

<b>SANYO</b>	No.3372	<b>DQ993</b> <b>Liquid Crystal Clock Module</b>
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**OVERVIEW**

The DQ993 is a compact, general-purpose clock module suitable for a wide range of applications. It incorporates a quartz-controlled clock timer, sleep timer, on/off timer, an LCD4114J liquid crystal display and an LC5851H 4-bit microcontroller.

The DQ993 uses logic-level control signals to select timing modes and to set the sleep and on/off timers. These signals enable automatic return from sleep and on/off timer modes and increment counters at 60 times normal speed.

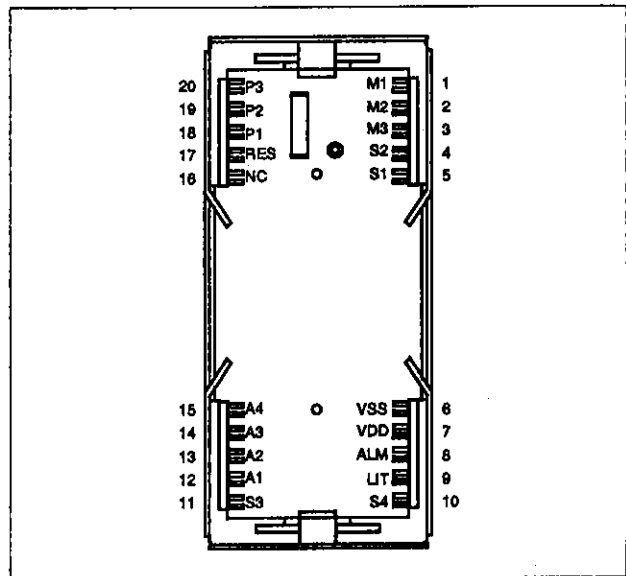
The DQ993 operates from a single 5 V supply and is available in 20-pin DIPs.

**FEATURES**

- Quartz-controlled clock
- Sleep timer
- On/off timer
- Supports LED backlighting
- Compact and easy-to-use
- Automatic return from sleep and on/off timer modes
- 5 V supply
- 20-pin DIP

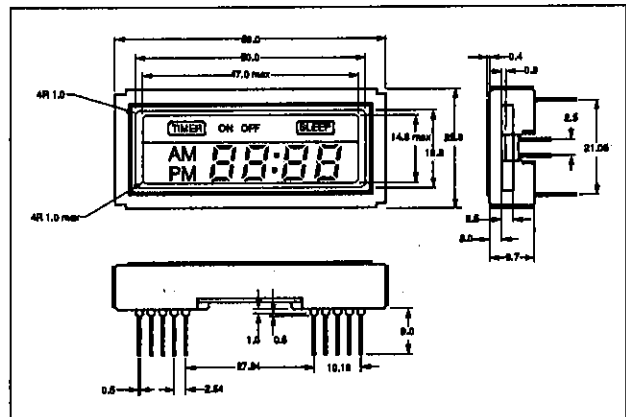
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**PINOUT**



