



LC5645N

LCD Digital Watch

Functions

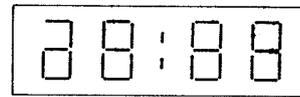
- Real time (month, date, hours, minutes, seconds).
- 2 switches of SET switch, SELECT switch.
- LCD light-up system by duplex drive.
- Selectable real time display mode.
 - Hours, minutes display mode.
 - Month, date display mode.
 - Seconds display mode.
- Alternating display mode available.
- 12/24-hour operation mode selectable by chip bonding.
- Automatic calendar (Programmed to count date in February up to the 28th).
- Reference frequency $f_{OSC}=32.768kHz$.
- Battery voltage 1.5V, with built-in doubler circuit.

Display System

1. 3-1/2 digits LCD
2. 32Hz duplex drive
3. Display font



4. Panel layout



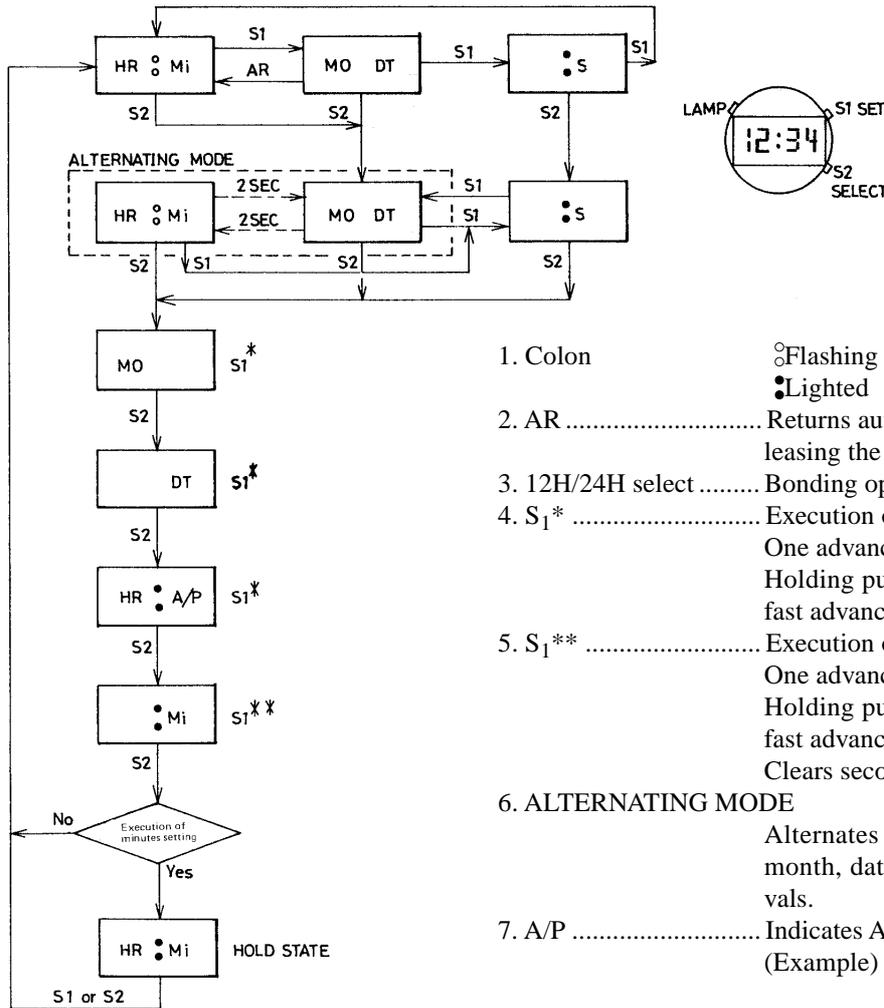
<u>Hours</u>	<u>Minutes</u>	←	Hours, minutes display mode
<u>Month</u>	<u>Date</u>	←	Month, date display mode
	<u>Seconds</u>	←	Seconds display mode
<u>Month</u>		←	Month display mode
	<u>Date</u>	←	Date display mode
<u>Hours</u>		←	Hours display mode
	<u>Minutes</u>	←	Minutes display mode

