x 30,4 mm 97,0 x 35,4 mm*
Viewing area	89,8 x 18,4 mm
Digit height	12,7 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

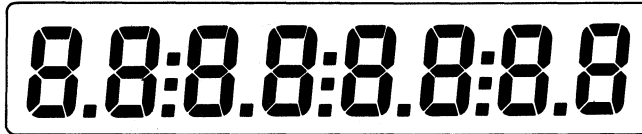
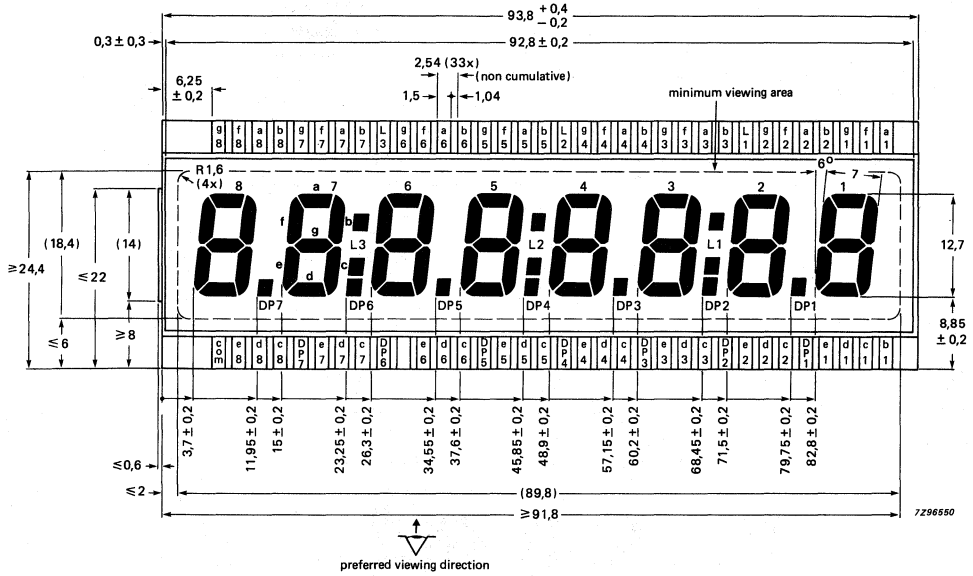


Fig. 1 Universal display

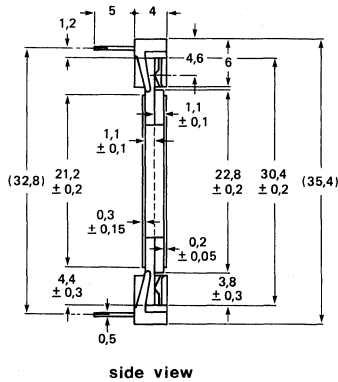
MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



with DIP III connectors



side view

Preferred drivers: PCF2112 (x3), PCF8576 (x3)

Fig. 2

**6-DIGIT LCD****DEVICE DESCRIPTION**

The LTD263-C01 and C11 is a direct drive, 6-digit, 7-segment LCD. The cell is available in reflective viewing mode. The LTD263 is a universal LCD. Transflective version is available on request.

**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C -25 to +80 °C
Overall dimensions	93,8 x 38,0 mm 97,0 x 43,0 mm*
Viewing area	88,8 x 25,4 mm
Digit height	17,8 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

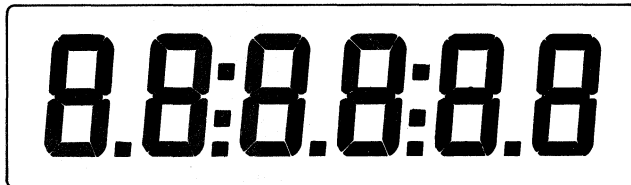
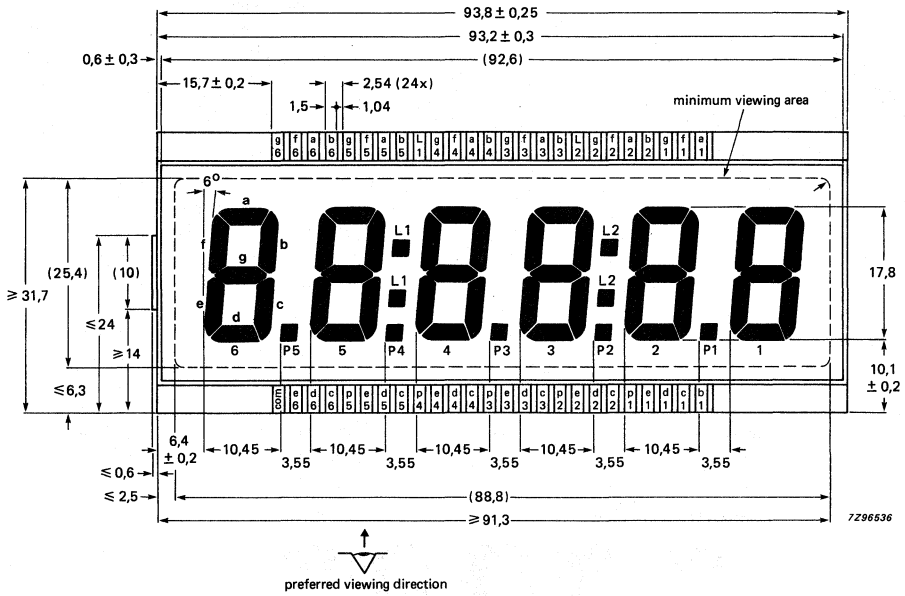


Fig. 1 Universal display

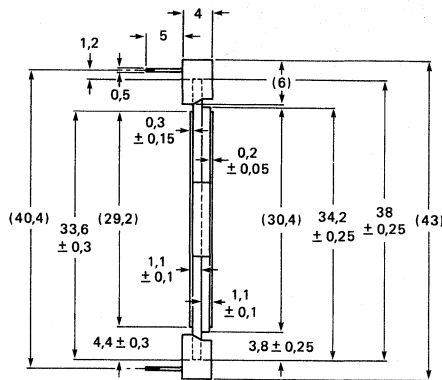
MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



with DIP III connectors



side view

Preferred drivers: PCF2112 (x2), PCF8577 (x2)

Fig. 2

## 5-DIGIT TILL LCD

### DEVICE DESCRIPTION

The LTD264-C11 and C12 is a direct drive, 5-digit, 7-segment till LCD. The cell is available in reflective viewing mode. Transflective version is available on request.

### QUICK REFERENCE DATA

V <sub>op</sub>	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	— — -25 to +80 °C
Overall dimensions	114,0 x 46,0 mm 117,4 x 51,0 mm*
Viewing area	109,0 x 33,4 mm
Digit height	25,0 mm

\* With DIL pin connector.

### DISPLAY MODE

Scale 1:1

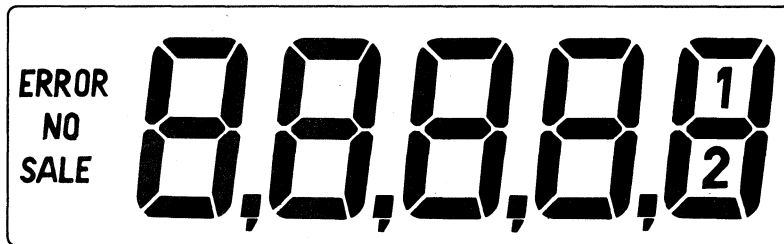
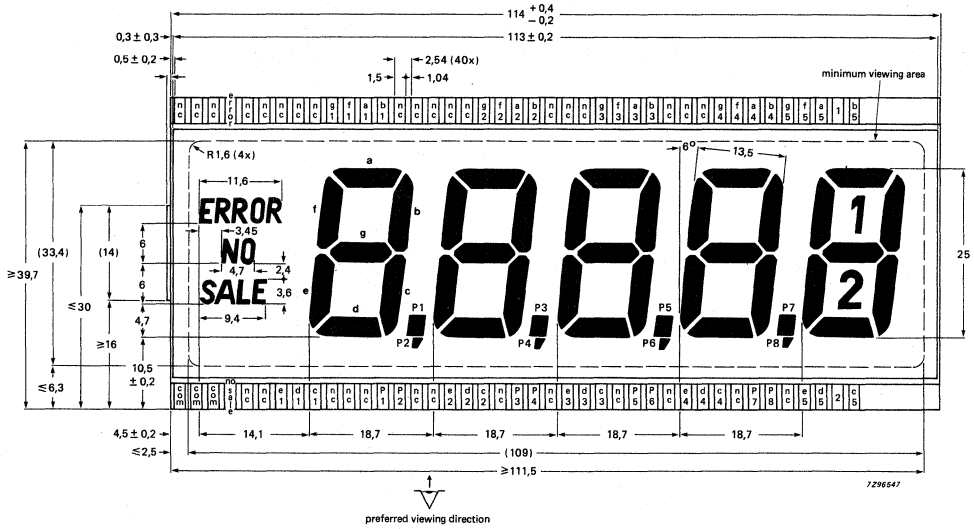


Fig. 1 Till display

MECHANICAL DATA

Dimensions in mm

Connect all unused segments to common.



with DIP III connectors

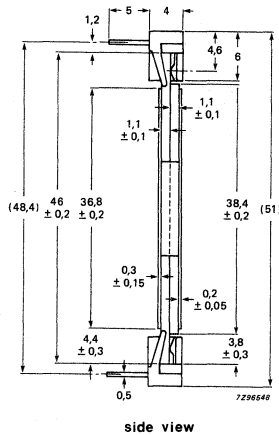


Fig. 2

Preferred drivers: PCF2112 (x2), PCF8577 (x2)

**BARGRAPH LCD****DEVICE DESCRIPTION**

The LTD321-C01 is a direct drive bargraph display with 2 commons. The cell is available in reflective viewing mode. The LTD321 is a universal LCD. Transflective version is available on request.

**COMMONS 1 AND 2**

comm 1	segments 1 to 20; a; b
comm 2	segments 21 to 40; c; d

Preferred drivers: HEF4754V, PCF8576

**QUICK REFERENCE DATA**

$V_{op}$	3,0 to 6,0 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	69,8 x 30,4 mm 73,0 x 35,4 mm*
Viewing area	64,8 x 17,8 mm
Digit height	5,0 mm

\* With DIL pin connector.

**DISPLAY MODE**

Scale 1:1

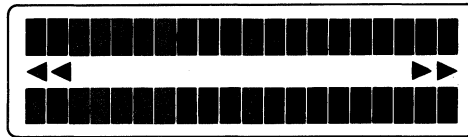


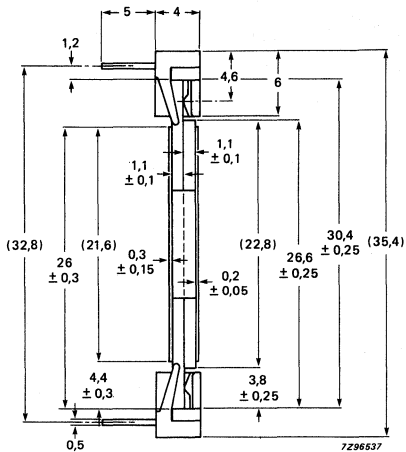
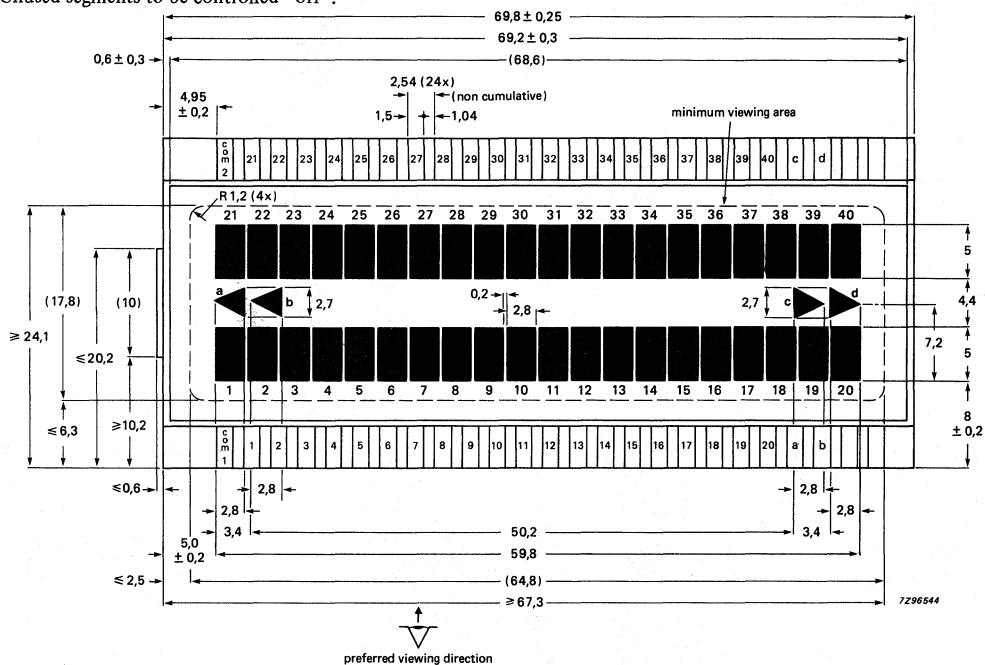
Fig. 1 Universal bargraph display



MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".



side view  
Fig. 2

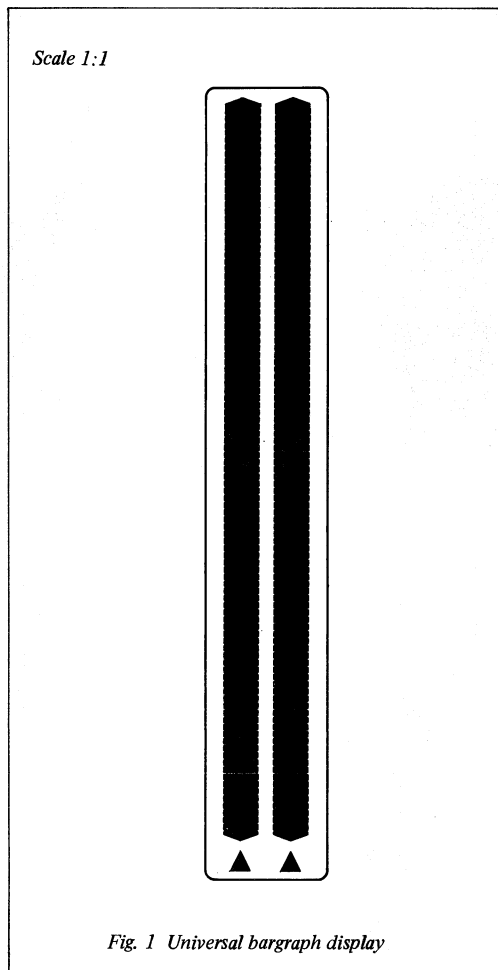
with DIP III connectors

## BARGRAPH LCD

### DEVICE DESCRIPTION

The LTD351-E01 is a bargraph display with a 1:2 multiplex drive ratio. The cell is available in reflective viewing mode. The LTD351 is a universal bargraph LCD. Transflective version is available on request.

### DISPLAY MODE



### QUICK REFERENCE DATA

$V_{op}$	3,0 to 3,2 V
Ambient operating temperature range commercial grade extended grade	-10 to +60 °C - -
Overall dimensions	26,0 x 114,0 mm
Viewing area	16,0 x 109,0 mm

Conductive rubber connection.

### MULTIPLEX DUTY FACTOR 1:2

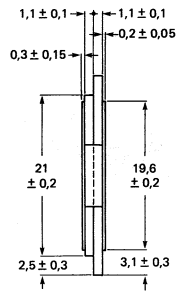
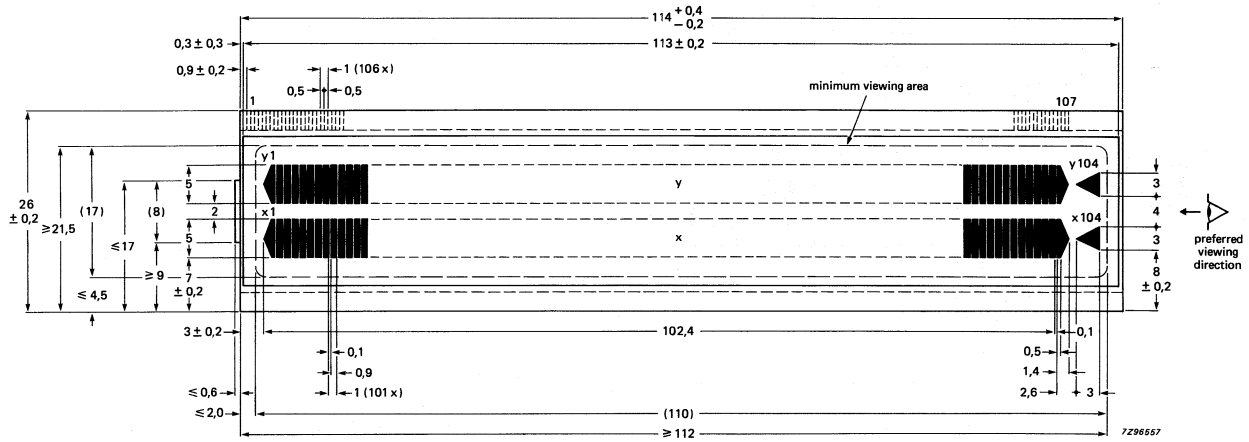
	1	2	3	4 to 107
comm 1	comm 1			x1 to x104
comm 2		comm 2	comm 2	y1 to y104

Preferred drivers: PCF2111 (x4), PCF8576 (x3)

MECHANICAL DATA

Dimensions in mm

Unused segments to be controlled "off".



side view

Fig. 2

*page*

**LCD MODULE DATA . . . . . 117**



**240 x 64 DOT MATRIX LCD MODULE****QUICK REFERENCE DATA**

Outline dimensions	180 x 75 x 10,5 mm
Viewing area	132,6 x 39,0 mm
Dot size (spacing 0,05 mm)	0,48 x 0,48 mm
Mass	≈ 120 g
Drive method	MUX 1:64
Supply voltage	+5; -11 V
Power consumption	30 mW
Temperature compensation circuit	built in
Data interface	serial
Controller	external
Viewing mode	reflective

**MODULE DESCRIPTION**

The LTG201-N01 is a 240 x 64 full dot LCD module. The module incorporates column and row driver LSI ICs and a temperature compensation circuit mounted on a single PC-board. The module is capable of displaying graphics, figures and symbols if connected to a microprocessor or specially designed LSI IC.

Using 5 x 7 dot character format the module can display up to 8 lines of 40 characters.

