Ordering number: EN3372

SANYO No.3372

DQ993

Liquid Crystal Clock Module

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.

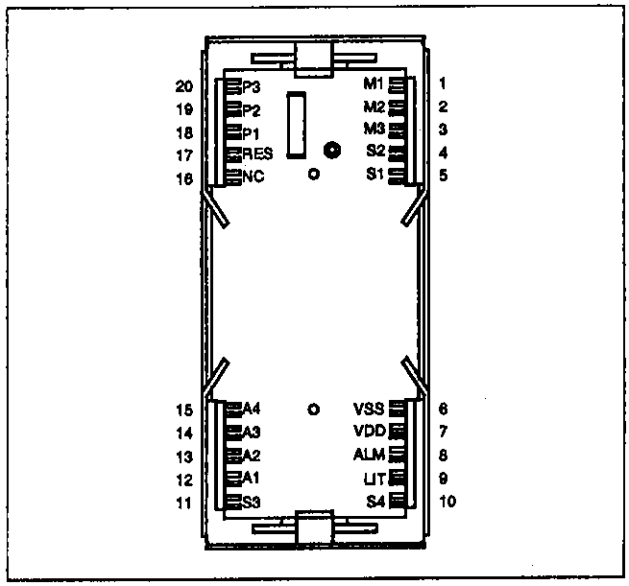
The DQ993 uses logic-level control signals to select timing modes and to set the sleep and on/off timers. These signals enable automatic return from sleep and on/off timer modes and increment counters at 60 times normal speed.

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

FEATURES

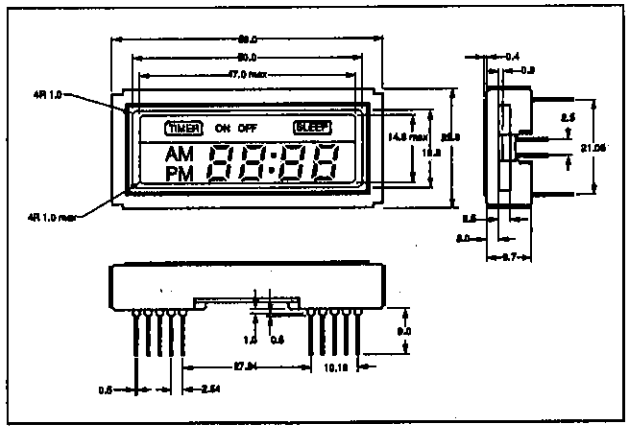
- Quartz-controlled clock
- Sleep timer
- On/off timer
- Supports LED backlighting
- Compact and easy-to-use
- Automatic return from sleep and on/off timer modes
- 5 V supply
- 20-pin DIP

PINOUT



PACKAGE DIMENSIONS

Unit: mm



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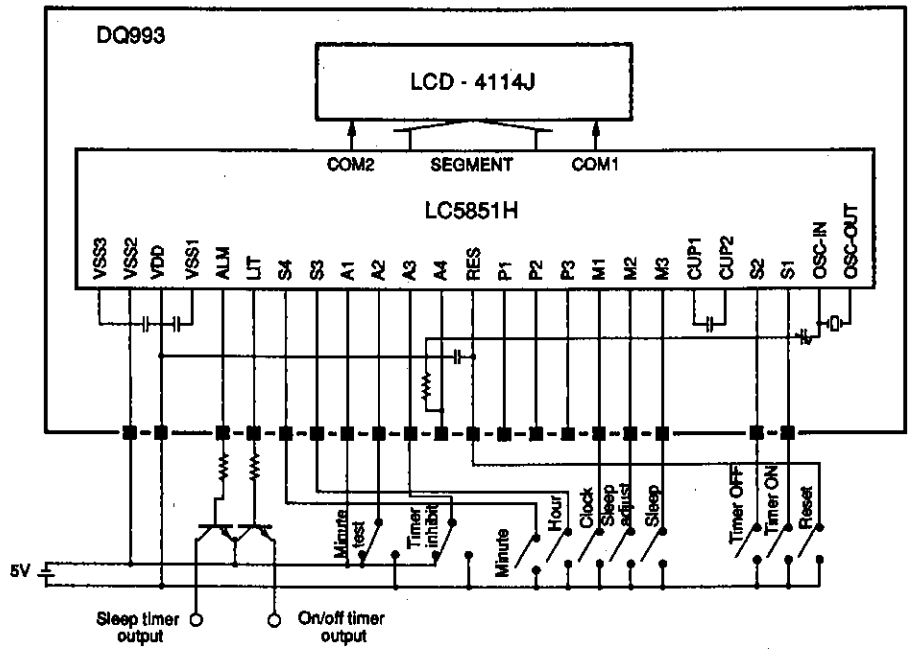
SCHEMATIC DIAGRAM