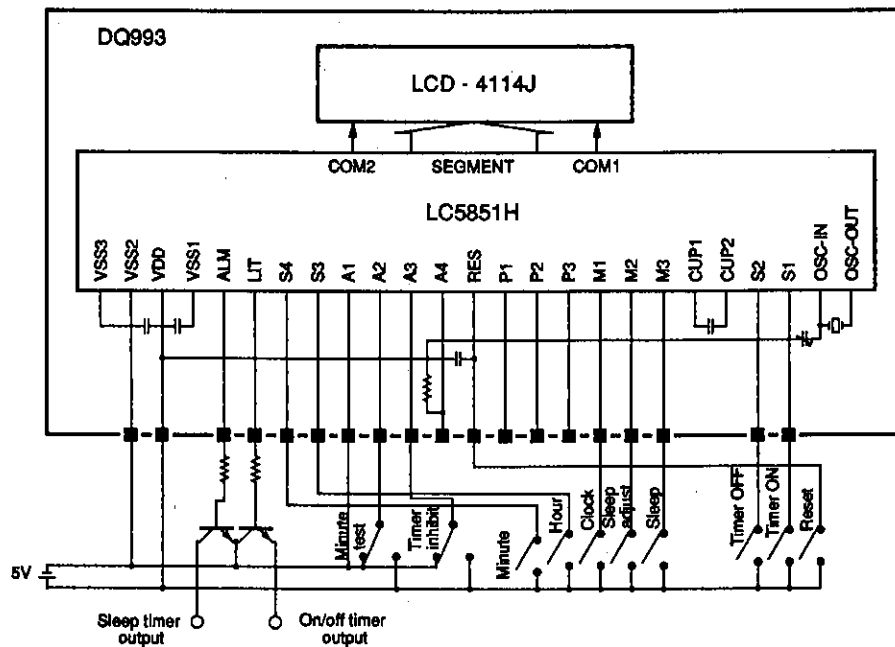
**PACKAGE DIMENSIONS**

Unit: mm



## DQ993

## SCHEMATIC DIAGRAM



## PIN DESCRIPTION

Number	Name	Description
1	M1	Current-time set control
2	M2	Sleep timer display control
3	M3	Sleep timer set control
4	S2	Timer OFF control
5	S1	Timer ON control
6	VSS	Ground
7	VDD	Supply voltage
8	ALM	Sleep timer output
9	LIT	On/off timer output
10	S4	Minute digits control
11	S3	Hour digits control
12	A1	On/off timer output control
13	A2	Counter speed control
14	A3	Timer inhibit control
15	A4	Not connected
16	NC	Not connected
17	RES	Reset control
18	P1	Not connected
19	P2	Not connected
20	P3	Not connected

## DQ993

## SPECIFICATIONS

## Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage range	$V_{DD}$	-0.3 to +5.5	V
Input voltage range	$V_{IN}$	-0.3 to $V_{DD} + 0.3$	V
Output voltage range	$V_{OUT}$	-0.3 to $V_{DD} + 0.3$	V
Operating temperature range	$T_{opr}$	-10 to +60	deg. C
Storage temperature range	$T_{stg}$	-30 to +80	deg. C

## Recommended Operating Conditions

$T_a = 25$  deg. C

Parameter	Symbol	Rating	Unit
Supply voltage	$V_{DD}$	5.0	V
Supply voltage range	$V_{DD}$	4.75 to 5.25	V

## Electrical Characteristics

$V_{DD} = 5$  V,  $V_{SS} = 0$  V,  $T_a = 25$  deg. C at RH  $\leq$  65% unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			Min	Typ	Max	
Supply voltage	$V_{DD}$	Including the LCD	4.75	5.0	5.25	V
Supply current	$I_{DD}$	After reset	-	-	80	$\mu$ A
HIGH-level input voltage	$V_{IH}$		$0.75 V_{DD}$	-	$V_{DD}$	V
LOW-level input voltage	$V_{IL}$		0	-	$0.25 V_{DD}$	V
HIGH-level output voltages	$V_{OH1}$	$V_{DD} = 3.5$ V, ALM pin used, $I_{OH} = 1.5$ mA	$V_{DD} - 1.0$	$V_{DD} - 0.3$	-	V
	$V_{OH2}$	$V_{DD} = 3.5$ V, LIT pin used, $I_{OH} = 0.5$ mA	$V_{DD} - 1.0$	$V_{DD} - 0.3$	-	V
LOW-level output voltages	$V_{OL1}$	$V_{DD} = 3.5$ V, ALM pin used, $I_{OL} = 1.5$ mA	-	0.3	1.0	V
	$V_{OL2}$	$V_{DD} = 3.5$ V, LIT pin used, $I_{OL} = 0.7$ mA	-	0.3	1.0	V
Oscillator hold voltage	$V_{HOLD}$		-	-	2.0	V
Oscillator start-up voltage	$V_{STA}$		-	-	2.2	V
Oscillator start-up time	$t_{STA}$		-	-	10	s
Time setting error	$E_{set}$	One year after delivery	-0.65	-	+0.65	s/day
Time error	$E_t$		-0.45	-	+0.45	s/day
Time error coefficient	$\epsilon_t$		-	0.045	-	ppm/deg. C <sup>2</sup>
Temperature range for peak accuracy	$T_{acc}$		20	-	30	deg. C

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## Optical Characteristics

$V_{DD} = 5.0 \text{ V} \pm 5\%$ ,  $T_a = 25 \text{ deg. C}$ , viewing angle =  $10^\circ$  unless otherwise noted