5. Output pins for display 14 pads
 Segment output 1st digit : 3 segments, 3rd digit : 6 segments, other 2 digits : 7 segments
 Colon 1 segment
 Common 2 pins of COMMON1, COMMON2
6. Total number of pads 32 pads

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Operation Flow



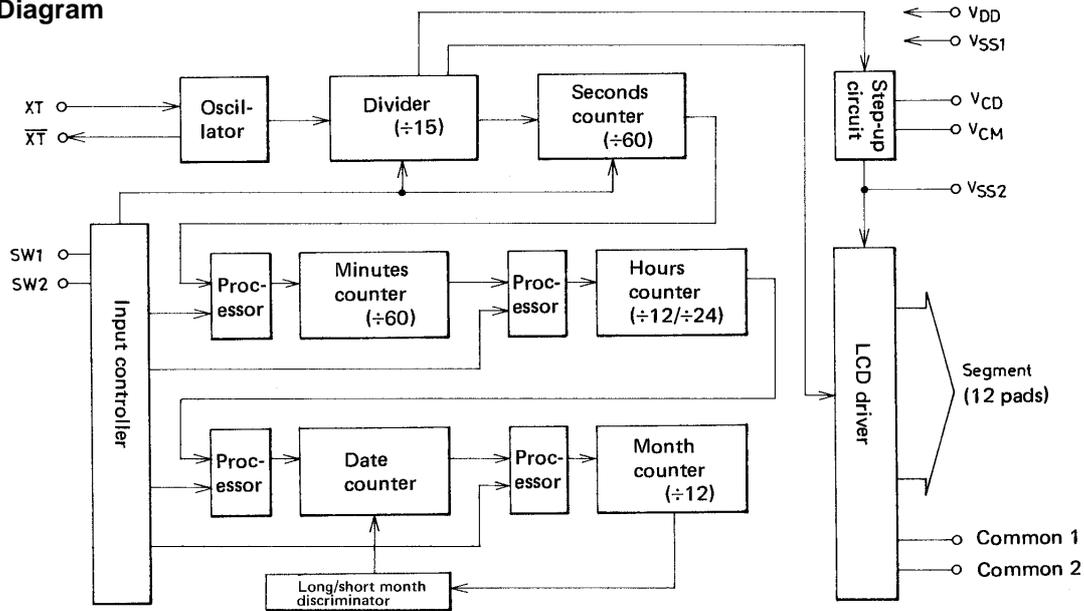
- 1. Colon ◌ Flashing at 1Hz 50% duty
● Lighted
- 2. AR Returns automatically 1 to 2 seconds after releasing the switch.
- 3. 12H/24H select Bonding option
- 4. S₁* Execution of setting
One advance per push
Holding pushed for 1 second or more causes fast advance at a 4Hz rate.
- 5. S₁** Execution of setting
One advance per push
Holding pushed for 1 second or more causes fast advance at a 4Hz rate.
Clears seconds and stops timekeeping.
- 6. ALTERNATING MODE
Alternates the hours, minutes display mode/month, date display mode at 2-second intervals.
- 7. A/P Indicates AM/PM in 12-hour operation mode. (Example)

AM: 6 : 12 P (6a.m.)
PM: 7 : 12 P (7p.m.)

- 8. HOLD STATE
Holds the counter and stops timekeeping.
Pushing switch S₁ or S₂ starts timekeeping.
- 9. Pushing switches S₁ and S₂ simultaneously causes the initial mode to occur and the hours, minutes display mode is entered as follows :
(12H display mode) AM 1 : 00 : 00 Jan. 1
(24H display mode) 1 : 00 : 00 Jan. 1

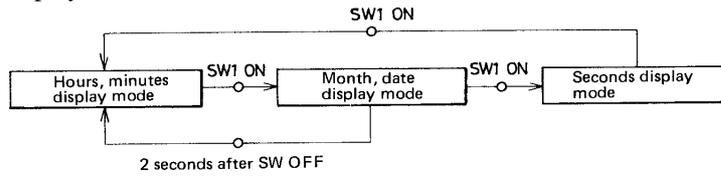
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Block Diagram



Operating Specification

1. Hours, minutes display mode



- In this hours, minutes display mode the colon flashes at a 1Hz rate and 50% duty.
- The 10's digit of hours is zero-blanked.
- In the 12-hour operation mode the hours digits change as 1 → 2 → → 12 → 1.
- In the 24-hour operation mode the hours digits change as 0 → 1 → → 23 → 0.