MECHANICAL DATA

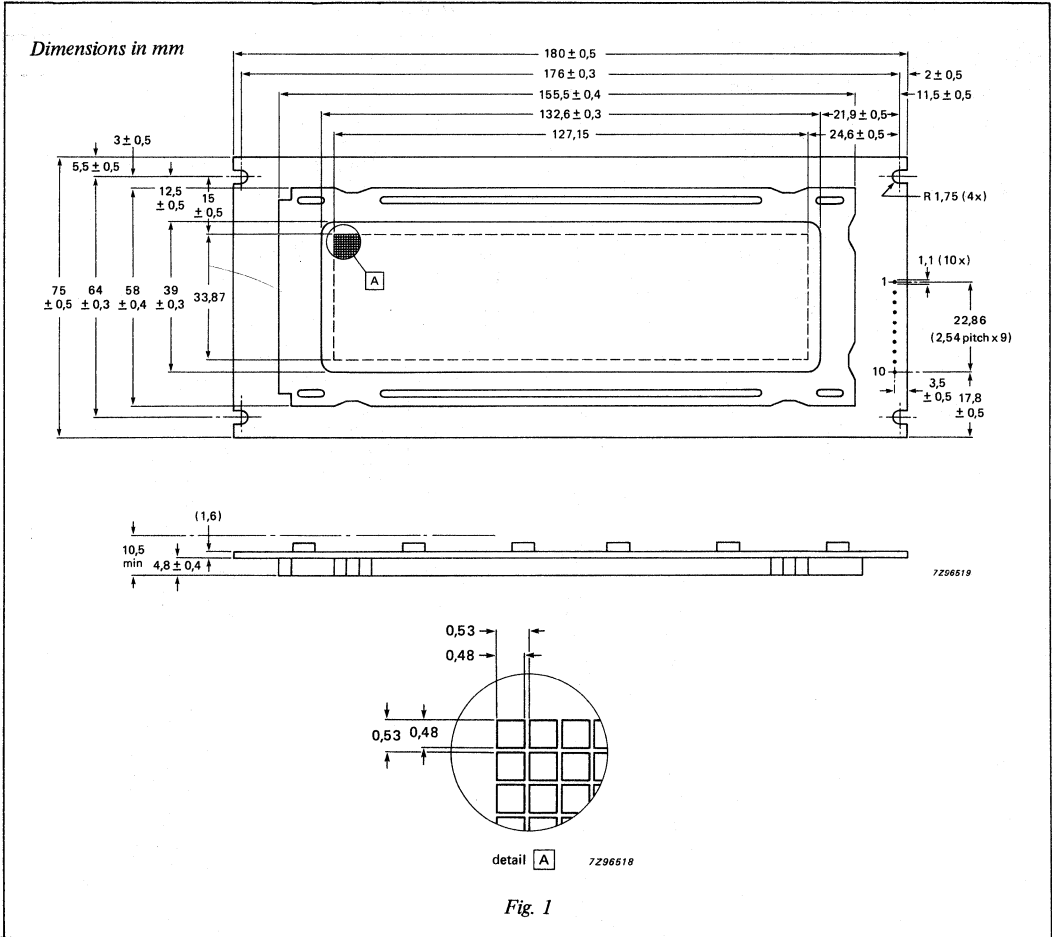
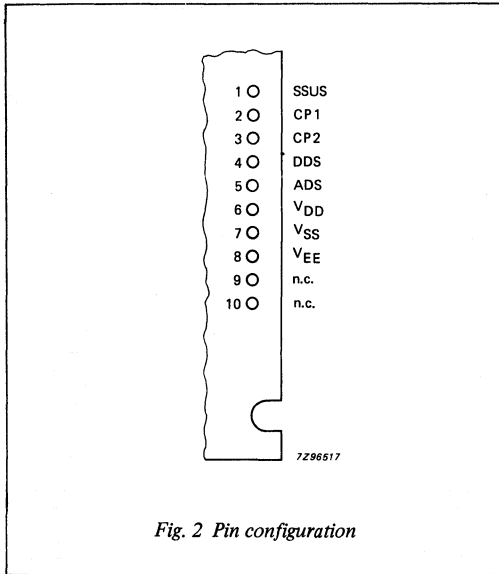


Fig. 1



**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	SSUS	scan start-up signal
2	CP1	clock pulse (latch)
3	CP2	clock pulse (data)
4	DDS	display data signal
5	ADS	alternating drive signal
6	VDD	power supply (logic)
7	VSS	ground
8	VEE	power supply (LCD)
9	n.c.	not connected
10	n.c.	not connected



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	0	—	6,0	V
Supply voltage (LCD driver)	$V_{DD}-V_{EE}$	0	—	18,0	V
Input voltage	$V_I$	0	—	$V_{DD}$	V
Storage temperature	$T_{stg}$	-25	—	+60	°C
Operating ambient temperature	$T_{amb}$	0	—	+50	°C

## OPERATING CHARACTERISTICS

 $T_{amb} = 25\text{ °C}$  unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	4,75	5,0	5,25	V
LCD driver voltage	$V_{EE}-V_{SS}$	-12,0	-11,0	—	V
LOW level input voltage	$V_{IL}$	0,0	—	0,2 $V_{DD}$	V
HIGH level input voltage	$V_{IH}$	0,8 $V_{DD}$	—	$V_{DD}$	V
LOW level input leakage current	$I_{IL}$	-10,0	—	—	$\mu\text{A}$
HIGH level input leakage current	$I_{IH}$	—	—	10	$\mu\text{A}$
Supply current (logic) $V_{EE} = -11\text{ V}$ $V_{DD} = 5\text{ V}$ $f = 80\text{ Hz}$	$I_{DD}$	—	6,0	12,0	mA
Supply current (LCD driver) $V_{EE} = -11\text{ V}$ $V_{DD} = 5\text{ V}$ $f = 80\text{ Hz}$	$I_{EE}$	—	1,0	2,0	mA
Power dissipation	$P_d$	—	41,0	82,0	mW
Input capacitance pin 1	$C_I$	—	50,0	—	pF
pins 2 and 5	$C_I$	—	200,0	—	pF
pin 3	$C_I$	—	250,0	—	pF
pin 4	$C_I$	—	100,0	—	pF

## TIMING CHARACTERISTICS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Frame cycle time	$t_{FRM}$	12,5	—	14,3	ms
HIGH level clock pulse width (CP1)	$t_{WH}$	400	—	—	ns
HIGH level clock pulse width (CP2)	$t_{WH}$	125	—	—	ns
LOW level clock pulse width (CP2)	$t_{WL}$	125	—	—	ns
Clock cycle time	$t_{cyc}$	390	—	—	ns
Data set-up time	$t_{dsu}$	100	—	—	ns
Data hold time	$t_{dh}$	100	—	—	ns
SSUS clock hold time	$t_{sh}$	800	—	—	ns
Clock rise time	$t_r$	—	—	50	ns
Clock fall time	$t_f$	—	—	50	ns

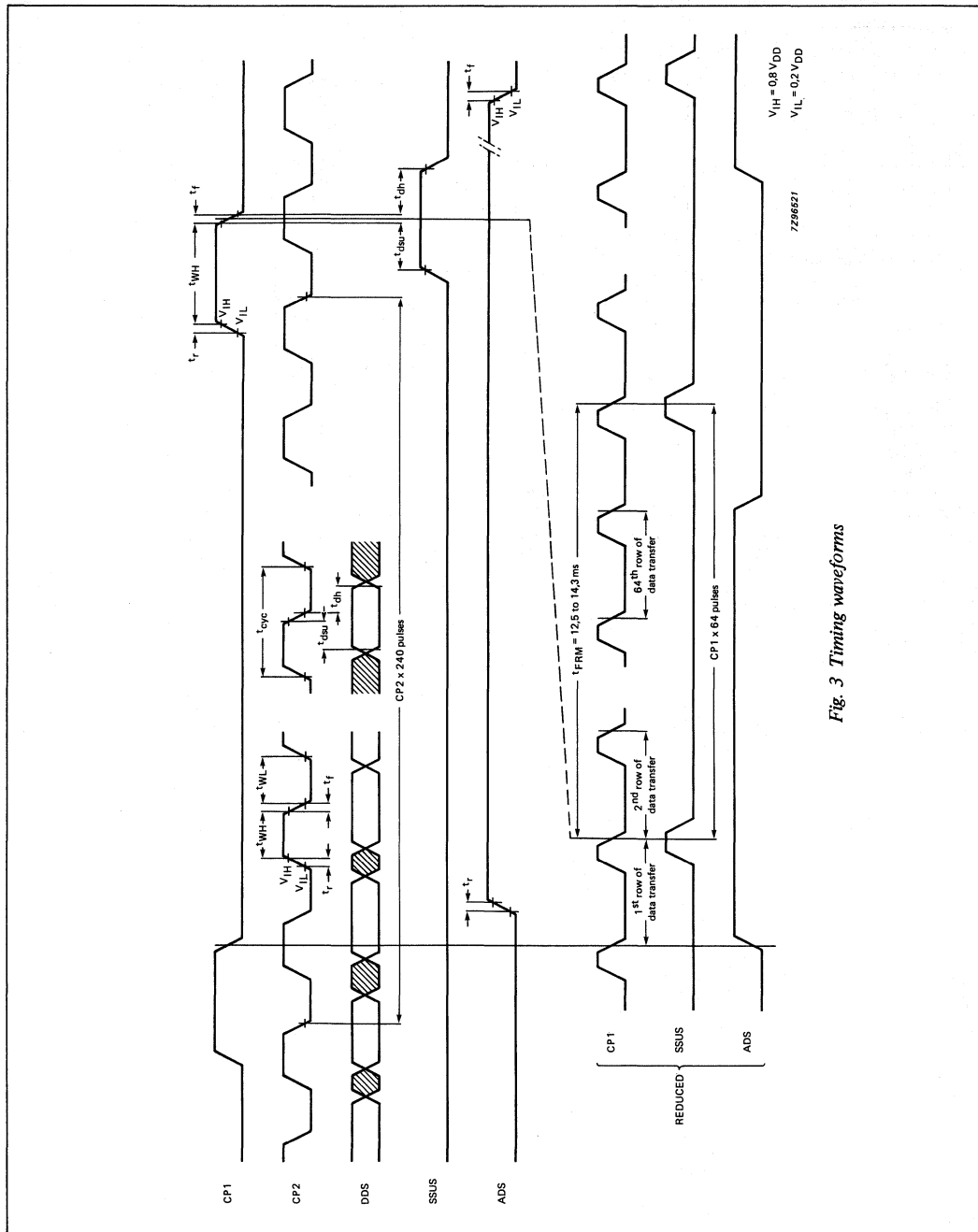
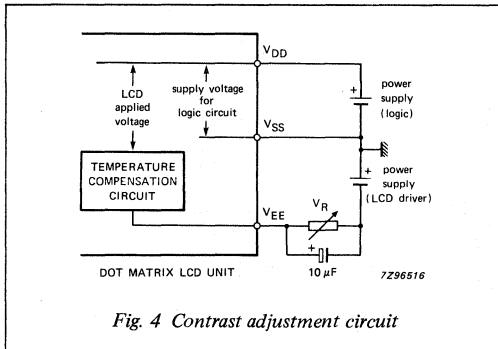


Fig. 3 Timing waveforms

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### DRIVING METHOD

The circuit configuration is shown in Fig. 5.

#### Input data and control signals

Input data and clock pulse are entered at the input data pin (pin 4) and the CP2 (pin 3) respectively; starting at the top left of the display. The data input is implemented in the form of 1-bit serial data (HIGH level-turn on, LOW level-turn off).

On the falling edge of CP2 clock the input data is sequentially transferred via the shift register in the signal electrode driver.

After 1 row of data (240 dots) has been entered it is latched in the form of parallel data corresponding to 240 lines of signal electrodes. The data is dispatched to the signal electrodes after it has been latched. Scan start-up signal SSUS is transferred from the scan signal driver to the first row of the scan electrodes displaying the data signals on the first row of the display. The data displayed will be according to the combination of voltages applied to the scan and signal electrodes of the LCD.

While the first row of data is being displayed the second row is being entered. When the full 240 dots of data has been entered and latched on the falling edge of the CP1 clock, the display proceeds to the second row.

The display input is repeated up to the 64th row to complete the whole area of the display, then the data input proceeds to the next display face.

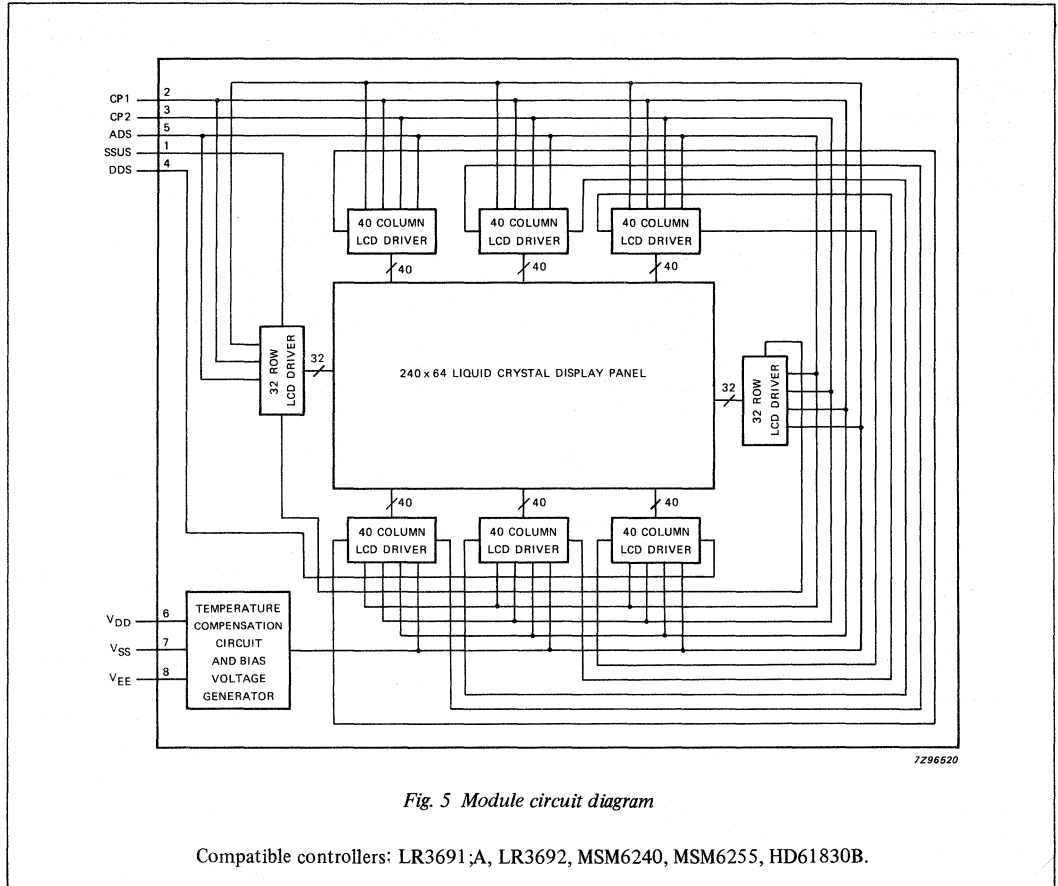


Fig. 5 Module circuit diagram

Compatible controllers: LR3691;A, LR3692, MSM6240, MSM6255, HD61830B.

**640 x 200 DOT MATRIX LCD MODULE (with optional EL backlight illumination)**

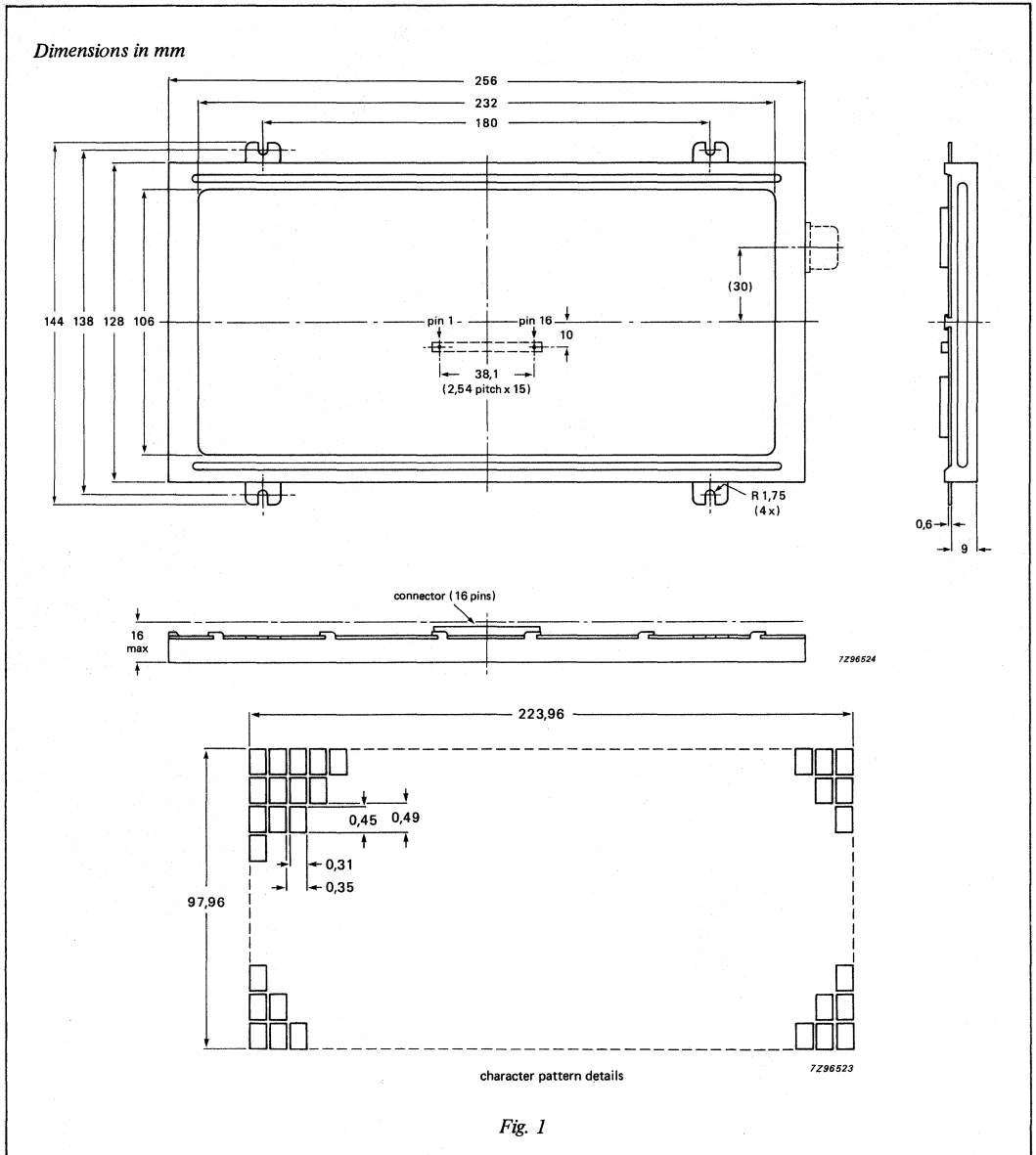
**QUICK REFERENCE DATA**

Outline dimensions	256 x 125 x 18 mm
Viewing area	232 x 106 mm
Dot size (spacing 0,04 mm)	0,31 x 0,45 mm
Mass	≈ 470 g
Drive method	MUX 1:100
Supply voltage	+5; -18 V
Temperature compensation circuit	built in
Data interface	parallel 2 x 4 bits
Controller	external
Viewing mode	transflective
Illumination (EL backlight)	optional

**MODULE DESCRIPTION**

The LTG401-D02 is a 640 x 200 dot, graphic LCD module. The module has an optional electro-luminescent (EL) backlight. The module offers a wide graphic display area incorporating up to 25 lines of 106, 5 x 7 dot characters.

MECHANICAL DATA



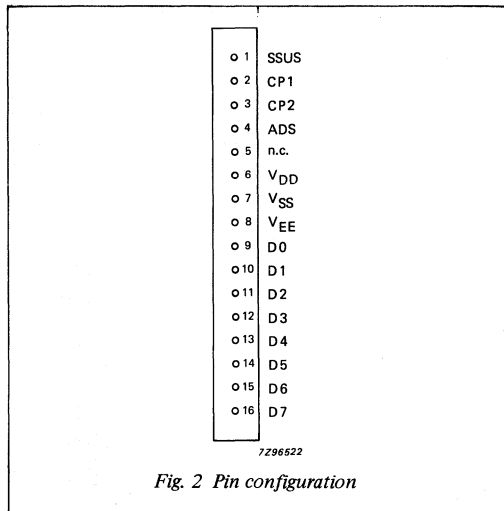


Fig. 2 Pin configuration

Note: Pins D0 to D3 are for the upper half of the display and pins D4 to D7 are for the lower half.