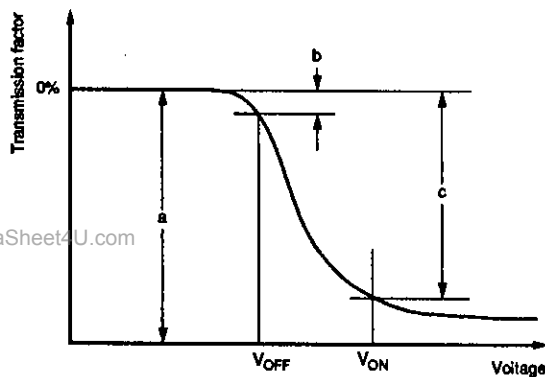
Parameter	Symbol	Condition	Rating			Unit
			Min	Typ	Max	
Display contrast turn-on time	$t_{on}$		–	35	70	ms
		$T_a = -10 \text{ deg. C}$	–	600	900	
Display contrast turn-off time	$t_{off}$		–	30	60	ms
		$T_a = -10 \text{ deg. C}$	–	150	300	
High-level display contrast	$C_{on}$		90	95	–	%
		$T_a = -10 \text{ deg. C}$	75	80	–	
Low-level display contrast	$C_{off}$	viewing angle = $40^\circ$	–	5	10	%
		$T_a = -10 \text{ deg. C}$ , viewing angle = $40^\circ$	–	20	30	

## Contrast

The following equations are used to determine the high- and low-level display contrast values.

$$C_{on} = c/a \times 100$$

$$C_{off} = b/a \times 100$$

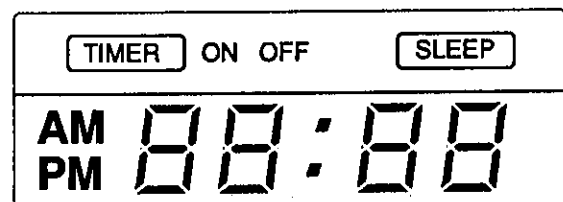


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- Handle the LCD panel with care as it is fragile.
- Do not wipe the polarizer with dry or hard materials that could damage its surface.
- Ground the work/assembly area, assembly equipment and all personnel using a  $1 \text{ M}\Omega$  earth connection to prevent electrostatic damage.
- Use an acrylic plate to protect the polarizer and LCD.
- Avoid strong mechanical shock.

## DISPLAY LAYOUT

0 1 2 3 4 5 6 7 8 9



## HANDLING PRECAUTIONS

- If the display surface is soiled, wipe it lightly with a clean cotton cloth or leather chamois soaked in petroleum benzene.

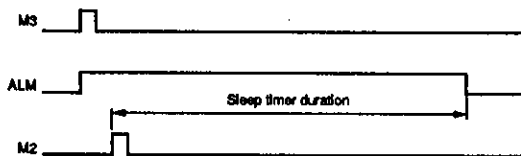


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- Pull M2 HIGH. The sleep time is set at 60 minutes and the SLEEP symbol is displayed. The sleep time cycles through the available time when M2 is held HIGH, as shown in the following figure.



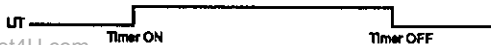
- The DQ993 automatically returns to current-time mode five seconds after M2 goes LOW. If M1 is held HIGH after setting the sleep time, it returns to the current-time mode. The remaining time can be displayed by pulling M2 HIGH.
- Pull M3 HIGH to disable the sleep timer mode.



### On/Off Timer Mode

To disable the timer, pull the A3 pin HIGH. Restart the timer by pulling A3 LOW. The TIMER symbol then appears on the screen. Note that after a power-on or reset, the TIMER symbol will not be displayed.

If the timer is enabled, the LIT pin goes HIGH when the current time equals the timer on-time. LIT goes LOW again when the current time equals the timer off-time.



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### Setting on-time

- Pull S1 HIGH. The display colon flashes and the TIMER ON symbol is displayed.

- Pull S3 HIGH to increment the hour digits once. If S3 is held LOW, the hour digits increment rapidly.
- Pull S4 HIGH to increment the minute digits once. If S3 is held LOW, the minute digits increment rapidly.
- The DQ993 automatically returns to the current-time mode five seconds after S1 goes LOW. Pulling M1 HIGH causes the clock to return to the current-time mode.

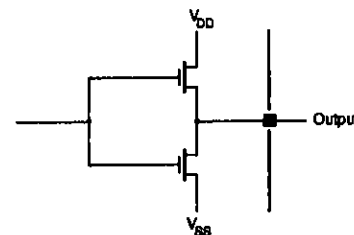
### Setting off-time

- Pull S2 HIGH. The display colon flashes and the TIMER OFF symbol is displayed.
- Set the hour and minute digits in the same way as the on-time. The DQ993 automatically returns to current-time mode five seconds after S2 goes LOW.

### Test Function

If the test pin A2 is held LOW, all counters increment at 60 times normal speed. A2 should be held HIGH for normal operation.

### Output Pin Circuit



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