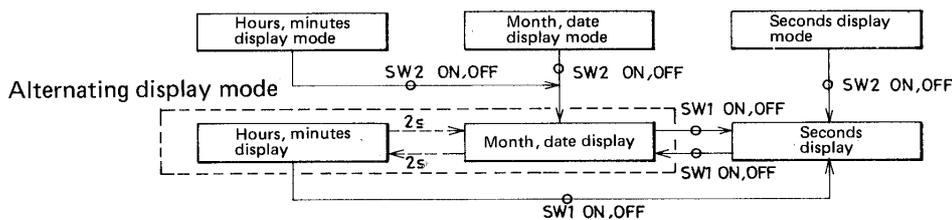
2. Month, date display mode

- In the month, date display mode the colon is unlighted.
- The 10's digit of both month and date is zero-blanked.
- Discrimination between long month and short month is exercised when an hour carry occurs and February date is counted up to 28th.

3. Seconds display mode

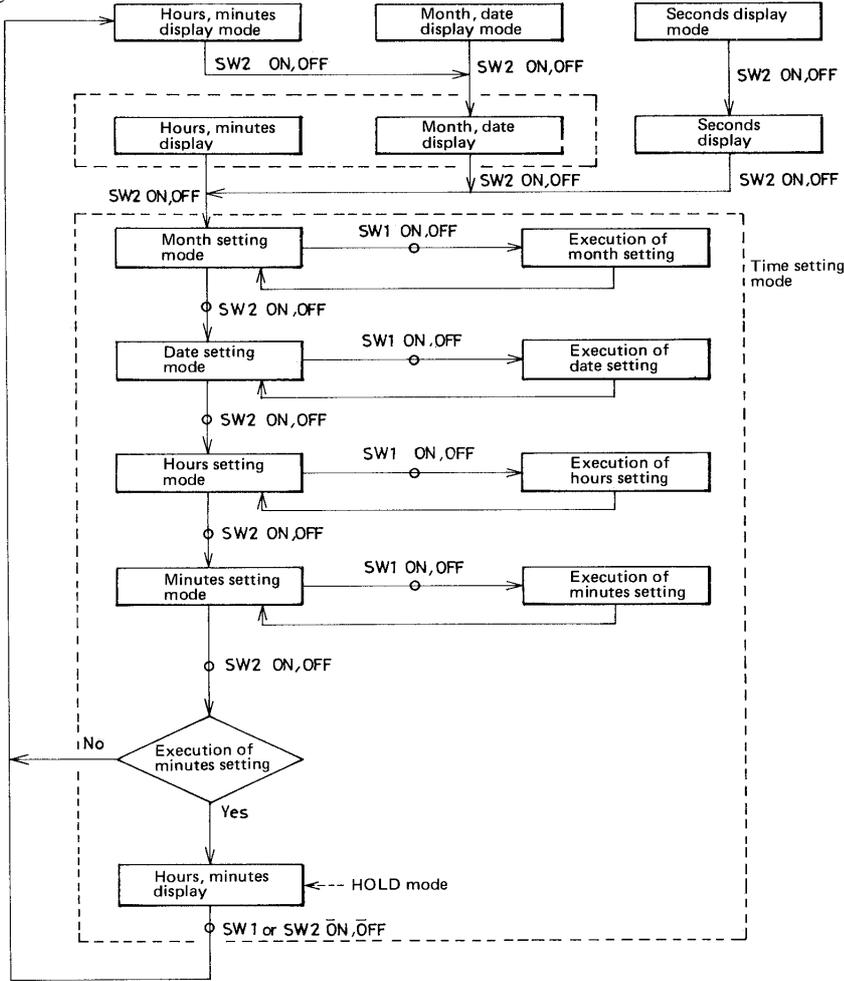
- In the seconds display mode the colon flashes.
- Seconds are displayed on the right 2 digits, with the left 2 digits blanked.