**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	SSUS	scan start-up signal
2	CP1	clock pulse (latch)
3	CP2	clock pulse (data)
4	ADS	alternating drive signal
5	n.c.	not connected
6	VDD	power supply (logic)
7	VSS	ground
8	VEE	power supply (LCD)
9	D0	display data signal
10	D1	display data signal
11	D2	display data signal
12	D3	display data signal
13	D4	display data signal
14	D5	display data signal
15	D6	display data signal
16	D7	display data signal



## RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	0	—	6,0	V
Supply voltage (LCD driver)	$V_{DD}-V_{EE}$	0	—	29,0	V
Input voltage	$V_I$	0	—	$V_{DD}$	V
Storage temperature	$T_{stg}$	-25	—	+60	°C
Operating ambient temperature	$T_{amb}$	0	—	+50	°C

## OPERATING CHARACTERISTICS

 $T_{amb} = 25\text{ °C}$  unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	4,75	5,0	5,25	V
LCD driver voltage	$V_{EE}-V_{SS}$	-23,0	—	-14,0	V
LOW level input voltage	$V_{IL}$	0,0	—	0,2 $V_{DD}$	V
HIGH level input voltage	$V_{IH}$	0,8 $V_{DD}$	—	$V_{DD}$	V
LOW level input leakage current	$I_{IL}$	-20,0	—	20	$\mu A$
Supply current (logic)	$I_{DD}$	—	22,0	28,0	mA
Supply current (LCD driver)	$I_{EE}$	—	15,0	19,0	mA
Power dissipation	$P_d$	—	41,0	82,0	mW
Input capacitance					
pin 1	$C_I$	—	50,0	—	pF
pins 2 and 4	$C_I$	—	200,0	—	pF
pin 3	$C_I$	—	250,0	—	pF
pins 9 to 16	$C_I$	—	100,0	—	pF

**TIMING CHARACTERISTICS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Frame cycle time	t <sub>FRM</sub>	12,5	—	14,3	ms
HIGH level clock pulse width (CP2)	t <sub>WH</sub>	230	—	—	ns
LOW level clock pulse width (CP2)	t <sub>WL</sub>	230	—	—	ns
HIGH level clock pulse width (CP1)	t <sub>WH</sub>	130	—	—	ns
Clock cycle time	t <sub>cyc</sub>	500	—	—	ns
Data set-up time	t <sub>dsu</sub>	100	—	—	ns
Data hold time	t <sub>dh</sub>	100	—	—	ns
Clock rise time	t <sub>r</sub>	—	—	50	ns
Clock fall time	t <sub>f</sub>	—	—	50	ns

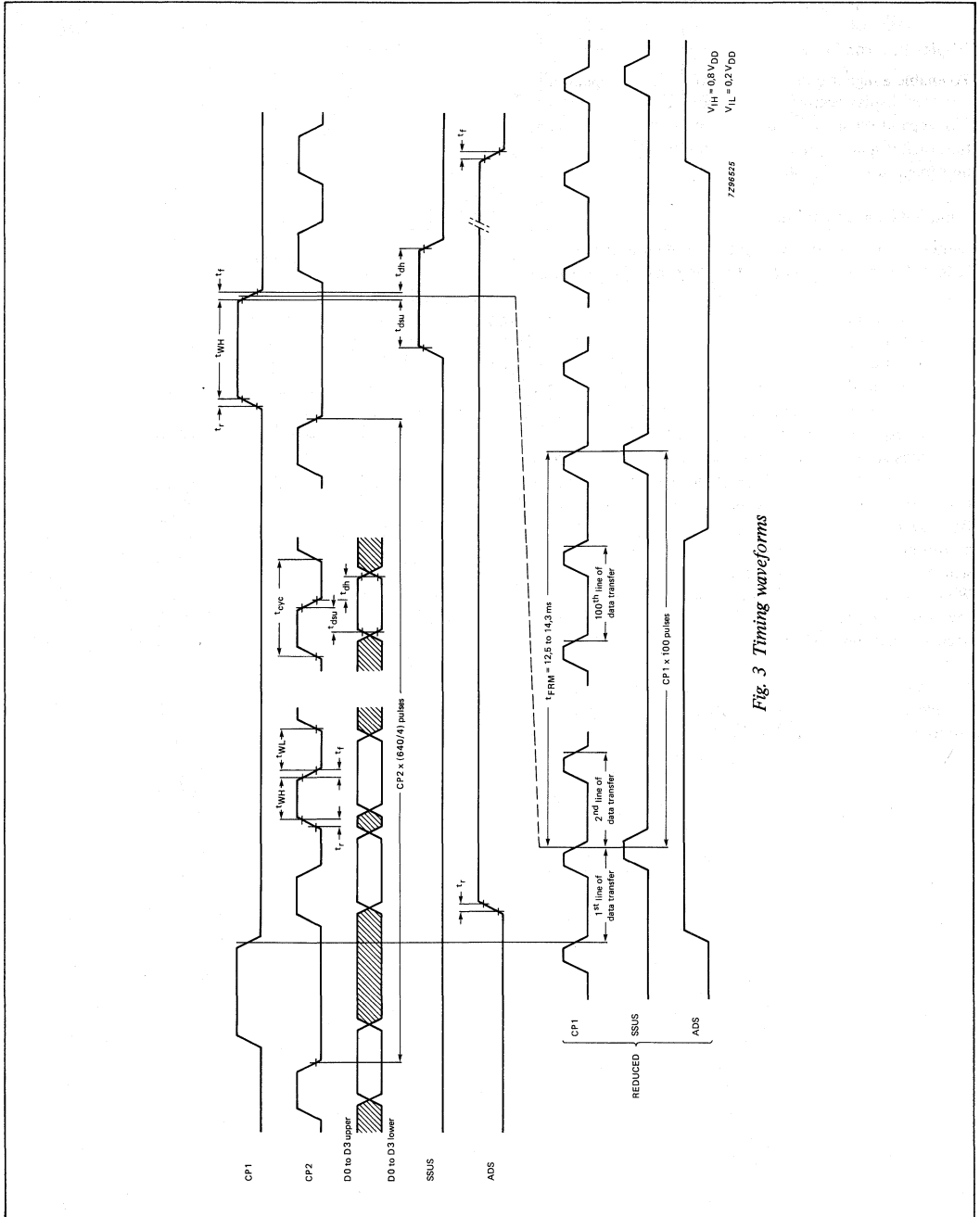


Fig. 3 Timing waveforms

## DRIVING METHOD

The circuit configuration is shown in Fig. 4.

### Display face configuration

To enable a higher contrast the display face is separated into two display segments (upper and lower segments). This separation allows a reduction in the multiplex ratio so that each display segment (640 x 100 dots) is driven at a multiplex ratio of 1:100.

### Input data and control signals

Display data is externally divided into data for each row (640 dots) and is implemented in the form of 4-bit parallel data.

On the falling edge of CP2 clock the input data is sequentially transferred via the shift register to the top left of the display.

After 1 row of data (640 dots) has been entered it is latched in the form of parallel data corresponding to 640 lines of signal electrodes. The data is dispatched to the signal electrodes after it has been latched. Scan start-up signal SSUS is transferred from the scan signal driver to the first row of the scan electrodes displaying the data signals on the first row of the display. The data displayed will be according to the combination of voltages applied to the scan and signal electrodes of the LCD.

While the first row of the data is being displayed the second row is being entered. When the full 640 dots of data has been entered and latched on the falling edge of the CP1 clock, the display proceeds to the second row.

The display input is repeated up to the 100th row to complete the whole area of the display, then the data input proceeds to the next display face.

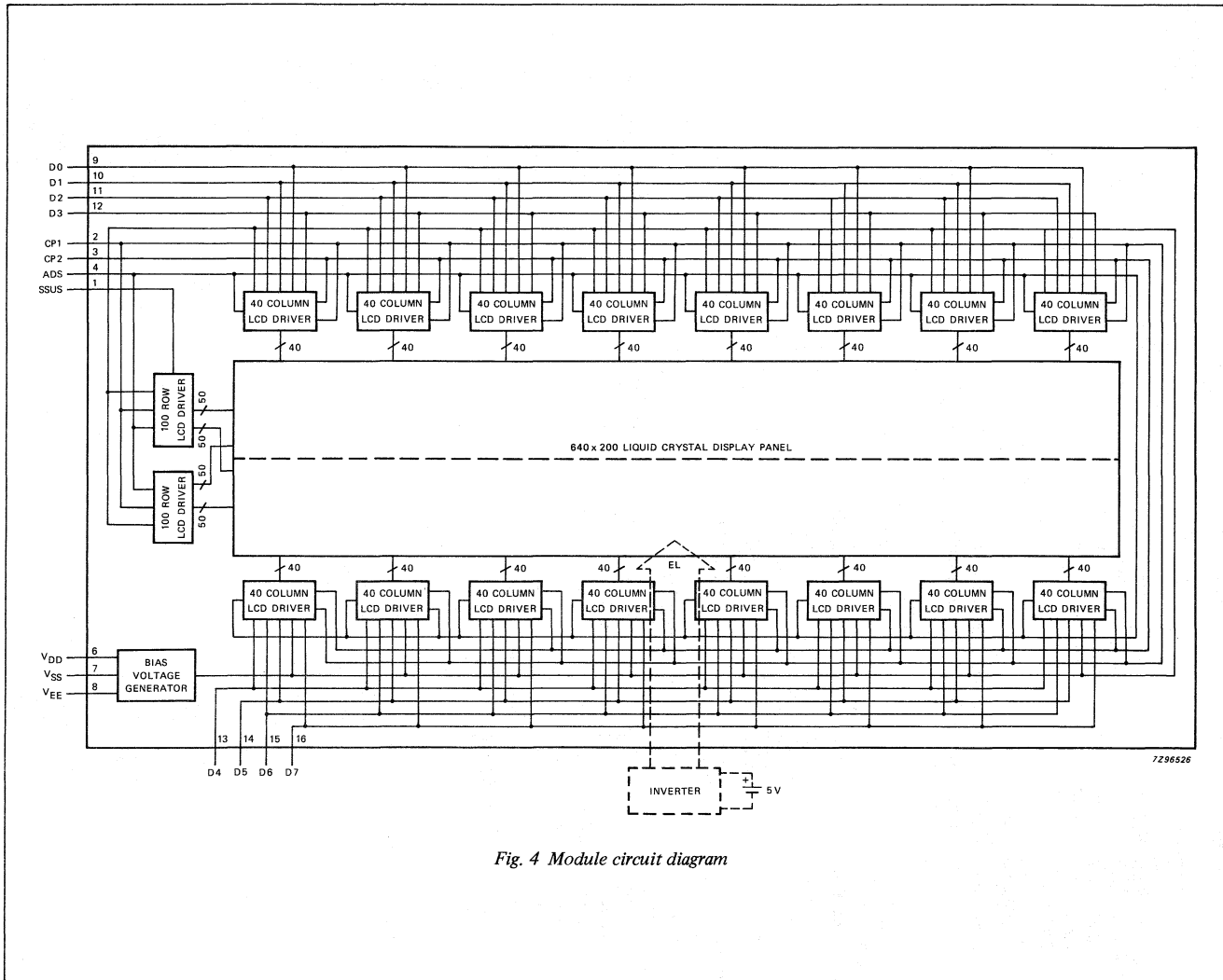


Fig. 4 Module circuit diagram

## 16-DIGIT LCD MODULE

## QUICK REFERENCE DATA

Outline dimensions	92,5 x 25,0 x 10,5 mm
Viewing area	65,8 x 11,2 mm
Character size	3,2 x 6,0 mm
Mass	≈ 21,0 g
Drive method	MUX 1 : 2
Supply voltage	+3 V
Supply current	30 μA
Viewing mode	reflective
Character generator	external
Data interface	serial (C-bus)

## MODULE DESCRIPTION

The LTM233-N01 is a 16-digit, 1-line, multiplex drive LCD module with a multiplex drive ratio of 1:2. The module is driven by 2 PCF2111 LCD drivers which are contained within the module housing. An external microcomputer can be programmed to supply display data of 16 numeric characters with some alphabetic characters possible.

## DISPLAY MODE

Scale 1:1

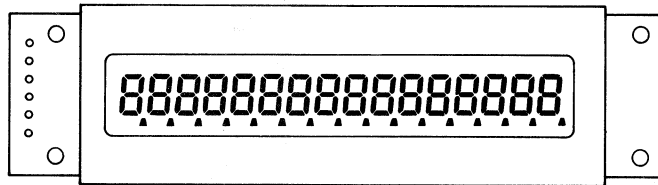


Fig. 1 Universal display module

Dimensions in mm

Unused segments to be controlled "off".

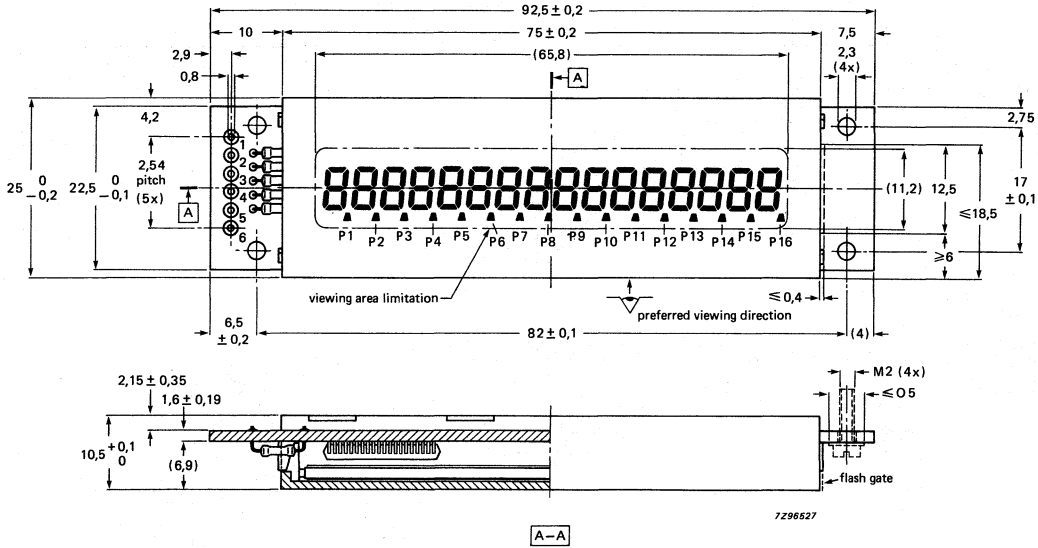


Fig. 2

PIN DESCRIPTION

1	2	3	4	5	6
DLEN 1	DATA	DLEN 2	CLB	V <sub>DD</sub>	GND

**DC CHARACTERISTICS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Power supply voltage	V <sub>DD</sub>	-0,3	-	8,0	V
HIGH level input voltage	V <sub>IH</sub>	2,0	-	V <sub>DD</sub> +3	V
LOW level input voltage	V <sub>IL</sub>	-0,3	-	0,6	V

**TIMING CHARACTERISTICS**

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
CLB pulse width HIGH	t <sub>WH</sub>	3,0	-	-	μs
CLB pulse width LOW	t <sub>WL</sub>	10,0	-	-	μs
Data set-up time DATA to CLB	t <sub>SUDA</sub>	10,0	-	-	μs
Data hold time DATA to CLB	t <sub>HDDA</sub>	10,0	-	-	μs
Enable set-up time DLEN to CLB	t <sub>SUEN</sub>	3,0	-	-	μs
Disable set-up time CLB to DLEN	t <sub>SUDI</sub>	10,0	-	-	μs
Set-up time load pulse DLEN to CLB	t <sub>SULD</sub>	10,0	-	-	μs
Busy-time from load pulse to next start of transmission	t <sub>BUSY</sub>	10,0	-	-	μs
Set-up time leading zero DATA to CLB	t <sub>SULZ</sub>	10,0	-	-	μs

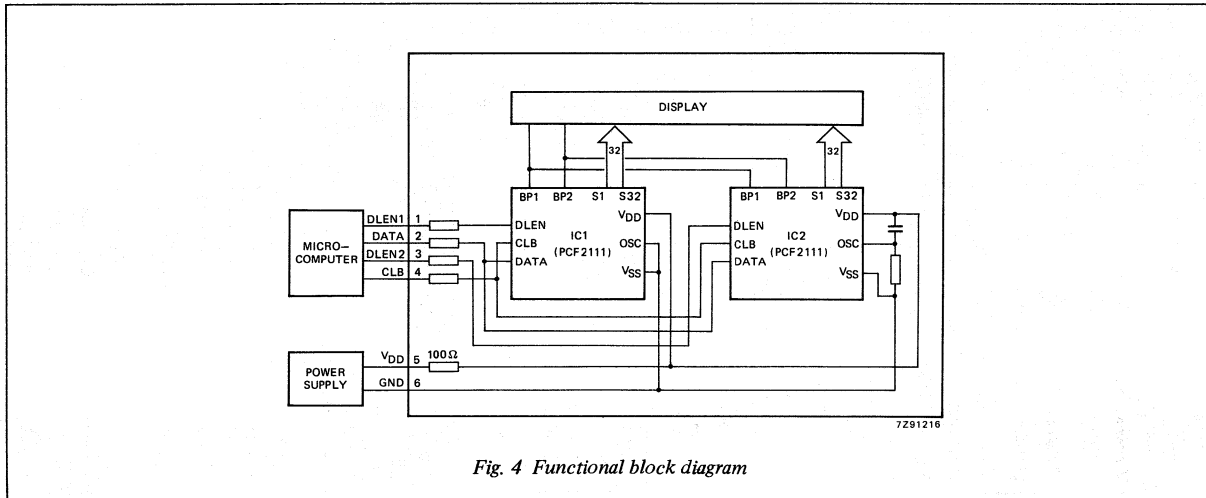
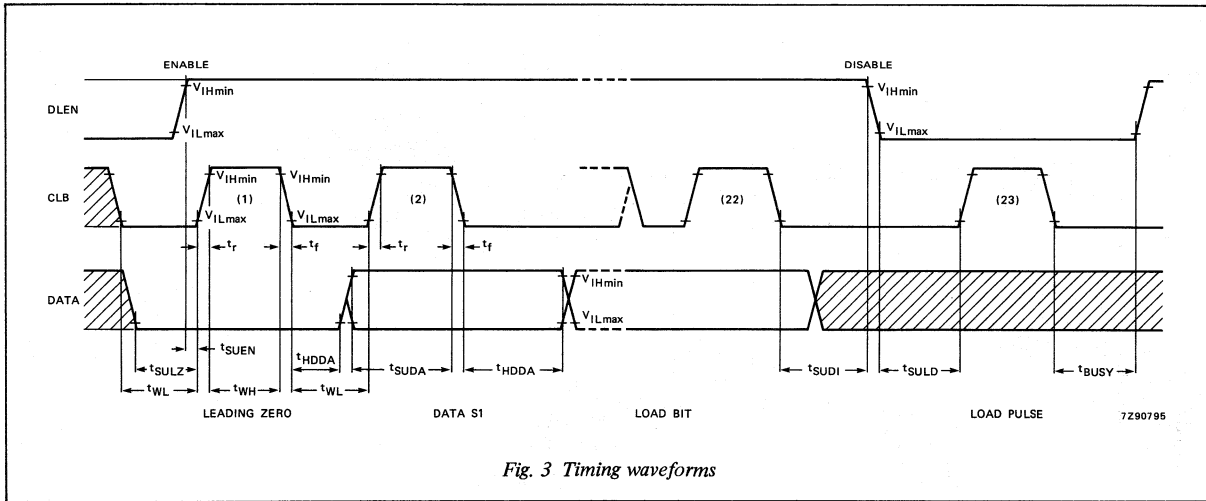
All times are measured with a voltage swing V<sub>IHmin</sub> to V<sub>ILmin</sub>.

Built in drivers: PCF2111 (x2)

**Correspondence between IC-outputs and LCD-segments**

Output	IC	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Segment	BP 1		f	e	p	d	f	e	p	d	f	e	p	d	f	e	p	d	f	e	p	d	f	e	p	d	f	e	p	d	f	e	p	d
	BP 2		a	g	b	c	a	g	b	c	a	g	b	c	a	g	b	c	a	g	b	c	a	g	b	c	a	g	b	c	a	g	b	c
Digit	IC 1		1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8
	IC 2		9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16



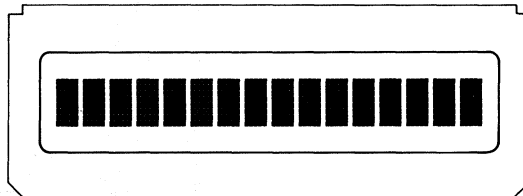


**16-CHARACTER, 1-LINE LCD MODULE****QUICK REFERENCE DATA**

Outline dimensions	80 x 36 x 12 mm
Viewing area	64,5 x 13,8 mm
Character format	5 x 7 dots and cursor
Character size	3,07 x 5,73 mm
Dot size (spacing 0,08 mm)	0,55 x 0,75 mm
Mass	≈ 25 g
Drive method	MUX 1:16
Supply voltage	+5 V
Power consumption	7,5 mW
Viewing mode	reflective
Character generator	built in
Data interface	parallel 4 or 8 bits

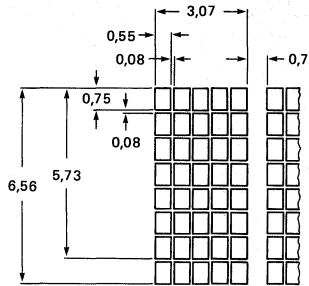
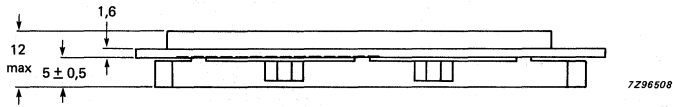
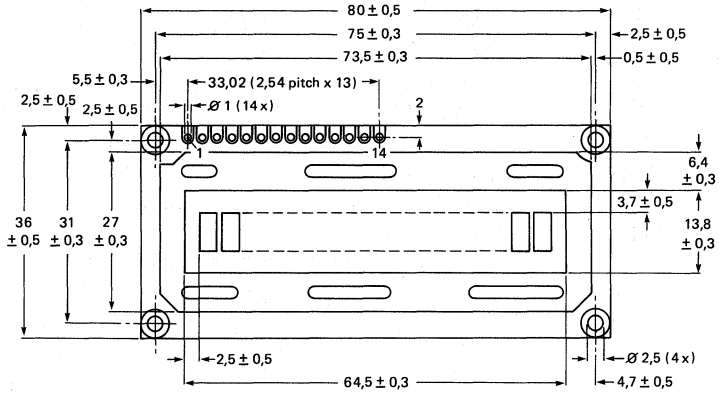
**MODULE DESCRIPTION**

The LTN111-N01 is a 5 x 7 dot, 16-character, 1-line dot matrix LCD module with LCD driver and controller LSI ICs mounted on a single PC-board. The LSI controller incorporates a ROM-based character generator with 160 characters and RAM display data with 8 characters. The module is capable of generating 160 fixed and 8 write by programme characters. The module operates from an extensive instruction set: display clear, cursor home, display ON/OFF, cursor ON/OFF, character blink, cursor shift and display shift.