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

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	Topr	–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 ≤ 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	μA
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	ϵ_t		–	0.045	–	ppm/deg. C^2
Temperature range for peak accuracy	T_{acc}		20	–	30	deg. C

Optical Characteristics

V_{DD} = 5.0 V ±5%, T_a = 25 deg. C, viewing angle = 10° unless otherwise noted

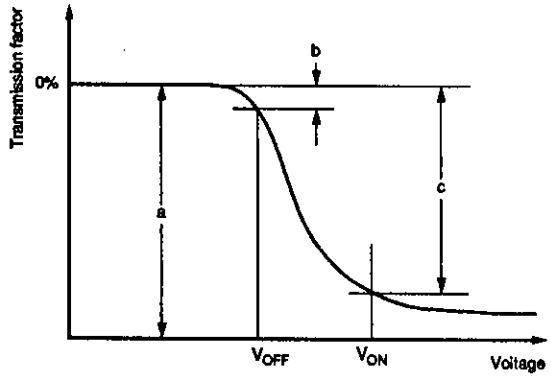
Parameter	Symbol	Condition	Rating			Unit
			Min	Typ	Max	
Display contrast turn-on time	t_{on}		–	35	70	ms
		T_a = –10 deg. C	–	600	900	
Display contrast turn-off time	t_{off}		–	30	60	ms
		T_a = –10 deg. C	–	150	300	
High-level display contrast	C_{on}		90	95	–	%
		T_a = –10 deg. C	75	80	–	
Low-level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