4. Alternating display mode



- By pushing switch S2 in the hours, minutes display mode or month, date display mode, the alternating display mode is entered. By pushing switch S2 and then switch S1 in the seconds display mode, the alternating display mode is also entered.
- When the alternating display mode is entered, the month, date display appears. The hour, minutes display appears 2 seconds later, and then the month, date display returns 2 seconds later. This is repeated.

5. Time setting mode



- Only the digit to be set is lighted and displayed. In the month setting mode the month digits only are displayed.
- In the month or hours setting mode the month or hours are displayed on the left 2 digits. In the date or minutes setting mode the date or minutes are displayed on the right 2 digits.
- In the hours or minutes setting mode the colon is lighted. In the month or date setting mode the colon is unlighted.
- Each time SW1 is pushed/released in each setting mode, the display contents are incremented +1. Holding SW1 pushed for 1 to 2 seconds or more causes the display contents to advance at a 4Hz rate.
- Execution of setting in each setting mode
 - (a) Execution of month setting The month counter counts up to 12.
 - (b) Execution of date setting The date counter counts up to 31 regardless of long/short month. No carry to the month digits occurs. Discrimination between long month and short month is exercised only when a carry from the hours digits occurs.
 - (c) Execution of hours setting In the 12-hour operation mode “A” is displayed on the rightmost digit when in the morning : “P” is displayed when in the afternoon. The display contents change as 11a.m. → 12p.m. → 1p.m. or 11p.m → 12a.m. → 1a.m. In the 24-hour operation mode the display contents change as 23 → 0. No carry to the date digits occurs.
 - (d) Execution of minutes setting When minutes setting is executed, seconds are cleared and the time is held as set. This is proved by the fact that when SW₂ is pushed/released after execution of minutes setting the hours, minutes display appears but the colon remains lighted without flashing. By pushing/releasing SW₁ or SW₂ under this state, the time hold is released, timekeeping starts, and the normal hours, minutes display mode returns with the colon flashing. If in the minutes setting mode SW₂ is pushed/released without execution of minutes setting, the setting mode returns to the normal hours, minutes display mode.

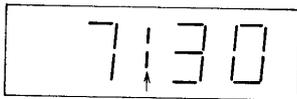
Sample Display of Each Mode

1. Hours, minutes display mode
(For the alternating display mode also, this applies.)



Colon : Flashing at a 1Hz rate (50% duty)
Hour, minutes display (12 :54)

2. Month, date display mode
(For the alternating display mode also, this applies.)



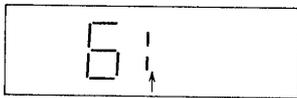
Colon : Unlighted
Month, date display (July 30)

3. Seconds display mode



Colon : Unlighted
Second display (08)

4. Month setting mode



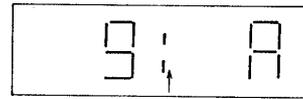
Colon : Unlighted
Month only (June)

5. Date setting mode



Colon : Unlighted
Date only (7)

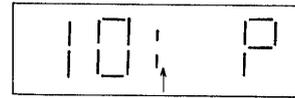
6. Hours setting mode



Indicating AM

Colon : Lighted

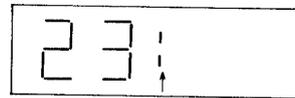
- 12-hour operation mode Hours only
(9a. m.)



Indicating PM

Colon : Lighted

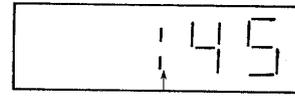
- 12-hour operation mode Hours only
(10p.m.)



Colon : Lighted

- 24-hour operation mode Hours only
(23)

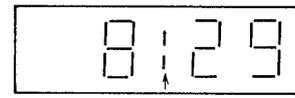
7. Minutes setting mode



Colon : Lighted

Minutes only (45)

8. Hold mode

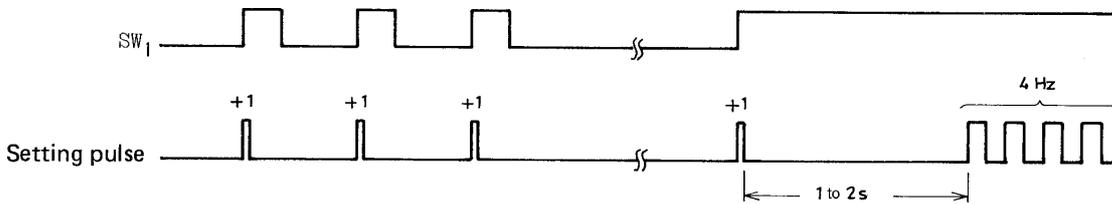


Colon : Lighted

Hours, minutes display (8 : 29)