**DISPLAY MODE***Scale 1:1**Fig. 1 16-character, 1-line LCD module*

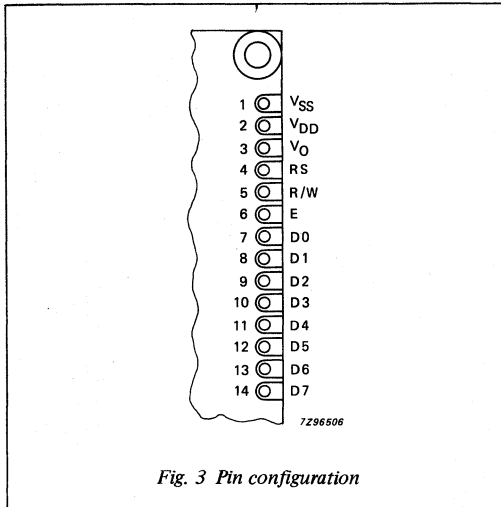
MECHANICAL DATA

*Dimensions in mm*



character pattern details 7296507

Fig. 2

**Notes to pin description**

1. Contrast is adjusted by varying the supply voltage between 0 and 5 V.
2. D7 doubles as a busy flag output.
3. When the module is interfaced with a microcomputer with 4-bit parallel outputs, pins D0 to D3 are not used.

Recommendable connectors:

W-P5014, 5267-14A, FCN-724P014-AU/S, 65507-114.

**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	VSS	ground
2	VDD	power supply (logic)
3	VO	contrast adjustment voltage
4	RS	register select
5	R/W	read/write
6	E	enable
7	D0	I/O data LSB
8	D1	I/O data 2nd bit
9	D2	I/O data 3rd bit
10	D3	I/O data 4th bit
11	D4	I/O data 5th bit
12	D5	I/O data 6th bit
13	D6	I/O data 7th bit
14	D7	I/O data MSB

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	-0,3	-	7,0	V
LCD driver voltage	$V_{DD}-V_{O}$	0	-	13,5	V
Input voltage	$V_I$	-0,3	-	$V_{DD}+0,3$	V
Storage temperature	$T_{stg}$	-25	-	+55	°C
Operating ambient temperature	$T_{amb}$	0	-	+50	°C

**OPERATING CHARACTERISTICS** $T_{amb} = 25\text{ °C}$  unless otherwise stated

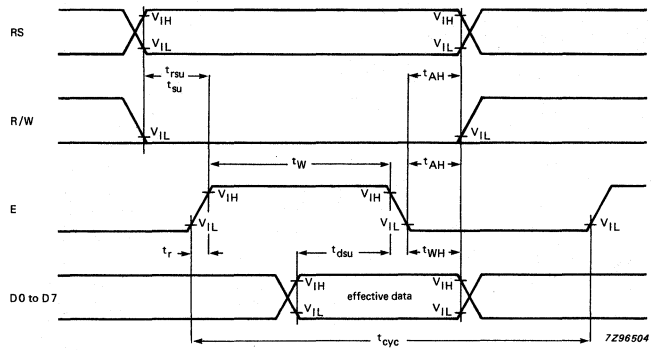
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	$V_{DD}-V_{SS}$	4,75	5,0	5,25	V
LCD driver voltage $V_{DD} = 5\text{ V}$	$V_{O}-V_{SS}$	-	0,6	-	V
LOW level input voltage	$V_{IL}$	-0,3	-	0,6	V
HIGH level input voltage	$V_{IH}$	2,2	-	$V_{DD}$	V
LOW level output voltage $I_{OL} = 1,2\text{ mA}$	$V_{OL}$	-	-	0,4	V
HIGH level output voltage $-I_{OH} = 0,205\text{ mA}$	$V_{OH}$	2,4	-	-	V
Input leakage current	$I_I$	-	-	1,0	$\mu\text{A}$
Internal oscillating frequency	$f_{osc}$	-	250	-	kHz
Supply current (logic) see note	$I_{DD}$	-	1,5	2,0	mA
Power dissipation see note	$P_d$	-	7,5	10,0	mW

Note:  $V_{DD} = 5\text{ V}$ ,  $V_{O} = 0\text{ V}$ .

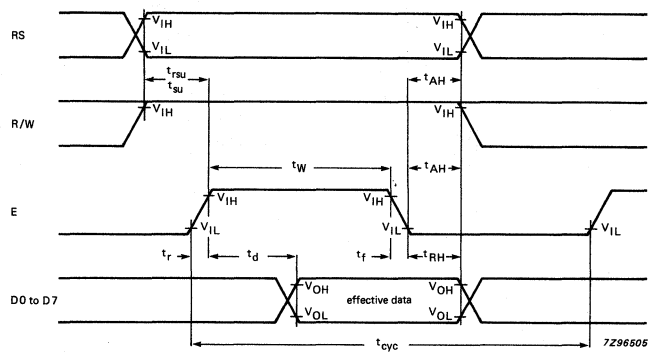
**TIMING CHARACTERISTICS**

$T_{amb} = 0$  to  $50\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 5\text{ V} \pm 5\%$  unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Enable cycle time	$t_{cyc}$	1000	—	—	ns
Enable pulse width	$t_W$	450	—	—	ns
Rise time	$t_r$	—	—	25	ns
Fall time	$t_f$	—	—	25	ns
Register select set-up time	$t_{rsu}$	140	—	—	ns
Read and write set-up time	$t_{su}$	140	—	—	ns
Data set-up time	$t_{dsu}$	195	—	—	ns
Data delay time	$t_d$	—	—	320	ns
Address hold time	$t_{AH}$	10	—	—	ns
Data hold time write	$t_{WH}$	10	—	—	ns
Data hold time read	$t_{RH}$	20	—	—	ns



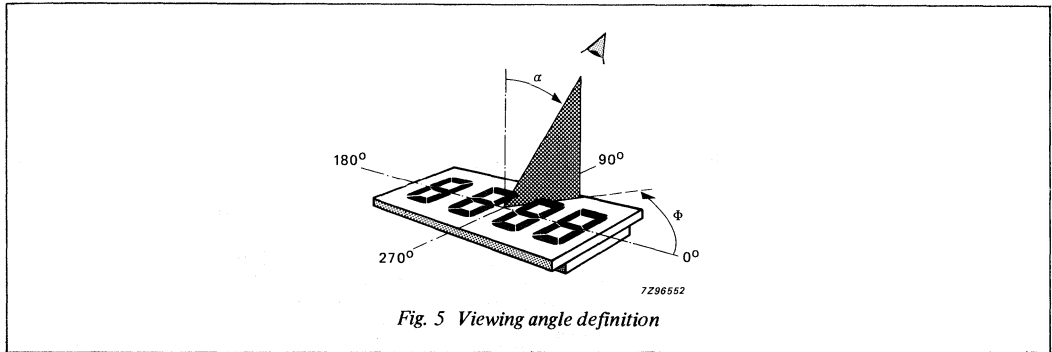
(a) Write operation; write data from MPU to module



(b) Read operation

Fig. 4 Timing waveforms

OPTICAL CHARACTERISTICS



Preferred viewing direction:  $\Phi$  and  $\alpha$ .



**Table 1** Instruction set

ADDRESSES INSTRUCTION	RS	R/W	D7	D6	D5	D4	D3	D2	D1	D0
Display clear	0	0	0	0	0	0	0	0	0	1
Cursor home	0	0	0	0	0	0	0	0	1	*
Entry mode set	0	0	0	0	0	0	0	1	I/D	S
Display on/off control	0	0	0	0	0	0	1	D	C	B
Cursor display shift	0	0	0	0	0	1	S/C	R/L	*	*
Function set	0	0	0	0	1	DL	1	0	*	*
CG RAM address set	0	0	0	1	ACG					
DD RAM address set	0	0	1	ADD						
Busy flag/address read	0	1	BF	AC						
CG RAM/DD RAM data write	1	0	write data							
CG RAM/DD RAM data read	1	1	read data							

**Notes:** I/D = 1: increment  
 S = 1: display shift  
 D = 1: display on  
 C = 1: cursor on  
 B = 1: character at cursor position blinks  
 S/C = 1: display shift  
 R/L = 1: right shift  
 DL = 1: 8 bits  
 BF = 1: during internal operation

I/D = 0: decrement  
 S = 0: display freeze  
 D = 0: display off  
 C = 0: cursor off  
 B = 0: character at cursor position does not blink  
 S/C = 0: cursor move  
 R/L = 0: left shift  
 DL = 0: 4 bits  
 BF = 0: end of internal operation

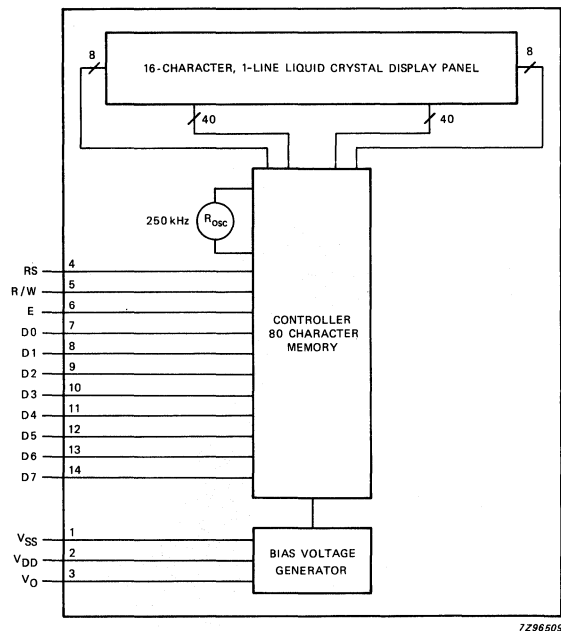


Fig. 6 Functional block diagram

### PHYSICAL ADDRESS

When the display address is not shifted it is as follows:  
 the second line's 8 characters in logic correspond to the  
 first line's 8 characters (right side) in display as the module  
 is driven by a 1:16 multiplex rate.

INPUT CODE vs CHARACTER PATTERN

High-Order Low-Order 4 bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	0	P	`	P		-	夕	三	0	P
xxxx0001	(2)	!	1	A	Q	a	q	.	7	チ	4	ä	q
xxxx0010	(3)	"	2	B	R	b	r	"	イ	ツ	×	β	θ
xxxx0011	(4)	#	3	C	S	c	s	、	ウ	テ	ε	ω	
xxxx0100	(5)	\$	4	D	T	d	t	、	イ	ト	ト	μ	ε
xxxx0101	(6)	%	5	E	U	e	u	.	7	ナ	1	ε	0
xxxx0110	(7)	&	6	F	V	f	v	ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)	'	7	G	W	g	w	7	†	ズ	ラ	q	π
xxxx1000	(1)	(	8	H	X	h	x	、	ウ	ホ	リ	フ	又
xxxx1001	(2)	)	9	I	Y	i	y	ウ	ウ	ル	、	ウ	
xxxx1010	(3)	*	:	J	Z	j	z	エ	コ	ン	ク	i	†
xxxx1011	(4)	+	:	K	L	k	l	(	オ	サ	ヒ	0	*
xxxx1100	(5)	,	<	L	*	l	*	、	シ	フ	フ	φ	π
xxxx1101	(6)	-	=	M	I	m	i	>	ユ	ズ	、	ト	÷
xxxx1110	(7)	.	>	N	^	n	→	ヨ	セ	ホ	、	ñ	
xxxx1111	(8)	/	?	0	_	o	+	、	ウ	マ	、	ö	■

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character pattern which enable to change freely by users program.

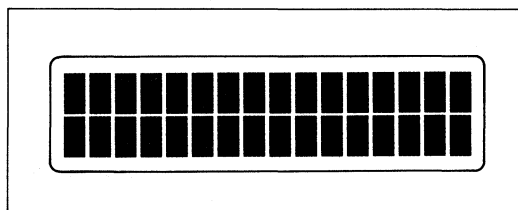
Fig. 7 Display address

**16-CHARACTER, 2-LINE LCD MODULE****QUICK REFERENCE DATA**

Outline dimensions	84 x 44 x 12 mm
Viewing area	61,0 x 15,8 mm
Character format	5 x 7 dots and cursor
Character size	2,96 x 4,86 mm
Dot size (spacing 0,04 mm)	0,56 x 0,66 mm
Mass	≈ 28 g
Drive method	MUX 1:16
Supply voltage	+5 V
Power consumption	7,5 mW
Viewing mode	reflective
Character generator	built in
Data interface	parallel 4 or 8 bits

**MODULE DESCRIPTION**

The LTN211-N01 is a 5 x 7 dot, 16-character, 2-line dot matrix LCD module with LCD driver and controller LSI ICs mounted on a single PC-board. The LSI controller incorporates a ROM-based character generator and RAM display data. The module is capable of generating 168 alpha-numeric and Japanese characters and has an extensive instruction set: display clear, cursor home, display ON/OFF, cursor ON/OFF, character blink, cursor shift and display shift. 160 of the characters are fixed and 8 are user programmable.

**DISPLAY MODE***Scale 1:1**Fig. 1 16-character, 2-line LCD module*

MECHANICAL DATA

Dimensions in mm

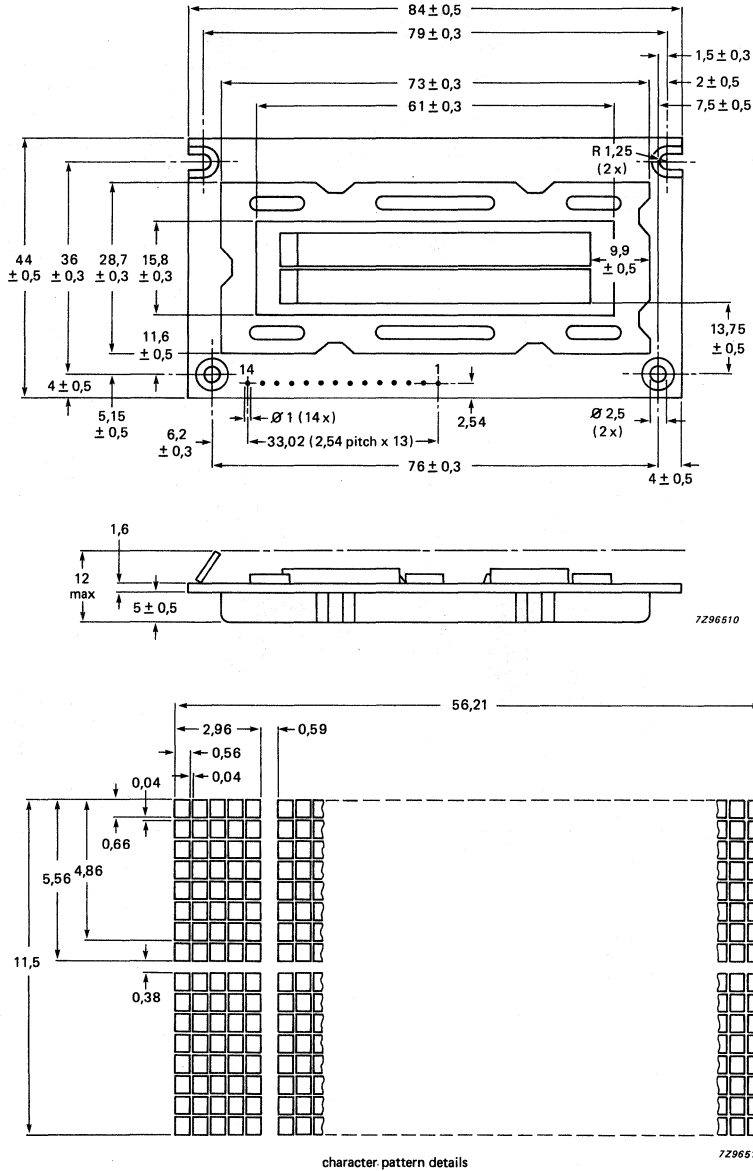
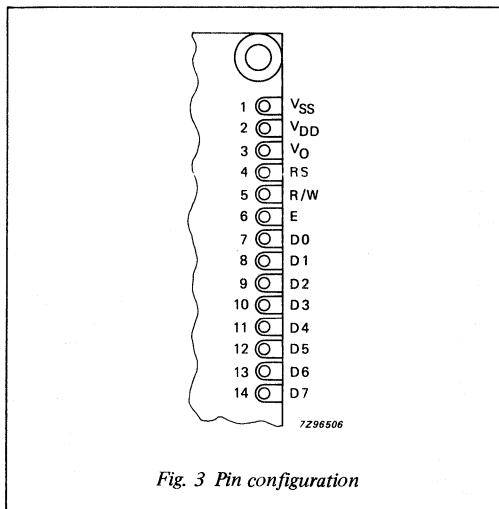


Fig. 2

**Notes to pin description**

1. Contrast is adjusted by varying the supply voltage between 0 and 5 V.
2. D7 doubles as a busy flag output.
3. When the module is interfaced with a microcomputer with 4-bit parallel outputs, pins D0 to D3 are not used.

**Recommendable connectors:**

W-P5014, 5267-14A, FCN-724P014-AU/S, 65507-114.

**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	VSS	ground
2	VDD	power supply (logic)
3	VO	contrast adjustment voltage
4	RS	register select
5	R/W	read/write
6	E	enable
7	D0	I/O data LSB
8	D1	I/O data 2nd bit
9	D2	I/O data 3rd bit
10	D3	I/O data 4th bit
11	D4	I/O data 5th bit
12	D5	I/O data 6th bit
13	D6	I/O data 7th bit
14	D7	I/O data MSB

**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage	V <sub>DD</sub>	-0,3	—	7,0	V
LCD driver voltage	V <sub>DD</sub> -V <sub>O</sub>	0	—	13,5	V
Input voltage	V <sub>I</sub>	-0,3	—	V <sub>DD</sub> +0,3	V
Storage temperature	T <sub>stg</sub>	-25	—	+70	°C
Operating ambient temperature	T <sub>amb</sub>	0	—	+50	°C

**OPERATING CHARACTERISTICS**T<sub>amb</sub> = 25 °C unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	V <sub>DD</sub> -V <sub>SS</sub>	4,75	5,0	5,25	V
LCD driver voltage V <sub>DD</sub> = 5 V	V <sub>O</sub> -V <sub>SS</sub>	—	0,6	—	V
LOW level input voltage	V <sub>IL</sub>	-0,03	—	0,6	V
HIGH level input voltage	V <sub>IH</sub>	2,2	—	V <sub>DD</sub>	V
LOW level output voltage I <sub>OL</sub> = 1,2 mA	V <sub>OL</sub>	—	—	0,4	V
HIGH level output voltage -I <sub>OH</sub> = 0,205 mA	V <sub>OH</sub>	2,4	—	—	V
Input leakage current	I <sub>I</sub>	—	—	1,0	μA
Internal oscillating frequency	f <sub>osc</sub>	—	250	—	kHz
Supply current (logic) see note	I <sub>DD</sub>	—	1,6	2,2	mA
Power dissipation see note	P <sub>d</sub>	—	8,0	11,0	mW

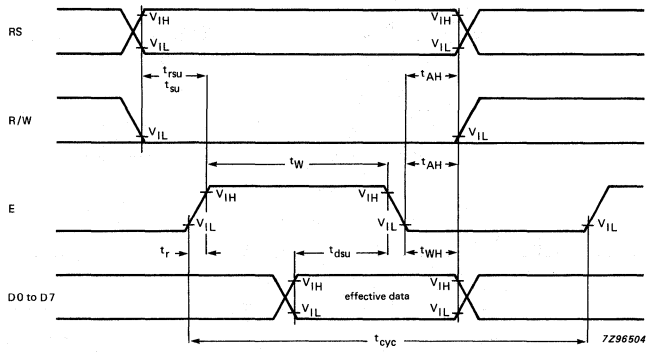
Note: V<sub>DD</sub> = 5 V, V<sub>O</sub> = 0 V.