Contrast

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

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

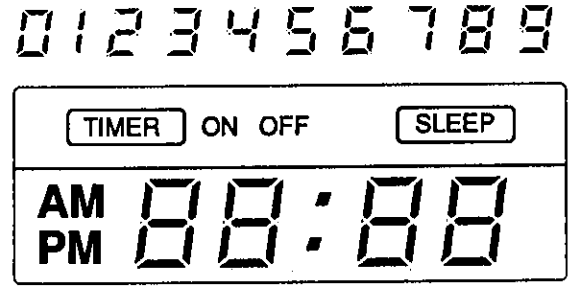
$C_{off} = b/a \times 100$



HANDLING PRECAUTIONS

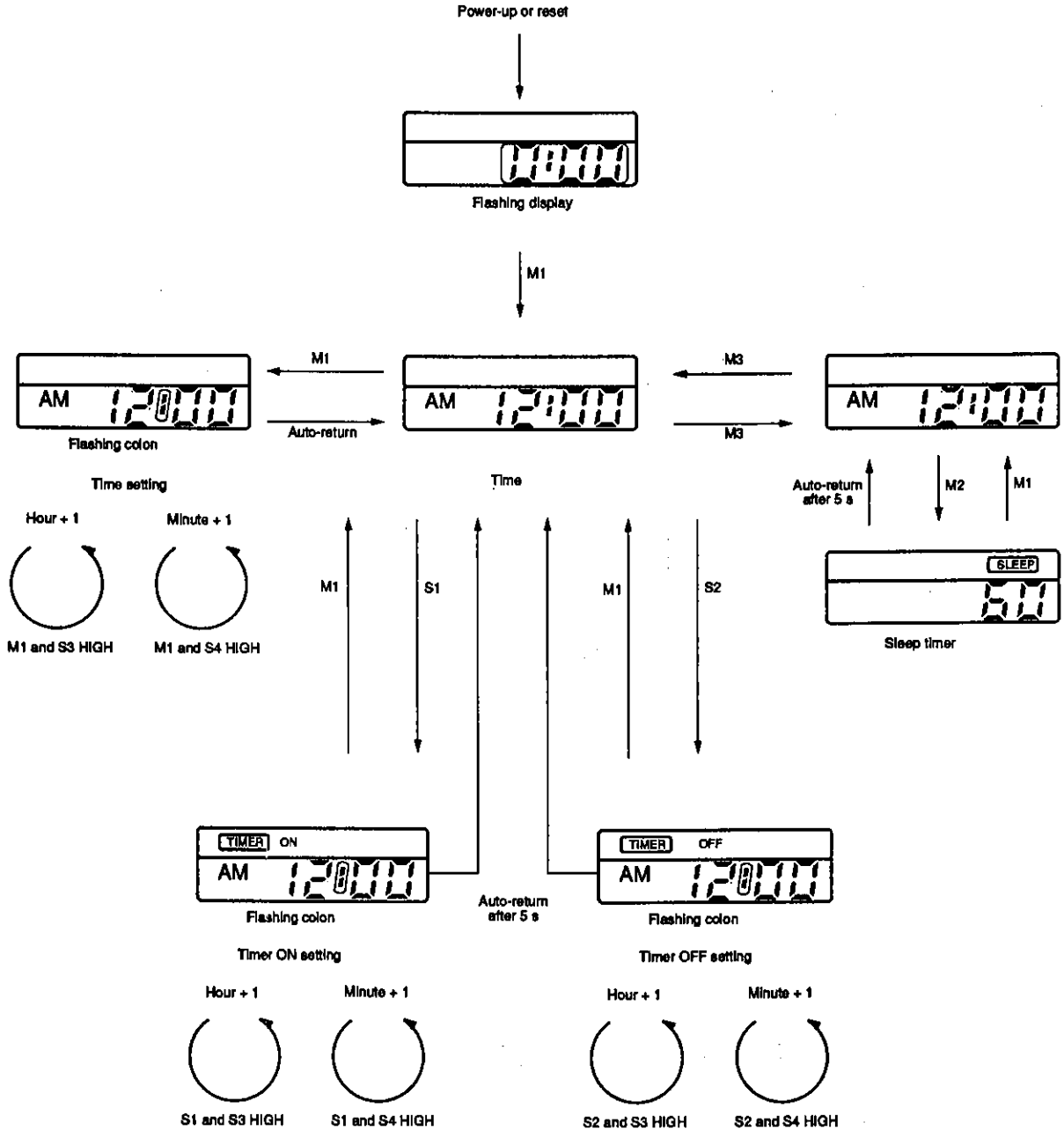
- If the display surface is soiled, wipe it lightly with a clean cotton cloth or leather chamois soaked in petroleum benzene.
- Handle the LCD panel with care as it is fragile.
- Do not wipe the polarizer with dry or hard materials that could damage its surface.
- Ground the work/assembly area, assembly equipment and all personnel using a 1 MΩ earth connection to prevent electrostatic damage.
- Use an acrylic plate to protect the polarizer and LCD.
- Avoid strong mechanical shock.

DISPLAY LAYOUT



OPERATING INFORMATION

Operational Flowchart



Note
The DQ993 cannot operate correctly if the oscillator start-up conditions are not met. If the DQ993 fails, reset it by applying V_{DD} to the RESET pin.

Current-Time Mode

Pull the M1 pin HIGH after power-up or reset. The DQ993 then enters its current-time mode.

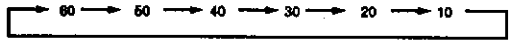
Time Setting Mode

1. Pull M1 HIGH. The display colon then flashes.
2. Pull S3 HIGH to increment the hour digits. If S3 is held HIGH, the hour digits increment rapidly.
3. Pull S4 HIGH to increment the minute digits. If S4 is held HIGH, the hour digits increment rapidly.
4. Pull M1 LOW to return to the current-time mode.

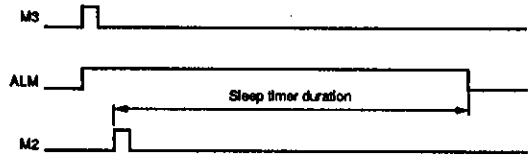
Sleep Timer Mode

1. Pull M3 HIGH to switch the ALM output pin HIGH. The DQ993 then switches to the sleep timer mode.

2. 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.



3. 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.
4. 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.

Setting on-time

1. Pull S1 HIGH. The display colon flashes and the TIMER ON symbol is displayed.
2. Pull S3 HIGH to increment the hour digits once. If S3 is held LOW, the hour digits increment rapidly.
3. Pull S4 HIGH to increment the minute digits once. If S3 is held LOW, the minute digits increment rapidly.
4. 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.

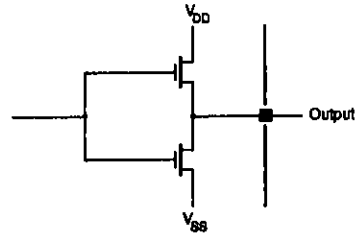
Setting off-time

1. Pull S2 HIGH. The display colon flashes and the TIMER OFF symbol is displayed.
2. 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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