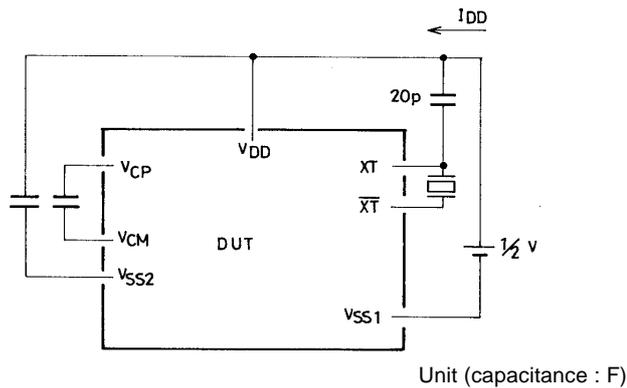
Others

1. Zero blanking Unnecessary 0's are unlighted.
 Unlighted content The 10's digit of month, date, hours is zero-blanked.
 Lighted content 0 in the 10's digit of minutes, seconds is lighted.
2. Switch input voltage
 The INPUT pin contains a floating preventing resistor. V_{DD} is applied to this pin to start operation.
3. 24/12-hour operation mode select
 For the 12-hour operation mode, the 24H/12H pin is not bonded. For the 24-hour operation mode, this pin is bonded.
4. Setting pulse
 Each time SW_1 is pushed in each setting mode, the display contents are incremented +1. Holding SW_1 pushed causes fast advance at a 4Hz rate to start approximately 1 second later.



5. Switch chattering preventer
 Chattering of 30ms or less is prevented. (More than 30ms is considered to be bounding.)
6. Step-up circuit
 Two capacitors ($0.1\mu F$) are connected externally. The step-up frequency is 512Hz.
7. Initial clear
 The circuit is built in. The initial mode can be also entered by pushing SW_1 and SW_2 simultaneously.
8. LCD output alternating frequency 32Hz

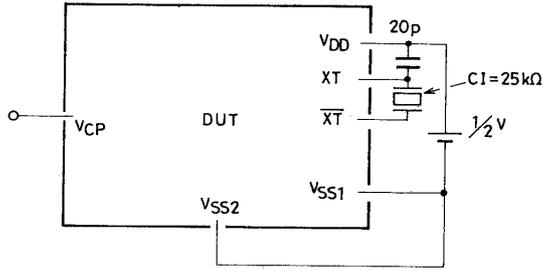
Supply current



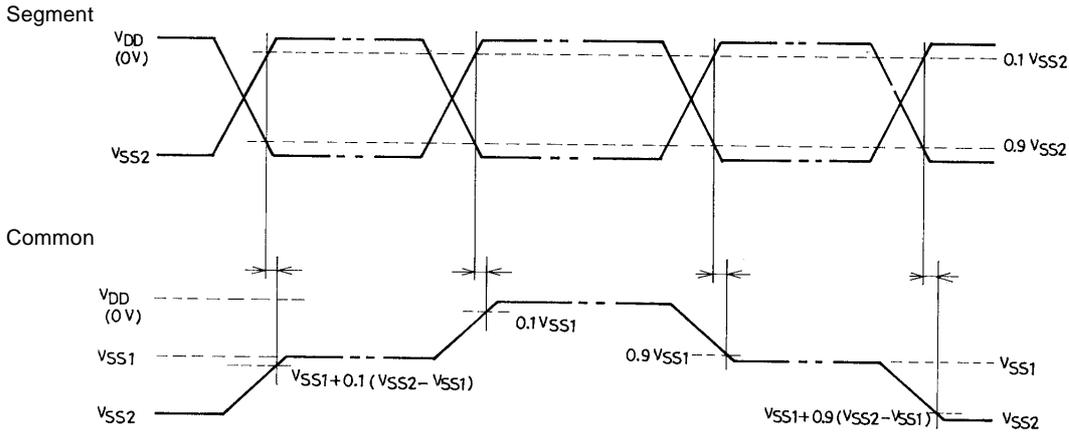
- (Note)
- Pins not entered are all open.
 - $C_I \leq 25k\Omega$