**TIMING CHARACTERISTICS**

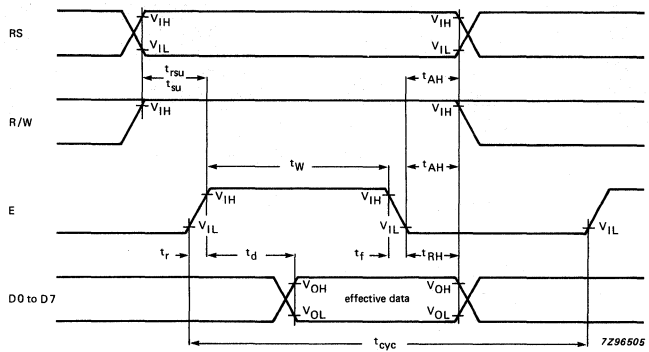
$T_{amb} = 0$  to  $50\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 5\text{ V} \pm 5\%$  unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Enable cycle time	$t_{cyc}$	1000	—	—	ns
Enable pulse width	$t_W$	450	—	—	ns
Rise time	$t_r$	—	—	25	ns
Fall time	$t_f$	—	—	25	ns
Register select set-up time	$t_{rsu}$	140	—	—	ns
Read and write set-up time	$t_{su}$	140	—	—	ns
Data set-up time	$t_{dsu}$	195	—	—	ns
Data delay time	$t_d$	—	—	320	ns
Address hold time	$t_{AH}$	10	—	—	ns
Data hold time write	$t_{WH}$	10	—	—	ns
Data hold time read	$t_{RH}$	20	—	—	ns





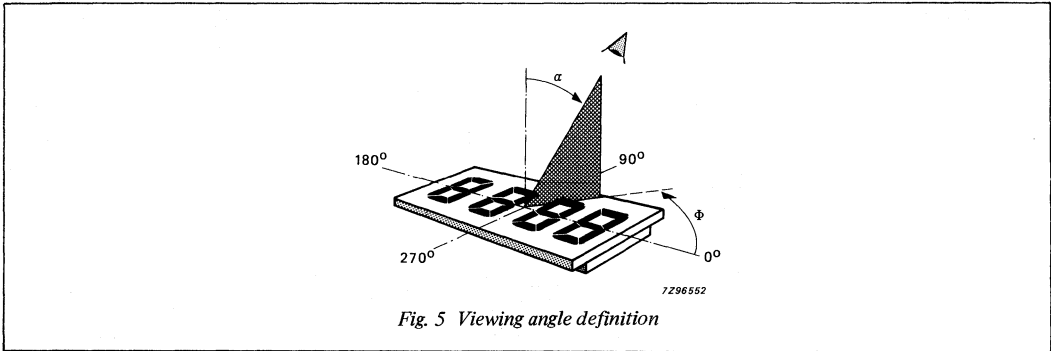
(a) Write operation; write data from MPU to module



(b) Read operation

Fig. 4 Timing waveforms

OPTICAL CHARACTERISTICS



Preferred viewing direction:  $\Phi$  and  $\alpha$ .

**Table 1** Instruction set

INSTRUCTION \ ADDRESSES	ADDRESSES										
	RS	R/W	D7	D6	D5	D4	D3	D2	D1	D0	
Display clear	0	0	0	0	0	0	0	0	0	1	
Cursor home	0	0	0	0	0	0	0	0	1	*	
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	
Display on/off control	0	0	0	0	0	0	1	D	C	B	
Cursor display shift	0	0	0	0	0	1	S/C	R/L	*	*	
Function set	0	0	0	0	1	DL	1	0	*	*	
CG RAM address set	0	0	0	1	ACG						
DD RAM address set	0	0	1	ADD							
Busy flag/address read	0	1	BF	AC							
CG RAM/DD RAM data write	1	0	write data								
CG RAM/DD RAM data read	1	1	read data								

**Notes:** I/D = 1: increment  
 S = 1: display shift  
 D = 1: display on  
 C = 1: cursor on  
 B = 1: character at cursor position blinks  
 S/C = 1: display shift  
 R/L = 1: right shift  
 DL = 1: 8 bits  
 BF = 1: during internal operation

I/D = 0: decrement  
 S = 0: display freeze  
 D = 0: display off  
 C = 0: cursor off  
 B = 0: character at cursor position does not blink  
 S/C = 0: cursor move  
 R/L = 0: left shift  
 DL = 0: 4 bits  
 BF = 0: end of internal operation

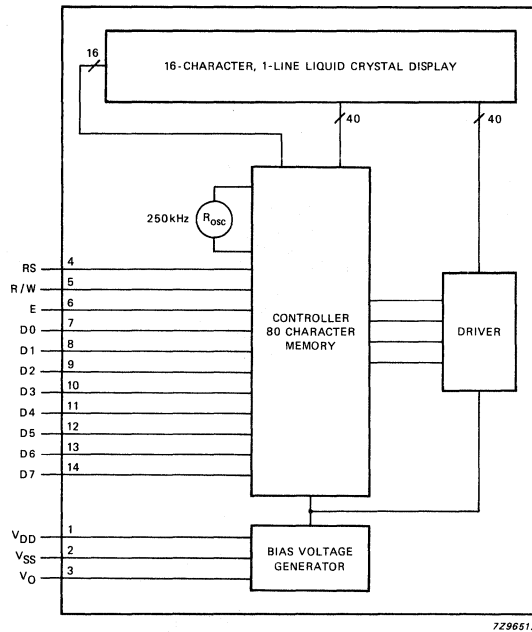


Fig. 6 Functional block diagram

INPUT CODE vs CHARACTER PATTERN

High-Order 4 bit Low- Order 4 bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxx0000	CG RAM (1)		00P`P					-9E0P					
xxx0001	(2)	!	1A0a9.	774	3d								
xxx0010	(3)	"	2BRbr	r	I	ツ	×	β	θ				
xxx0011	(4)	#	3CScs	」	ウ	テ	E	ε	ω				
xxx0100	(5)	\$	4DTdt	.	、	エ	ト	φ	μ	ω			
xxx0101	(6)	%	5EUeu	.	オ	オ	1	ε	ū				
xxx0110	(7)	&	6FUfu	フ	カ	ニ	ヨ	ρ	Σ				
xxx0111	(8)	'	7GWgw	7	†	ヌ	ラ	q	π				
xxx1000	(1)	<	8HXhx	ィ	ウ	ホ	リ	フ	又				
xxx1001	(2)	>	9IYiy	ウ	フ	ル	リ	ウ					
xxx1010	(3)	*	: JZjz	エ	コ	ン	レ	i	≠				
xxx1011	(4)	+	: KIK	<	オ	サ	ヒ	ロ	×	ア			
xxx1100	(5)	,	< L	≠	1	1	†	シ	フ	φ	ア		
xxx1101	(6)	-	= M	M	>	ユ	ズ	ハ	シ	ト	÷		
xxx1110	(7)	.	> N	^	n	→	ヨ	セ	ホ	ハ			
xxx1111	(8)	/	? 0	_	o	←	ウ	リ	マ	°	ō		

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character pattern which enable to change freely by users program.

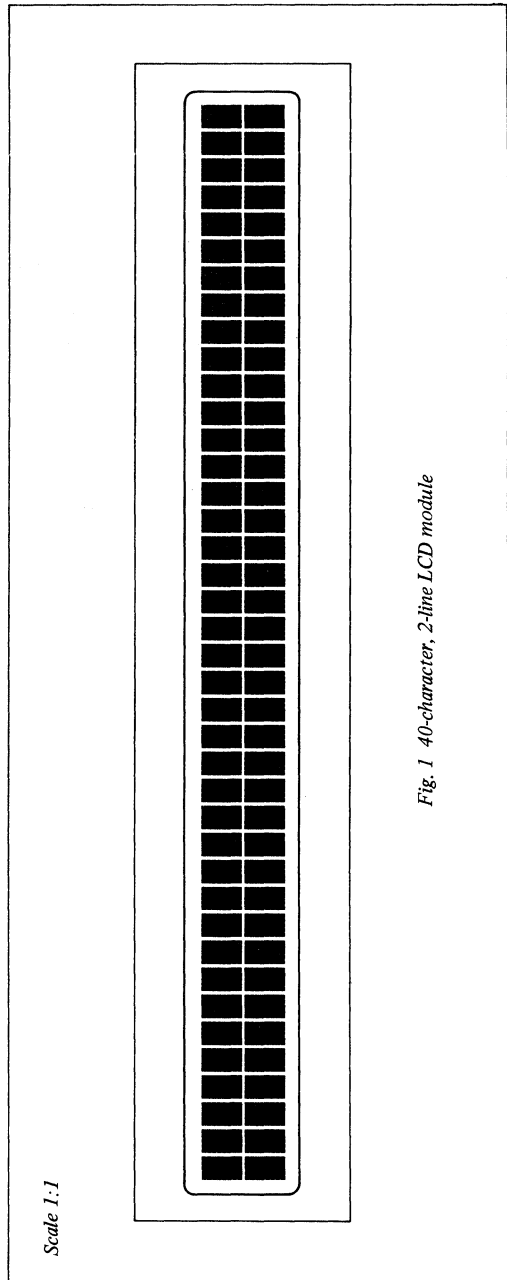
Fig. 7 Display address

**40-CHARACTER, 2-LINE LCD MODULE****QUICK REFERENCE DATA**

Outline dimensions	182 x 33,5 x 11 mm
Viewing area	154,4 x 15,8 mm
Character format	5 x 7 dots and cursor
Character size	3,2 x 4,85 mm
Dot size (spacing 0,05 mm)	0,6 x 0,65 mm
Mass	≈ 65 g
Drive method	MUX 1:16
Supply voltage	+5 V; -5 V
Power consumption	11 mW
Viewing mode	reflective
Character generator	built in
Data interface	parallel 4 or 8 bits

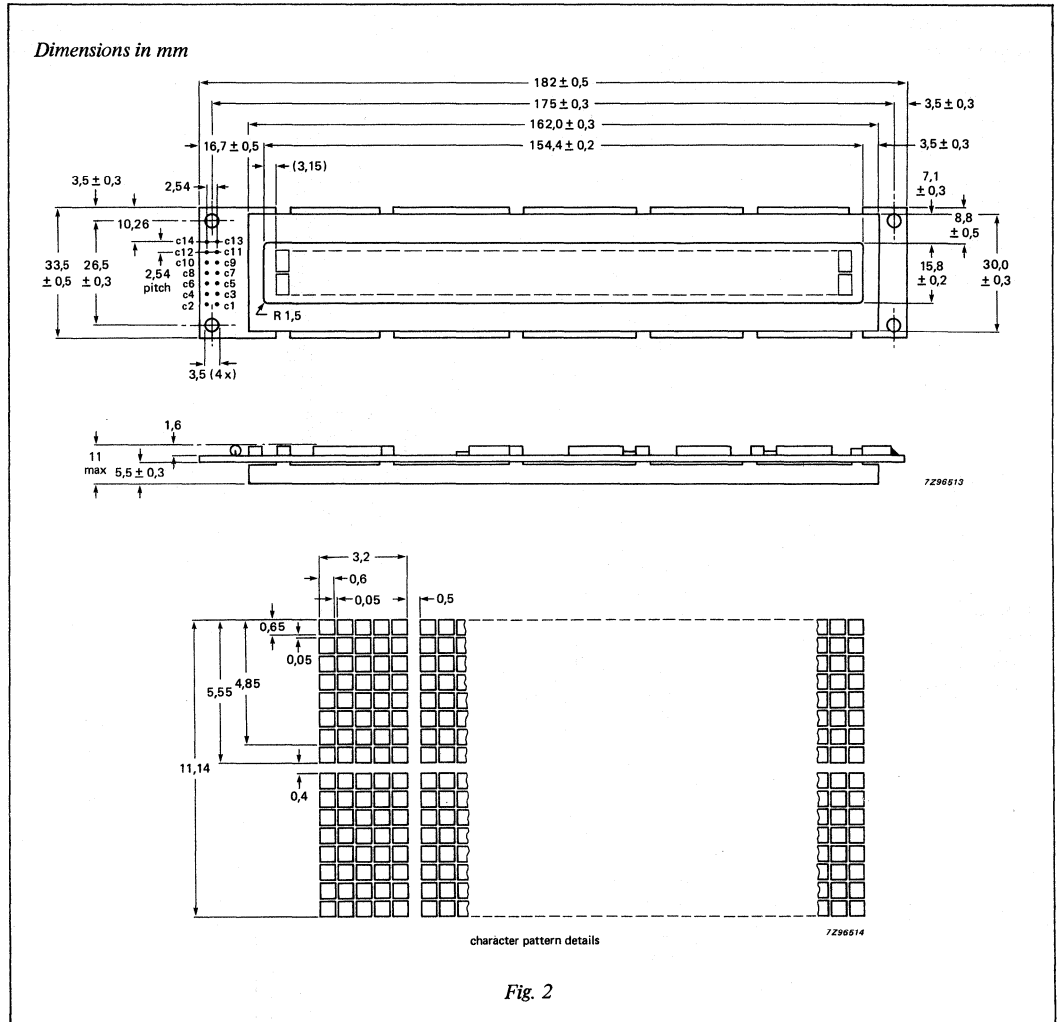
**MODULE DESCRIPTION**

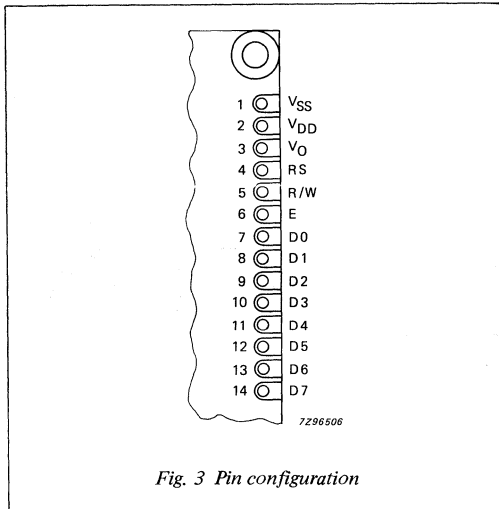
The LTN241-N01 is a 5 x 7 dot, 40-character, 2-line dot matrix LCD module with LCD driver and controller LSI ICs mounted on a single PC-board. The LSI controller incorporates a ROM-based character generator and RAM display data. The module is capable of generating 168 alpha-numeric and Japanese characters and has an extensive instruction set: display clear, cursor home, display ON/OFF, cursor ON/OFF, character blink, cursor shift and display shift. 160 of the characters are fixed and 8 are user programmable.

**DISPLAY MODE**

*Fig. 1 40-character, 2-line LCD module*

MECHANICAL DATA



**Notes to pin description**

1. Contrast is adjusted by varying the supply voltage between 1 and 2 V.
2. D7 doubles as a busy flag output.
3. When the module is interfaced with a microcomputer with 4-bit parallel outputs, pins D0 to D3 are not used.

**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	VSS	ground
2	VDD	power supply (logic)
3	VO	LCD applied voltage
4	RS	register select
5	R/W	read/write
6	E	enable
7	D0	I/O data LSB
8	D1	I/O data 2nd bit
9	D2	I/O data 3rd bit
10	D3	I/O data 4th bit
11	D4	I/O data 5th bit
12	D5	I/O data 6th bit
13	D6	I/O data 7th bit
14	D7	I/O data MSB



**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage V <sub>SS</sub> = 0 V	V <sub>DD</sub>	-0,3	—	7,0	V
LCD driver voltage	V <sub>DD</sub> -V <sub>O</sub>	0	—	13,5	V
Input voltage V <sub>SS</sub> = 0 V	V <sub>I</sub>	-0,3	—	V <sub>DD</sub> +0,3	V
Storage temperature	T <sub>stg</sub>	-25	—	+55	°C
Operating ambient temperature	T <sub>amb</sub>	0	—	+50	°C

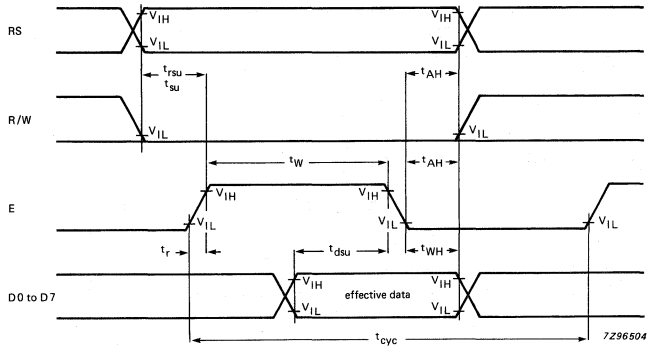
**OPERATING CHARACTERISTICS**T<sub>amb</sub> = 25 °C unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (logic)	V <sub>DD</sub> -V <sub>SS</sub>	4,75	5,0	5,25	V
LCD driver voltage	V <sub>DD</sub> -V <sub>O</sub>	—	5,5	—	V
LOW level input voltage	V <sub>IL</sub>	-0,03	—	0,6	V
HIGH level input voltage	V <sub>IH</sub>	2,2	—	V <sub>DD</sub>	V
LOW level output voltage I <sub>OL</sub> = 1,2 mA	V <sub>OL</sub>	—	—	0,4	V
HIGH level output voltage -I <sub>OH</sub> = 0,205 mA	V <sub>OH</sub>	2,4	—	—	V
Input leakage current	I <sub>I</sub>	—	—	1,0	μA
Internal oscillating frequency	f <sub>osc</sub>	—	160	—	kHz
Power dissipation	P <sub>d</sub>	—	11,0	16,0	mW

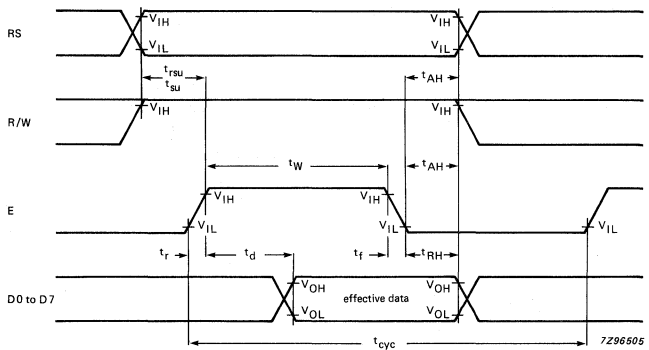
**TIMING CHARACTERISTICS**

$T_{amb} = 0$  to  $50\text{ }^{\circ}\text{C}$ ,  $V_{DD} = 5\text{ V} \pm 5\%$  unless otherwise stated

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Enable cycle time	$t_{cyc}$	1000	—	—	ns
Enable pulse width	$t_w$	450	—	—	ns
Rise time	$t_r$	—	—	25	ns
Fall time	$t_f$	—	—	25	ns
Register select set-up time	$t_{rsu}$	140	—	—	ns
Read and write set-up time	$t_{su}$	140	—	—	ns
Data set-up time	$t_{dsu}$	195	—	—	ns
Data delay time	$t_d$	—	—	320	ns
Address hold time	$t_{AH}$	10	—	—	ns
Data hold time write	$t_{WH}$	10	—	—	ns
Data hold time read	$t_{RH}$	20	—	—	ns



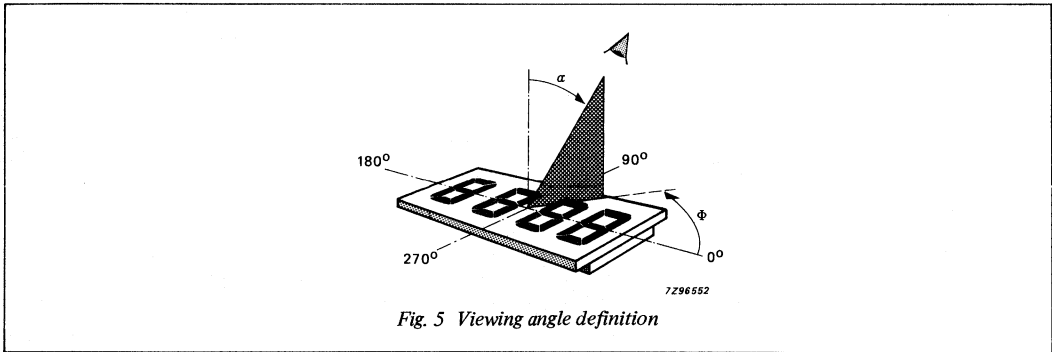
(a) Write operation; write data from MPU to module



(b) Read operation

Fig. 4 Timing waveforms

OPTICAL CHARACTERISTICS



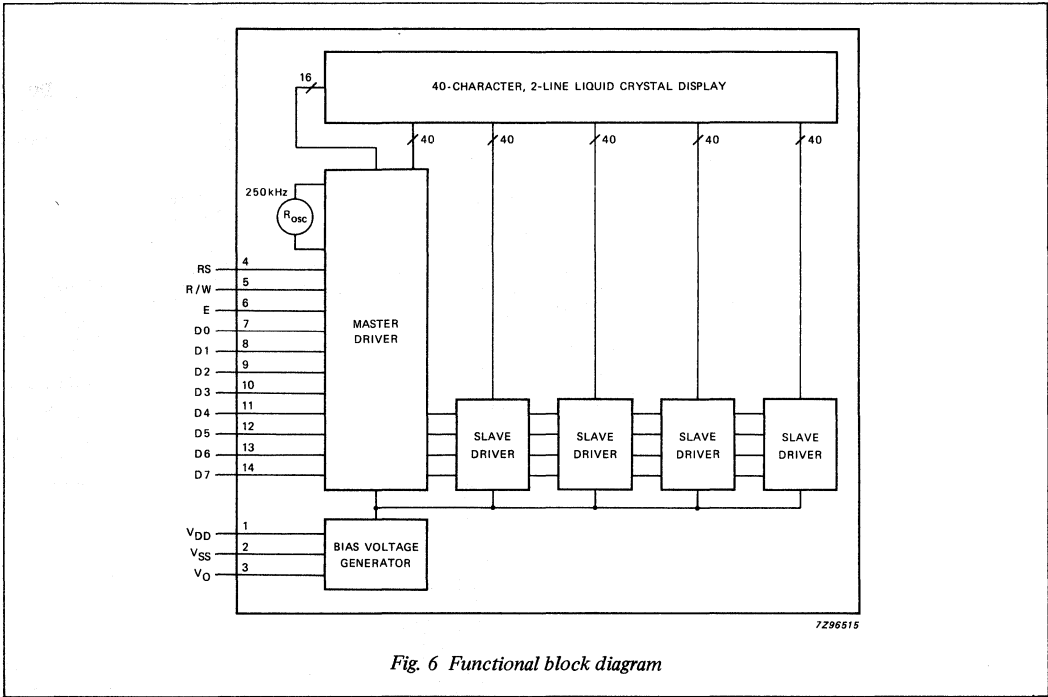
Preferred viewing direction:  $\Phi$  and  $\alpha$ .

**Table 1** Instruction set

ADDRESSES INSTRUCTION	RS	R/W	D7	D6	D5	D4	D3	D2	D1	D0
Display clear	0	0	0	0	0	0	0	0	0	1
Cursor home	0	0	0	0	0	0	0	0	1	*
Entry mode set	0	0	0	0	0	0	0	1	I/D	S
Display on/off control	0	0	0	0	0	0	1	D	C	B
Cursor display shift	0	0	0	0	0	1	S/C	R/L	*	*
Function set	0	0	0	0	1	DL	1	0	*	*
CG RAM address set	0	0	0	1	ACG					
DD RAM address set	0	0	1	ADD						
Busy flag/address read	0	1	BF	AC						
CG RAM/DD RAM data write	1	0	write data							
CG RAM/DD RAM data read	1	1	read data							

Notes: I/D = 1: increment  
 S = 1: display shift  
 D = 1: display on  
 C = 1: cursor on  
 B = 1: character at cursor position blinks  
 S/C = 1: display shift  
 R/L = 1: right shift  
 DL = 1: 8 bits  
 BF = 1: during internal operation

I/D = 0: decrement  
 S = 0: display freeze  
 D = 0: display off  
 C = 0: cursor off  
 B = 0: character at cursor position does not blink  
 S/C = 0: cursor move  
 R/L = 0: left shift  
 DL = 0: 4 bits  
 BF = 0: end of internal operation



INPUT CODES vs CHARACTER PATTERN

High-Order 4 bit Low-Order 4 bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0aP`P							-9Eap			
xxxx0001	(2)		!1AQaa							774äq			
xxxx0010	(3)		"2BRbr							"/xæø			
xxxx0011	(4)		#3CSca							177Eε*			
xxxx0100	(5)		\$4DTdt							.Itpuø			
xxxx0101	(6)		%5EUeu							.171εü			
xxxx0110	(7)		&6FUFv							7カニヨρΣ			
xxxx0111	(8)		'7GUgw							77779qπ			
xxxx1000	(1)		(8HXh							x47777777			
xxxx1001	(2)		)9IYiy							77777777			
xxxx1010	(3)		*:JZjz							ε77777777			
xxxx1011	(4)		+;Klk							(77777777			
xxxx1100	(5)		, <L							77777777			
xxxx1101	(6)		-=MIn							>77777777			
xxxx1110	(7)		. >N							^77777777			
xxxx1111	(8)		/?0							_77777777			

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character patters which enable to change freely by users program.

Fig. 7 Display address

	<i>page</i>
<b>BRIEF DRIVER DEVICE DATA . . . . .</b>	<b>169</b>





TYPE NO.	DESCRIPTION	PAGE
<b>Duplex drive</b>		
PCF2100	CBUS control, 40-segments	178
PCF2110	CBUS control, 60-segments, 2 LEDs	179
PCF2111	CBUS control, 64-segments	180
<b>Direct drive</b>		
PCF2112	CBUS control, 32-segments	181
<b>Multiplex and direct drive</b>		
PCF8566	I <sup>2</sup> C bus control, direct and multiplex drive, 1:2 to 1:4 MUX ratios (24, 48, 72, 96 segments)	182
PCF8576	I <sup>2</sup> C bus control, direct and multiplex drive, 1:2 to 1:4 MUX ratios (40, 80, 120, 160 segments)	183
<b>Duplex and direct drive</b>		
PCF8577	I <sup>2</sup> C bus control, direct drive (32 segments), duplex drive (64 segments)	184
<b>Bargraph drivers</b>		
PCF1303T	18-segment bargraph display LCD driver, with analog input	177
HEF4754V	18-segment bargraph display LCD driver with analog input	172
<b>BCD drivers</b>		
PC74HC4543	BCD to 7-segment latch/decoder/driver for LCD	185
PC74HCT4543		
HEF4543B	BCD to 7-segment latch/decoder/driver for LED and LCD	171
<b>LCD car clock circuits</b>		
PCF1171	4-digit LCD car clock circuit	173
PCF1172	3½-digit LCD car clock circuit	174
PCF1174	4-digit LCD car clock circuit	175
PCF1175	4-digit, duplex drive LCD car clock circuit	176
<b>LCD interface circuit</b>		
SAA1062A	20-segment latch/decoder LCD interface circuit	187



**BCD TO 7-SEGMENT LATCH/DECODER/DRIVER**

**GENERAL DESCRIPTION**

The HEF4543B is a BCD to 7-segment latch/decoder/driver for liquid crystal and LED displays. It has four address inputs ( $D_A$  to  $D_D$ ), an active HIGH latch disable input (LD), an active HIGH blanking input (BI), an active HIGH phase input (PH) and seven buffered segment outputs ( $O_a$  to  $O_g$ ). The circuit provides the function of a 4-bit storage latch and an 8-4-2-1 BCD to 7-segment decoder/driver. It can invert the logic levels of the output combination. The phase (PH),

blanking (BI) and latch disable (LD) inputs are used to reverse the function table phase, blank the display and store a BCD code, respectively.

For liquid crystal displays a square-wave is applied to PH and the electrical common backplane of the display. The outputs of the device are directly connected to the segments of the liquid crystal.

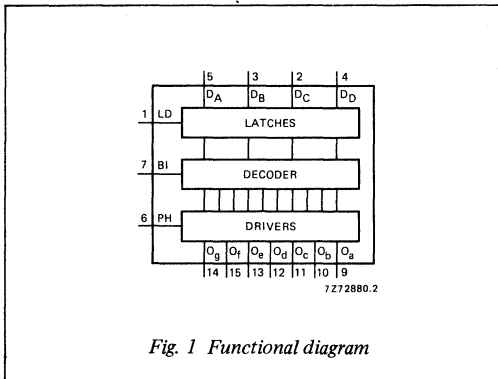


Fig. 1 Functional diagram

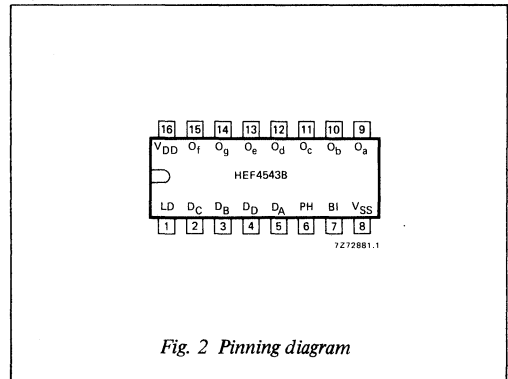


Fig. 2 Pinning diagram

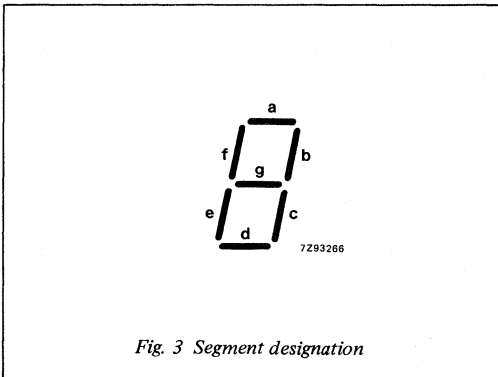


Fig. 3 Segment designation

**PIN DESCRIPTION**

- $D_A$  to  $D_D$  address (data) inputs
- PH phase input (active HIGH)
- BI blanking input (active HIGH)
- LD latch disable input (active HIGH)
- $O_a$  to  $O_g$  segment outputs

**ORDERING INFORMATION/PACKAGE OUTLINES**

- HEF4543BP : 16-lead-DIL; plastic (SOT-38Z)
- HEF4543BD : 16-lead-DIL; ceramic (cerdip) (SOT-74)
- HEF4543BT : 16-lead mini-pack; plastic (SO-16; SOT-109A)

## 18-ELEMENT BARGRAPH LCD DRIVER

### GENERAL DESCRIPTION

The HEF4754V drives an 18-element bargraph LCD in linear relation to control voltage ( $V_C$ ) in a pointer or thermometer mode. The first bar lights up when  $V_C$  is smaller than  $V_T(\text{bar})^2$ .

In the pointer mode, the circuit can drive 9 or 18 bars; in the thermometer mode, the circuit also drives the peak value indication. This can be reset or repetitively reset, after 1,5 to 2 seconds.

The circuit has analogue and digital parts. The analogue parts consists of 17 comparators, with their non-inverting inputs connected together and coupled to the control input  $V_C$ . The inverting inputs of the comparators are connected in succession to the nodes of an 18-part resistor divider. The distance between the switching levels of the comparators is defined by the voltage difference across this divider. The

extremities of the resistor divider are coupled via high-input amplifiers to the maximum reference voltage input and the minimum reference voltage input.

The digital part has one reference output ( $O_R$ ) to drive the backplane, and 18 outputs ( $O_1$  to  $O_{18}$ ) to drive each bar. Three latches and some gates are incorporated for each bar output. An on-chip oscillator (1024 Hz) with external R and C drives the circuit. The outputs are driven at 64 Hz. The select inputs  $I_1$  to  $I_3$  are provided with an on-chip pull-up element, and they may therefore be left floating (equals HIGH state).

### ORDERING INFORMATION/PACKAGE OUTLINES

HEF4754VP: 28-lead DIL; plastic (SOT-117)

HEF4754VD: 28-lead DIL; ceramic (cerdip) (SOT-135A)

HEF4754VT: 28-lead mini-pack; plastic  
(SO-28; SOT-136A)

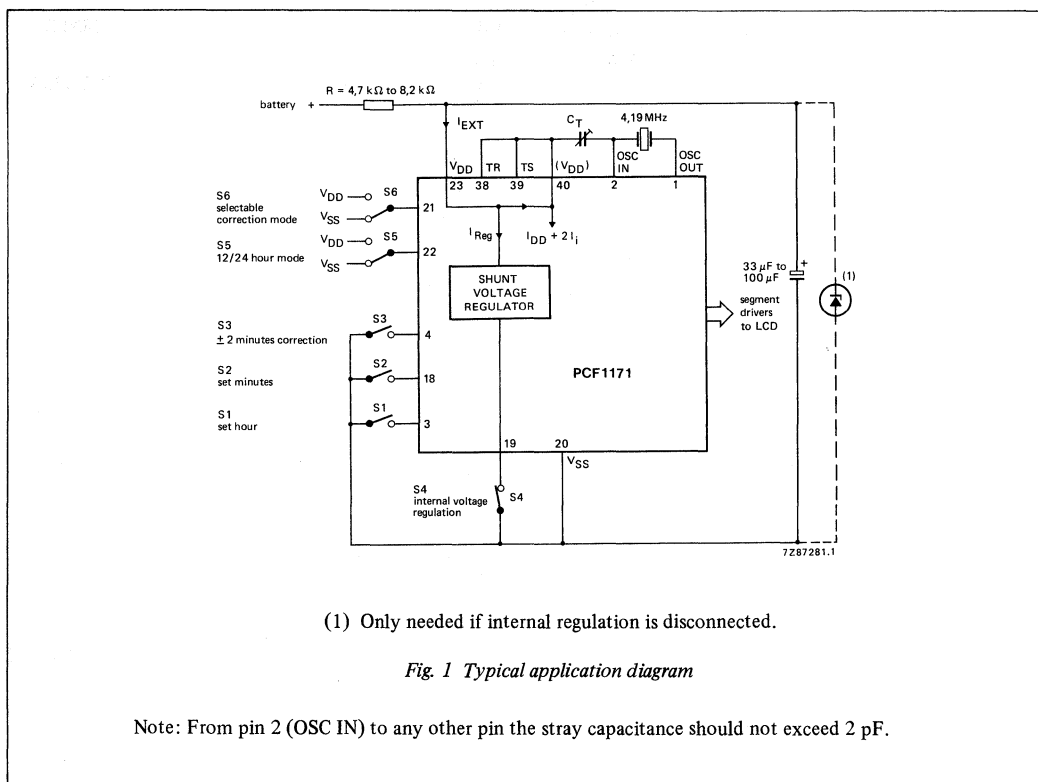
## 4-DIGIT LCD CAR CLOCK

### GENERAL DESCRIPTION

The PCF1171 is a single chip, 4,19 MHz CMOS clock circuit indicating hours and minutes. It is designed to drive a 3½ or 4-digit liquid crystal display (LCD). Two single-pole, single-throw switches accomplish all time setting functions. A bonding option allows the selection of 12-hour or 24-hour display mode. The circuit is battery operated via an internal 5 V voltage regulator or by an external stabilized voltage supply.

### FEATURES

- Driving standard 3½ or a 4-digit LCD
- Internal voltage regulator for 5 V LCD
- Option for external stabilized voltage supply
- 4,19 MHz oscillator
- Integrated oscillator output capacitor and polarization resistor
- Operating ambient temperature range  $-40$  to  $+85$  °C
- 40-lead plastic mini-pack (VSO-40)



### ORDERING INFORMATION/PACKAGE OUTLINES

PCF1171BT: 40-lead mini-pack; plastic (VSO-40; SOT-158B)

PCF1171U : uncased chip in tray

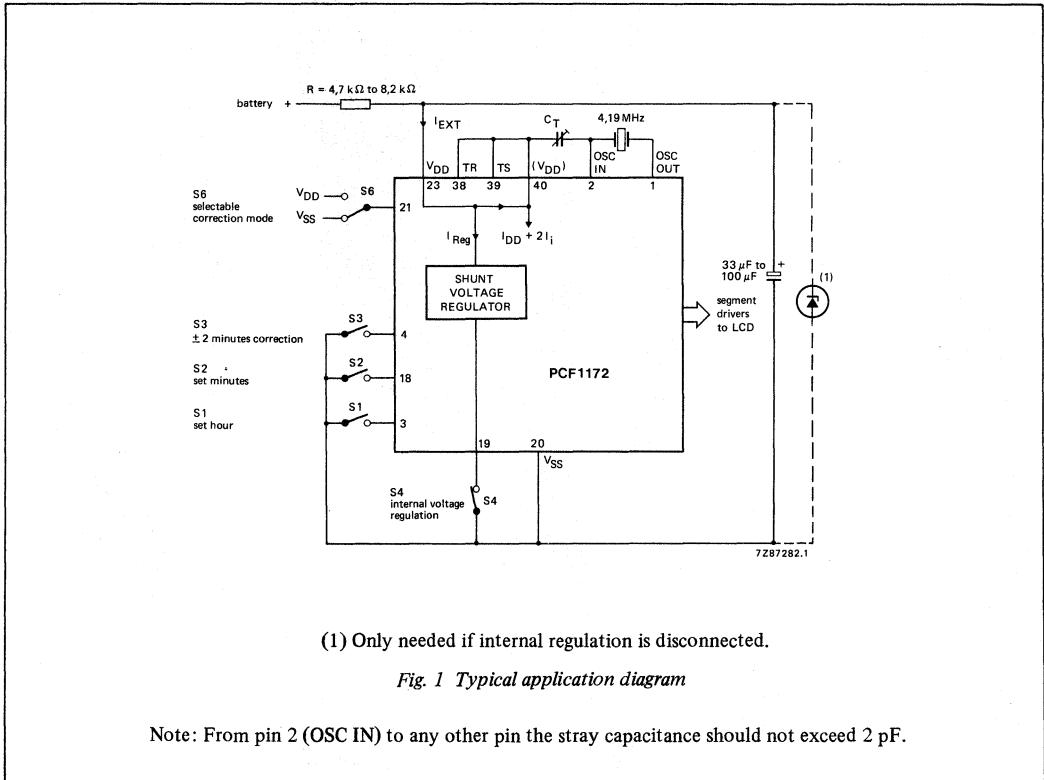
### 3½-DIGIT LCD CAR CLOCK CIRCUIT

#### GENERAL DESCRIPTION

The PCF1172 is a single chip, 4,19 MHz CMOS clock circuit indicating hours and minutes. It is designed to drive 3½-digit liquid crystal display (LCD) with AM and PM indicators. Two single-pole, single-throw switches accomplish all time setting functions. The circuit is battery operated via an internal 5 V voltage regulator or by an external stabilized voltage supply.

#### FEATURES

- Driving standard 3½-digit LCD with AM and PM indicators
- Internal voltage regulator for 5 V LCD
- Option for external stabilized voltage supply
- 4,19 MHz oscillator
- Integrated oscillator output capacitor and polarization resistor
- Operating ambient temperature range  $-40$  to  $+85$  °C
- 40-lead plastic mini-pack (VSO-40)



#### ORDERING INFORMATION/PACKAGE OUTLINES

PCF1172BT: 40-lead mini-pack; plastic (VSO-40; SOT-158B)

PCF1172U : uncased chip in tray

## DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

PCF1174

## 4-DIGIT STATIC-LCD CAR CLOCK

### GENERAL DESCRIPTION

The PCF1174 is a single chip, 4,19 MHz CMOS clock circuit indicating hours and minutes. It is designed to drive a 4-digit static-liquid crystal display (LCD). Two single-pole, single-throw switches accomplish all time setting functions. The frequency and regulator voltage are electrically programmable via an on-chip EEPROM. The circuit is battery operated via an internal voltage regulator and an external resistor.

### FEATURES

- Internal voltage regulator electrically programmable for LCD
- Frequency electrically programmable (no trimming capacitor)
- 4,19 MHz oscillator
- 12 hour or 24 hour mode
- Operating ambient temperature range  $-40$  to  $+85$  °C
- 40-lead plastic mini-pack (VSO-40)

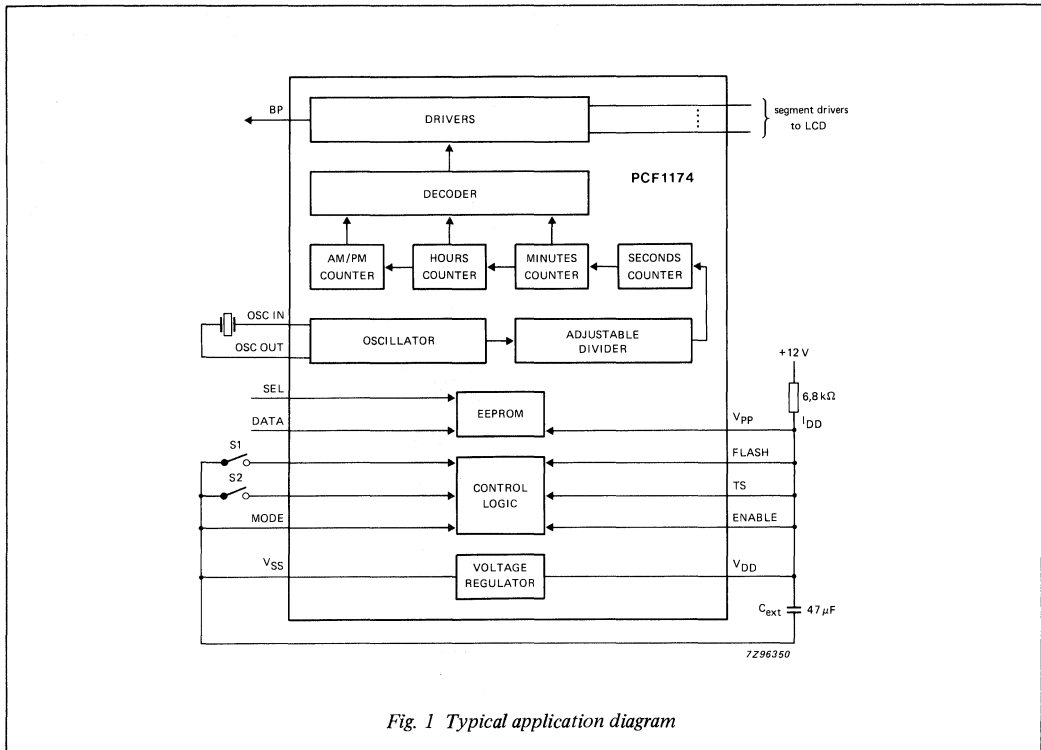


Fig. 1 Typical application diagram

### ORDERING INFORMATION/PACKAGE OUTLINES

PCF1174BT: 40-lead mini-pack; plastic (VSO-40; SOT-158B)

PCF1174U : uncased chip in tray



## 4-DIGIT DUPLEX-LCD CAR CLOCK

## GENERAL DESCRIPTION

The PCF1175 is a single chip, 4,19 MHz CMOS clock circuit indicating hours and minutes. It is designed to drive a 4-digit duplex liquid crystal display (LCD). Two single-pole, single-throw switches accomplish all time setting functions. The frequency and regulator voltage are electrically programmable via an on-chip EEPROM. The circuit is battery operated via an internal voltage regulator and an external resistor.

## FEATURES

- Internal voltage regulator electrically programmable for LCD
- Frequency electrically programmable (no trimming capacitor)
- LCD voltage adjusts with temperature for good contrast
- 4,19 MHz oscillator
- 12 hour or 24 hour mode
- Operating ambient temperature range  $-40$  to  $+85$  °C
- 28-lead plastic mini-pack

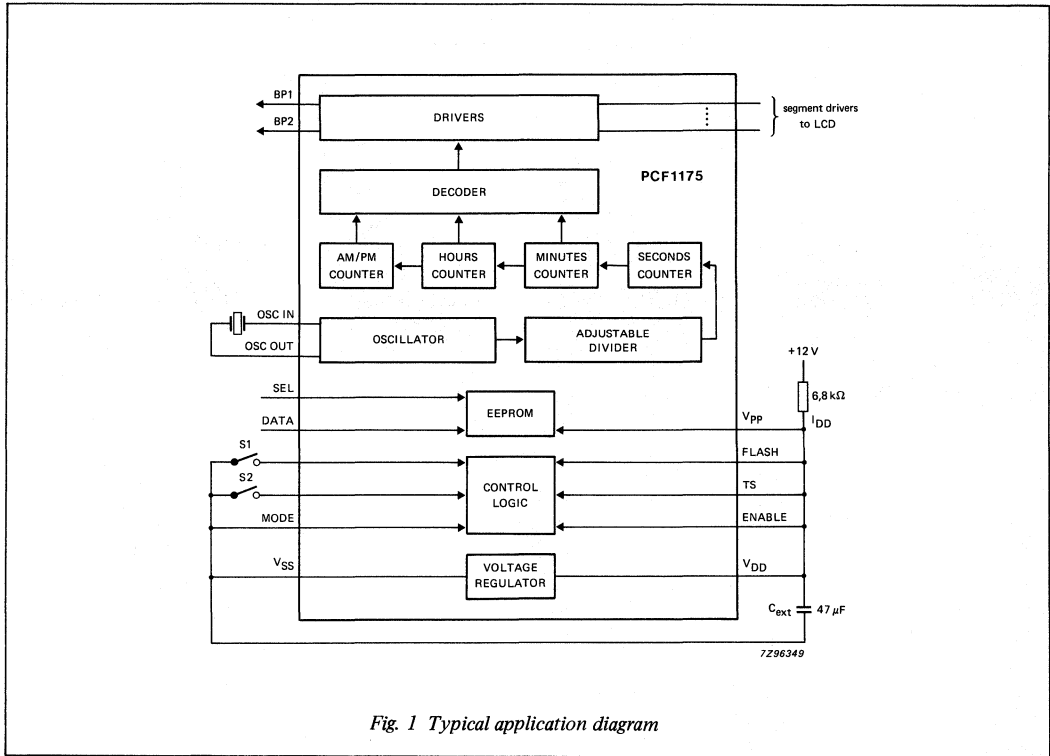


Fig. 1 Typical application diagram

## ORDERING INFORMATION/PACKAGE OUTLINES

PCF1175T: 28-lead mini-pack; plastic (SO-28; SOT-136A)

PCF1175U: uncased chip in tray

## 18-ELEMENT BARGRAPH LCD DRIVER

### GENERAL DESCRIPTION

The PCF1303T is an 18-element bargraph LCD driver with linear relation to the control voltage when in pointer or thermometer mode.

The first segment will energize when the control voltage is less than the trigger voltage ( $V_{T(\text{bar}2)}$ ).

The circuit has analogue and digital sections.

The analogue section consists of a comparator with the inverting input coupled to the input control voltage. The non-inverting input of the comparator is connected via 17 analogue switches to the nodes of an 18-element resistor divider. The extremities of the resistor divider are coupled via high-input impedance amplifiers to the maximum reference voltage input and the minimum reference voltage input.

The control input functions with Schmitt trigger action.

The digital section has one reference output ( $Q_R$ ) to drive the backplane and 18 outputs ( $Q_1$  to  $Q_{18}$ ) to drive the segments.

The segment outputs incorporate two latches and some gates.

The circuit is driven by an on-chip oscillator with external resistors and capacitors. The outputs are driven at 100 Hz typical.

### ORDERING INFORMATION/PACKAGE OUTLINES

PCF1303T: 28-lead mini-pack; plastic (SO-28; SOT-136A)

## LCD DUPLEX DRIVER

### GENERAL DESCRIPTION

The PCF2100 is a single chip, silicon gate CMOS circuit designed to drive an LCD (Liquid Crystal Display) with up to 40 segments in a duplex manner; specially for low voltage applications. A three-line bus structure enables serial data transfer with microcontrollers. All inputs are CMOS/NMOS compatible.

### FEATURES

- 40 LCD-segment drive capability
- Supply voltage 2,25 to 6,5 V
- Low current consumption
- Serial data input
- CBUS control
- One-point built-in oscillator
- Expansion possibility

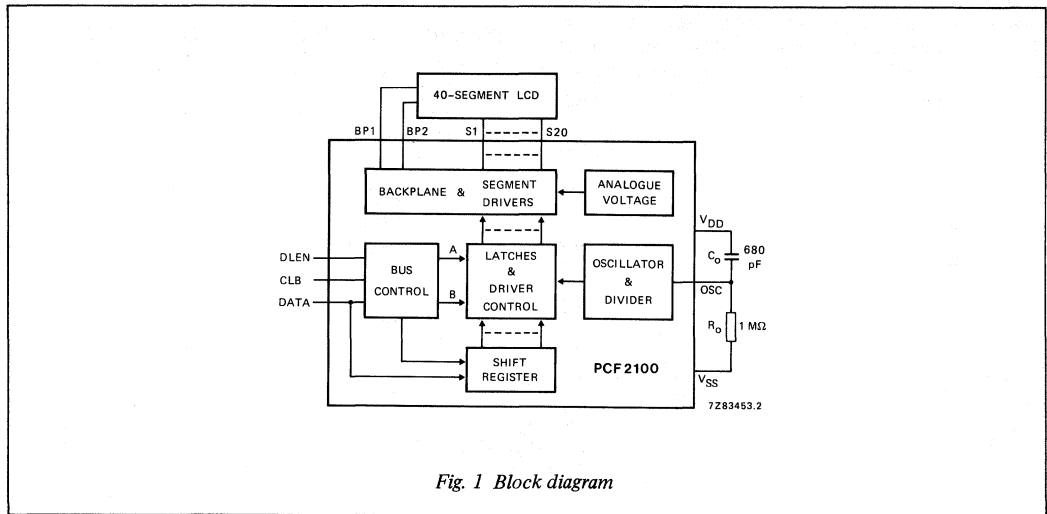


Fig. 1 Block diagram

### ORDERING INFORMATION/PACKAGE OUTLINES

PCF2100P: 28-lead DIL; plastic (SOT-117D)

PCF2100T: 28-lead mini-pack; plastic (SO-28; SOT-136A)

## LCD DUPLEX DRIVER

### GENERAL DESCRIPTION

The PCF2110 is a single chip, silicon gate CMOS circuit designed to drive 2 LEDs (Light Emitting Diodes) and an LCD (Liquid Crystal Display) with up to 60 segments in a duplex manner; specially for low voltage applications. A three-line bus structure enables serial data transfer with microcontrollers. All inputs are CMOS/NMOS compatible.

### FEATURES

- 60 LCD-segment drive capability
- Two LED-driver outputs
- Supply voltage 2,25 to 6,5 V
- Low current consumption
- Serial data input
- CBUS control
- One-point built-in oscillator
- Expansion possibility

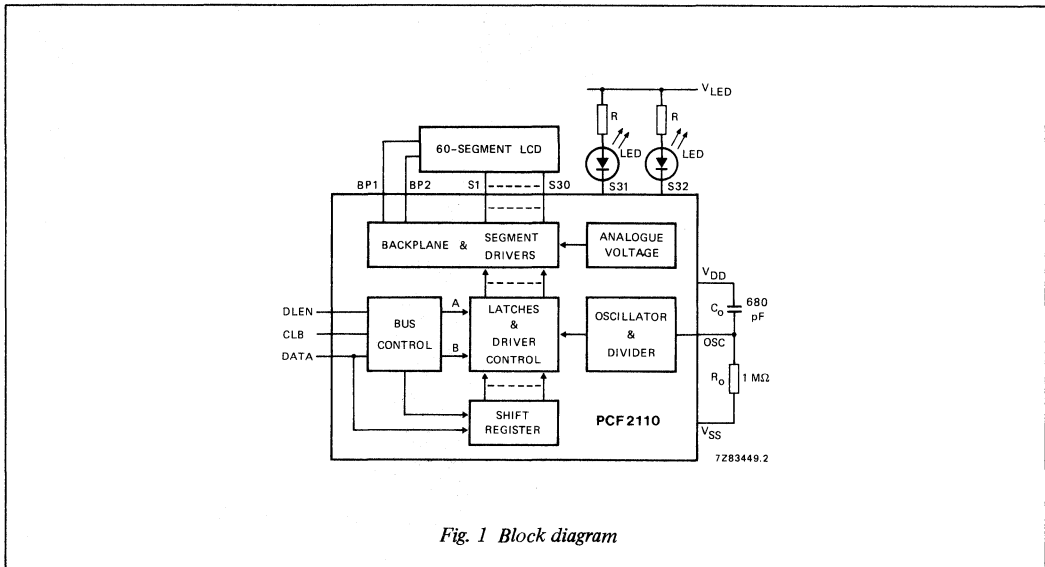


Fig. 1 Block diagram

### ORDERING INFORMATION/PACKAGE OUTLINES

PCF2110P: 40-lead DIL; plastic (SOT-129)

PCF2110T: 40-lead mini-pack; plastic (VSO-40; SOT-158A)

## LCD DUPLEX DRIVER

## GENERAL DESCRIPTION

The PCF2111 is a single chip, silicon gate CMOS circuit designed to drive an LCD (Liquid Crystal Display) with up to 64 segments in a duplex manner; specially for low voltage applications. A three-line bus structure enables serial data transfer with microcontrollers. All inputs are CMOS/NMOS compatible.

## FEATURES

- 64 LCD-segment drive capability
- Supply voltage 2,25 to 6,5 V
- Low current consumption
- Serial data input
- CBUS control
- One-point built-in oscillator
- Expansion possibility

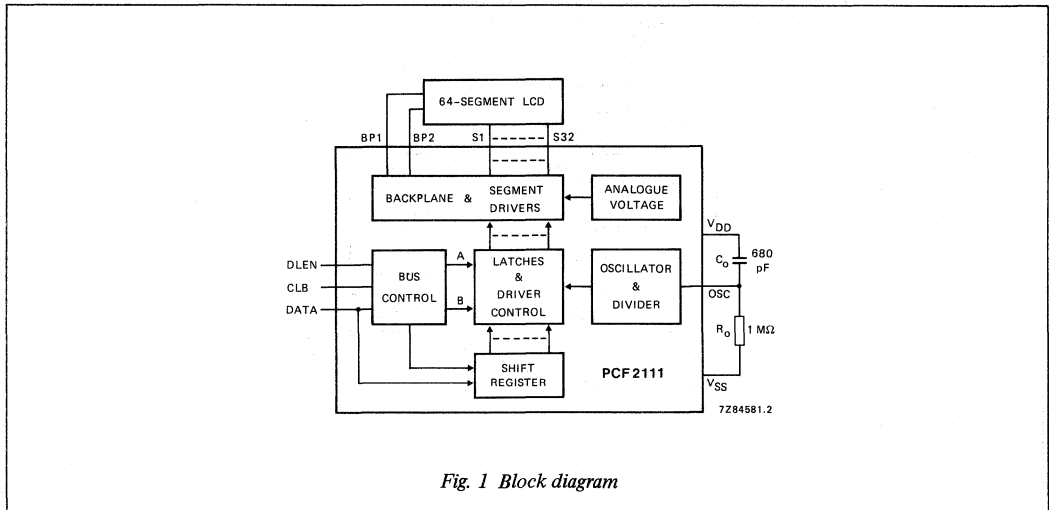


Fig. 1 Block diagram

## ORDERING INFORMATION/PACKAGE OUTLINES

PCF2111P: 40-lead DIL; plastic (SOT-129)

PCF2111T: 40-lead mini-pack; plastic (VSO-40; SOT-158A)

## LCD DRIVER

### GENERAL DESCRIPTION

The PCF2112 is a single chip, silicon gate CMOS circuit designed to drive an LCD (Liquid Crystal Display) with up to 32 segments in direct drive; specially for low voltage applications. A three-line bus structure enables serial data transfer with microcontrollers. All inputs are CMOS/NMOS compatible.

### FEATURES

- 32 LCD-segment drive capability
- Supply voltage 2,25 to 6,5 V
- Low current consumption
- Serial data input
- CBUS control
- One-point built-in oscillator
- Expansion possibility

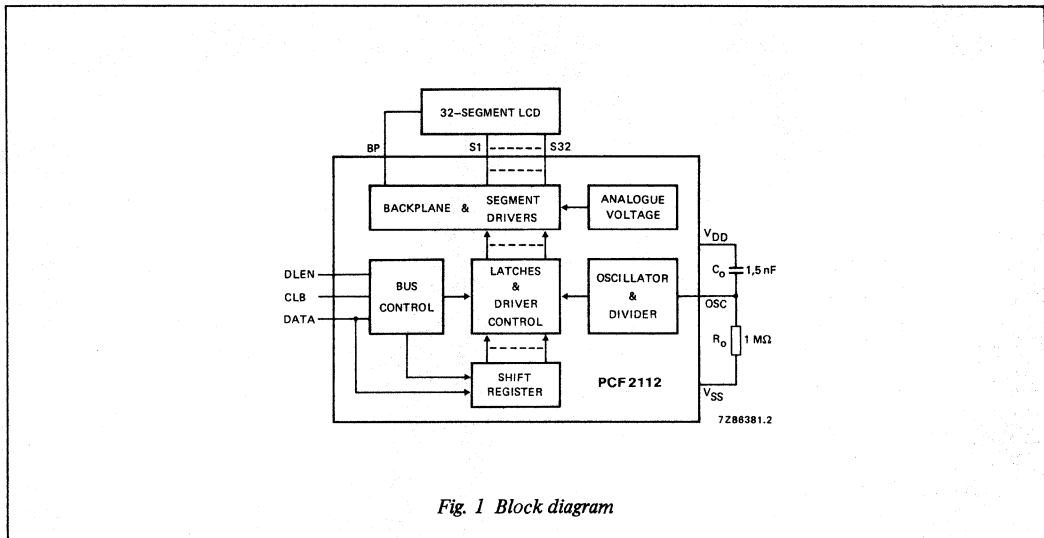


Fig. 1 Block diagram

### ORDERING INFORMATION/PACKAGE OUTLINES

PCF2112P: 40-lead DIL; plastic (SOT-129)

PCF2112T: 40-lead mini-pack; plastic (VSO-40; SOT-158A)



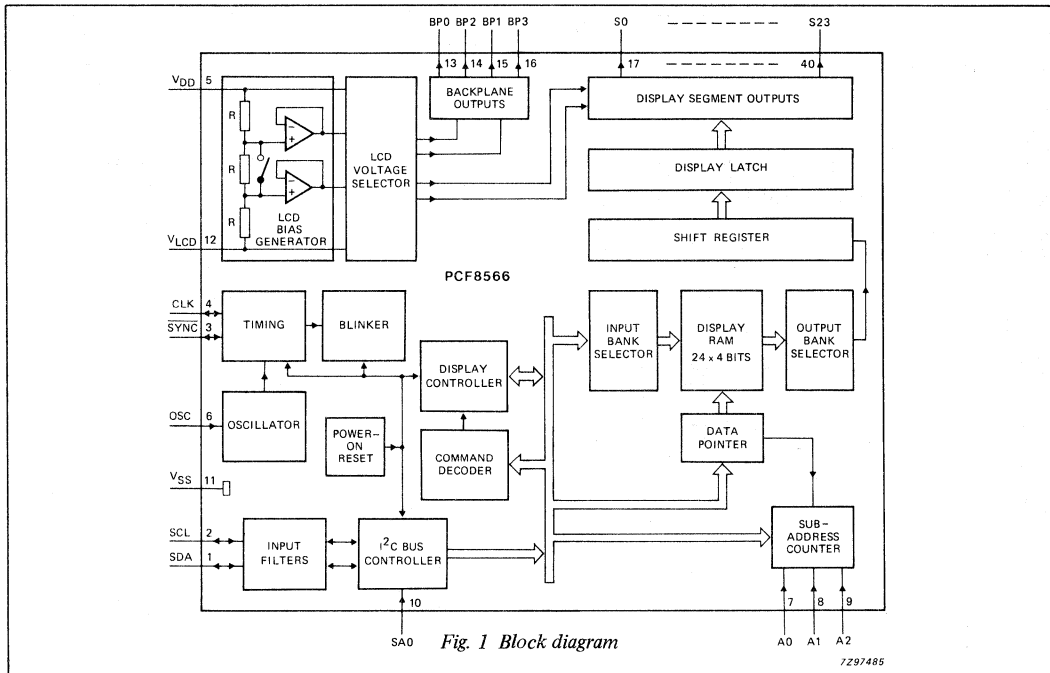
## UNIVERSAL LCD DRIVER FOR LOW MULTIPLEX RATES

## GENERAL DESCRIPTION

The PCF8566 is a peripheral device which interfaces to almost any liquid crystal display (LCD) having low multiplex rates. It generates the drive signals for any static or multiplexed LCD containing up to four backplanes and up to 24 segments and can easily be cascaded for larger LCD applications. The PCF8566 is compatible with most microprocessors/microcontrollers and communicates via a two-line bidirectional bus (I<sup>2</sup>C). Communication overheads are minimized by a display RAM with auto-incremented addressing, by hardware subaddressing and by display memory switching (static and duplex drive modes).

## FEATURES

- Single-chip LCD controller/driver
- Selectable backplane drive configuration: static or 1:2/3/4 backplane multiplexing
- Selectable display bias configuration: static, 1:2 or 1:3
- Internal LCD bias generation with voltage-follower buffers
- 24 segment drives: up to twelve 8-segment numeric characters; up to six 15-segment alphanumeric characters; or any graphics of up to 96 elements
- 24 x 4-bit RAM for display data storage
- Auto-incremented display data loading across device subaddress boundaries
- Display memory bank switching in static and duplex drive modes
- Versatile blinking modes
- LCD and logic supplies may be separated
- 3 V to 6 V power supply range
- Low power consumption
- Power-saving mode for extremely low power consumption in battery-operated and telephone applications
- I<sup>2</sup>C bus interface
- TTL/CMOS compatible
- Compatible with any 4-bit, 8-bit or 16-bit microprocessors/microcontrollers
- May be cascaded for large LCD applications (up to 1536 segments possible)
- Cascadable with the 40 segment LCD driver PFC8576
- Optimized pinning for single wiring in both single and multiple PCF8576 applications
- Space-saving 40-lead plastic mini-pack (VSO-40; SOT-158A)
- No external components required (even in multiple device applications)
- Manufactured in silicon gate CMOS process



## ORDERING INFORMATION/PACKAGE OUTLINES

PCF8566P: 40-lead DIL; plastic (SOT-129), PCF8566T: 40-lead mini-pack (VSO-40; SOT-158A)

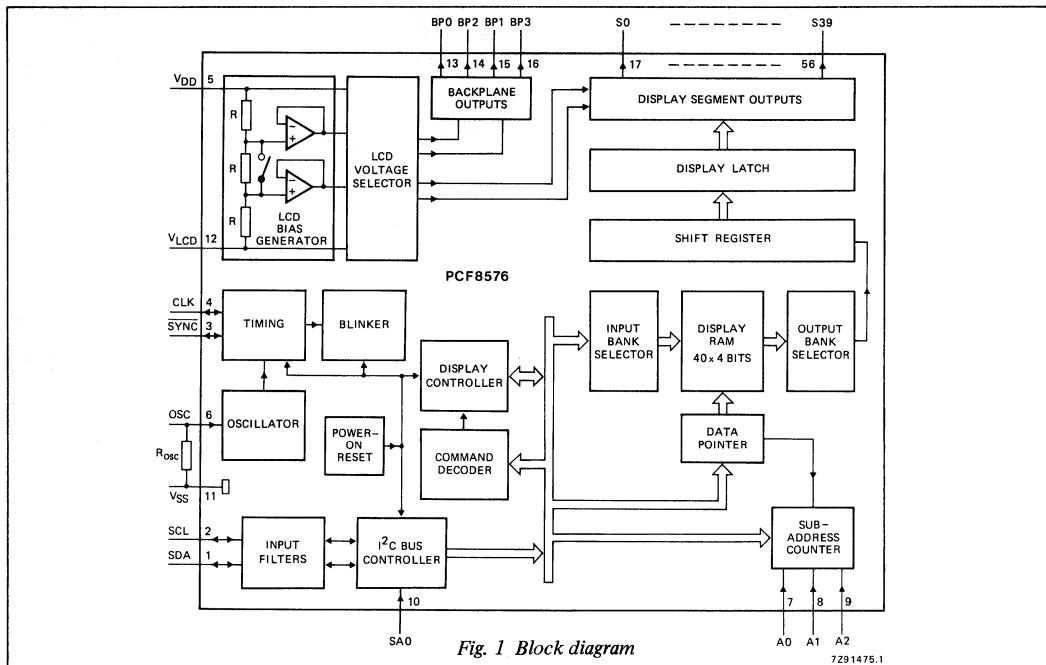
## UNIVERSAL LCD DRIVER FOR LOW MULTIPLEX RATES

### GENERAL DESCRIPTION

The PCF8576 is a peripheral device which interfaces to almost any liquid crystal display (LCD) having low multiplex rates. It generates the drive signals for any static or multiplexed LCD containing up to four backplanes and up to 40 segments and can easily be cascaded for larger LCD applications. The PCF8576 is compatible with most microprocessors and communicates via a two-line bidirectional bus (I<sup>2</sup>C). Communication overheads are minimized by a display RAM with auto-incremented addressing, by hardware subaddressing and by display memory switching (static and duplex drive modes).

### FEATURES

- Single-chip LCD controller/driver
- Selectable backplane drive configuration: static or 1:2/3/4 backplane multiplexing
- Selectable display bias configuration: static, 1:2 or 1:3
- Internal LCD bias generation with voltage-follower buffers
- 40 segment drives: up to twenty 8-segment numeric characters; up to ten 15-segment alphanumeric characters; or any graphics of up to 160 elements
- 40 x 4-bit RAM for display data storage
- Auto-incremented display data loading across device subaddress boundaries
- Display memory bank switching in static and duplex drive modes
- Versatile blinking modes
- LCD and logic supplies may be separated
- Wide power supply range: from 2 V for low-threshold LCDs and up to 9 V for guest-host LCDs and high-threshold (automobile) twisted nematic LCDs
- Low power consumption
- Power-saving mode for extremely low power consumption in battery-operated and telephone applications
- I<sup>2</sup>C bus interface
- TTL/CMOS compatible
- Compatible with any 4-bit, 8-bit or 16-bit microprocessors
- May be cascaded for large LCD applications (up to 2560 segments possible)
- Optimized pinning for single wiring in both single and multiple PCF8576 applications
- Space-saving 56-lead plastic mini-pack (VSO-56)
- Very low external component count (at most one resistor, even in multiple device applications)
- Manufactured in silicon gate CMOS process



### ORDERING INFORMATION/PACKAGE OUTLINES

PCF8576T: 56-lead mini-pack; plastic (VSO-56; SOT-190), PCF8576U: uncased chip in tray





LCD DIRECT/DUPLEX DRIVER WITH I<sup>2</sup>C BUS INTERFACE

GENERAL DESCRIPTION

The PCF8577 is a single chip, silicon gate CMOS circuit. It is designed to drive liquid crystal displays (LCDs) with up to 32 segments directly, or 64 segments in a duplex manner. The two-line I<sup>2</sup>C bus interface substantially reduces wiring overheads in remote display applications. Bus traffic is minimized in multiple IC applications by automatic address incrementing, hardware subaddressing and display memory switching (direct drive mode).

The PCF8577 and PCF8577A differ only in their slave address.

FEATURES

- Direct/duplex drive modes with up to 32/64 LCD-segment drive capability per device
- Operating supply voltage: 2,5 to 9 V
- Low power consumption
- I<sup>2</sup>C bus interface
- Optimized pinning for single plane wiring
- Single-pin built-in oscillator
- Auto-incremented loading across device sub-address boundaries
- Display memory switching in direct drive mode
- May be used for I<sup>2</sup>C bus output expander
- System expansion up to 256 segments (512 segments with PCF8577A)
- Power-on-reset sets all segments off (to blank)

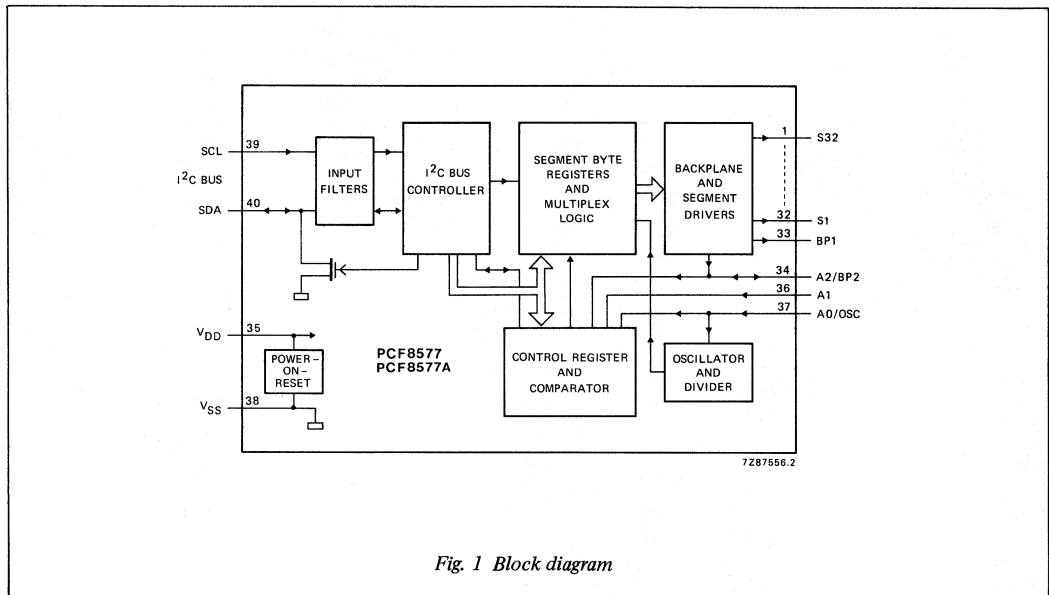


Fig. 1 Block diagram

ORDERING INFORMATION/PACKAGE OUTLINES

PCF8577P, PCF8577AP: 40-lead DIL; plastic (SOT-129)  
 PCF8577T, PCF8577AT: 40-lead mini-pack; plastic  
 (VSO-40; SOT-158A)

**BCD TO 7-SEGMENT LATCH/DECODER/DRIVER FOR LCDs****GENERAL DESCRIPTION**

The 74HC/HCT4543 are high-speed Si-gate CMOS devices and are pin compatible with "4543" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7. The 74HC/HCT4543 are BCD to 7-segment latch/decoder/drivers for liquid crystal displays. They have four address inputs ( $D_0$  to  $D_3$ ), an active HIGH latch disable input (LD), an active HIGH blanking input (BI), an active HIGH phase input (PH) and seven buffered outputs ( $Q_a$  to  $Q_g$ ). The "4543" provides the function of a 4-bit storage latch and an 8-4-2-1 BCD to 7-segment decoder/driver. The "4543" can invert the logic levels of the output combination. The phase (PH), blanking (BI) and latch disable (LD) inputs are used to reverse the function table phase, blank the display and store a BCD code, respectively. For liquid crystal displays a square-wave is applied to PH and the electrical common backplane of the display. The outputs of the "4543" are directly connected to the segments of the liquid crystal.

**FEATURES**

- Latch storage of BCD inputs
- Blanking inputs
- Output capability: non-standard
- ICC category: MSI

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
$t_{PHL}/$ $t_{PLH}$	propagation delay $D_n$ to $Q_n$	$C_L = 15$ pF $V_{CC} = 5$ V	29	33	ns
	LD to $Q_n$		32	31	ns
	BI to $Q_n$		20	28	ns
$C_I$	input capacitance		3,5	3,5	pF
$C_{PD}$	power dissipation capacitance per package	notes 1 and 2	42	42	pF

$GND = 0$  V;  $T_{amb} = 25$  °C;  $t_r = t_f = 6$  ns

**Notes**

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ W):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

$f_i$  = input frequency in MHz

$f_o$  = output frequency in MHz

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs

$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in V

2. For HC the condition is  $V_I = GND$  to  $V_{CC}$   
For HCT the condition is  $V_I = GND$  to  $V_{CC} - 1,5$  V

**ORDERING INFORMATION/PACKAGE OUTLINES**

PC74HC/HCT4543P: 16-lead DIL; plastic (SOT-38Z)

PC74HC/HCT4543T: 16-lead mini-pack; plastic  
(SO-16; SOT-109A)

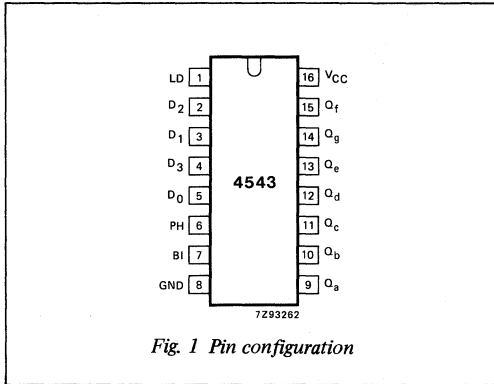


Fig. 1 Pin configuration

**PIN DESCRIPTION**

PIN NO.	SYMBOL	NAME AND FUNCTION
1	LD	latch disable input (active HIGH)
5,3,2,4	D <sub>0</sub> to D <sub>3</sub>	address (data) inputs
6	PH	phase input (active HIGH)
7	BI	blanking input (active HIGH)
8	GND	ground (0 V)
9,10,11, 12,13, 15,14	Q <sub>a</sub> to Q <sub>g</sub>	segment outputs
16	VCC	positive supply voltage

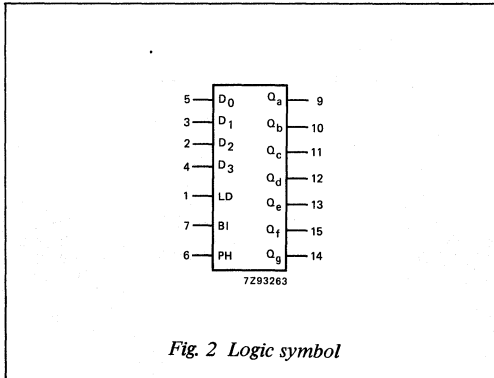


Fig. 2 Logic symbol

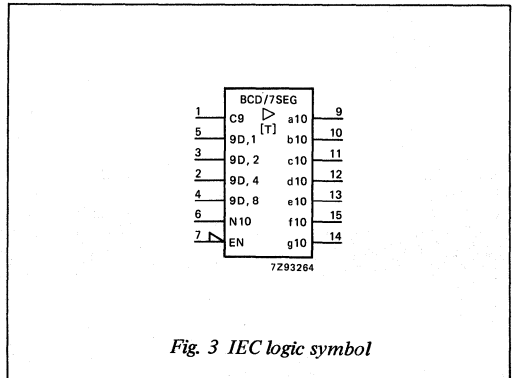


Fig. 3 IEC logic symbol

## LCD DISPLAY/INTERFACE CIRCUIT

### GENERAL DESCRIPTION

The SAA1062A is designed to drive a Liquid Crystal Display (LCD) of a digital tuning system. It contains a shift register with programmable length (18 or 21 bits), latches, both synchronized or static, exclusive-OR segment drivers (17 or 20 bits), an l.f. oscillator and a backplane driver for the LCD. The circuit is designed to be driven by a 3 bus structure from a microcomputer and can also be used as a programmable 17 or 20 bits serial-to-parallel decoder. It is also capable of storing 40 bits of information.

### FEATURES

- Driving 7 to 20-segment displays
- Driving linear displays
- Serial to parallel decoder of digital signals
- Bus control for the selection of 18/21-bit words
- 17/20-bit latch
- A.C. segment drive
- On-chip oscillator

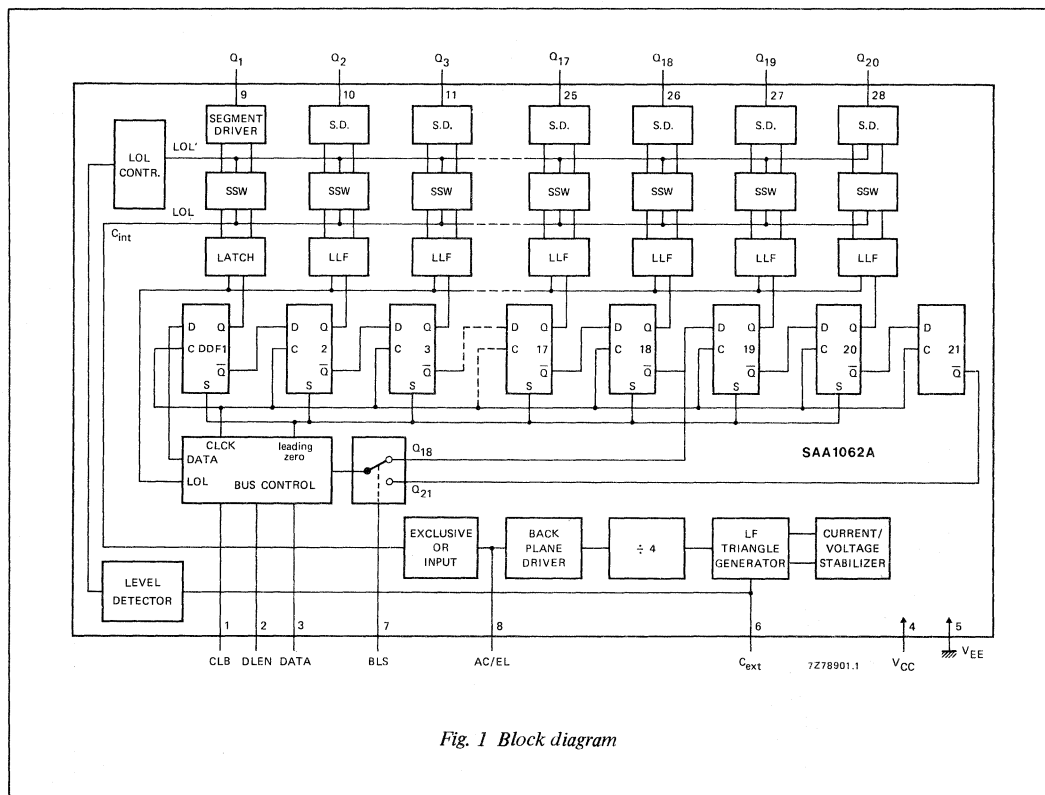


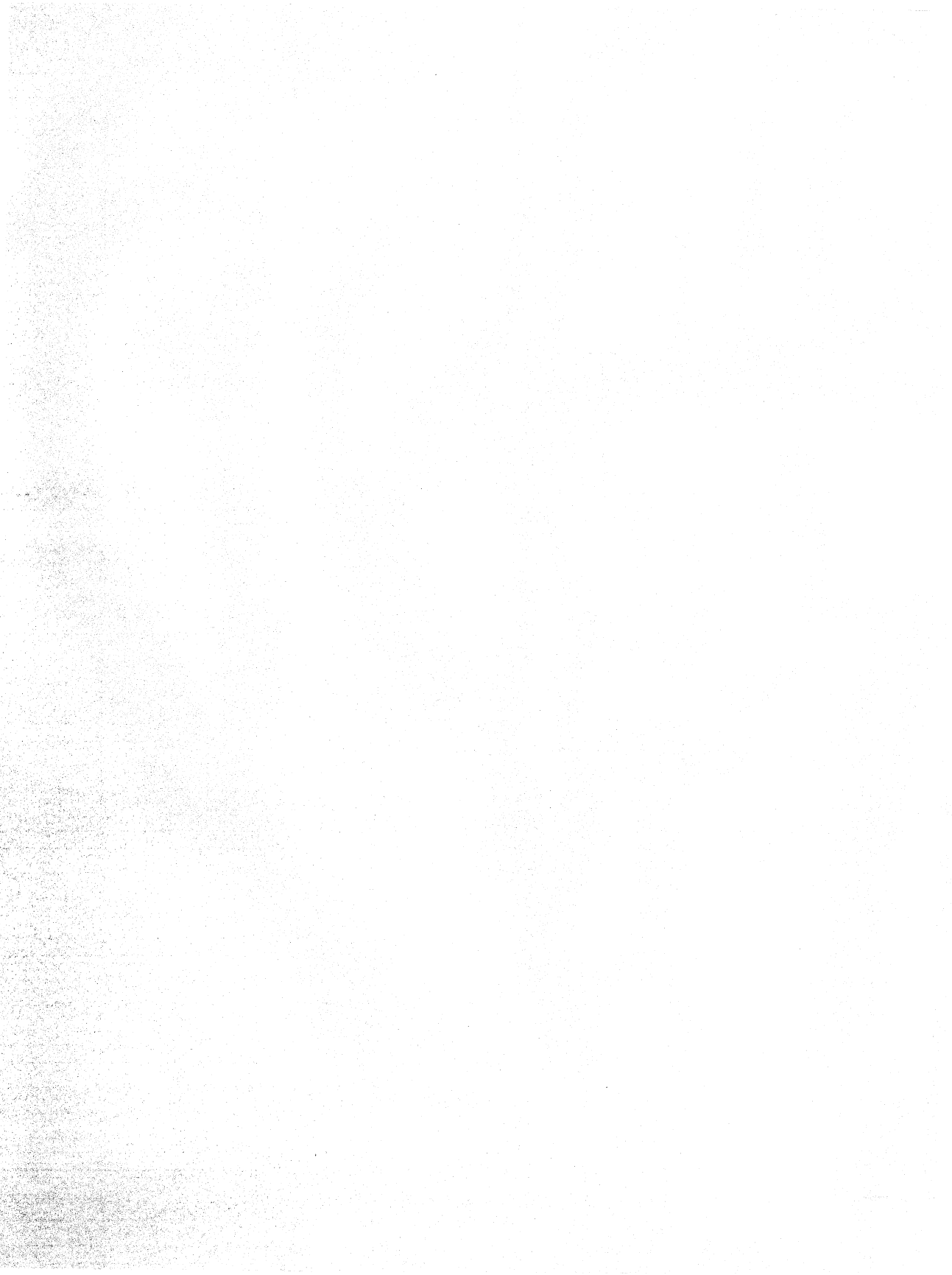
Fig. 1 Block diagram

### ORDERING INFORMATION/PACKAGE OUTLINES

SAA1062A : 28-lead DIL; plastic (SOT-117)

SAA1062AT: 28-lead mini-pack; plastic

(SO-28; SOT-136A)



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