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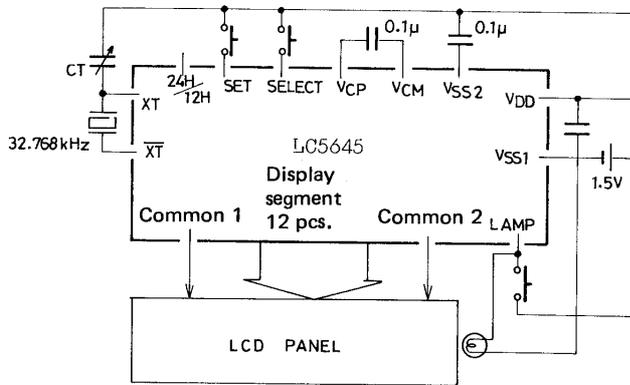
Oscillation start voltage, oscillation stop voltage, oscillation start time.



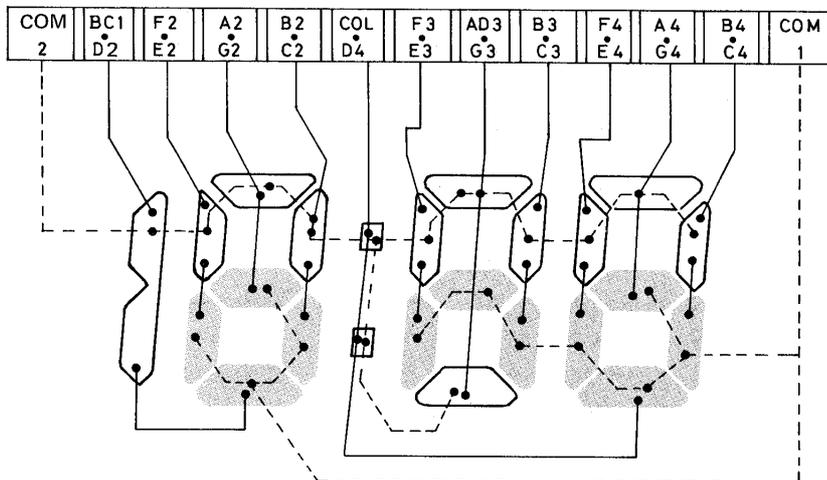
Common-segment time lag



Sample Application Circuit

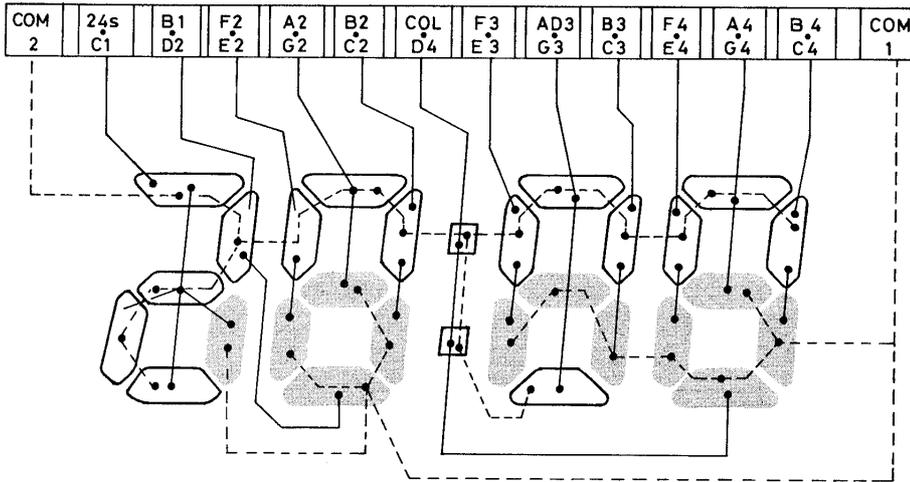


LCD Format (12 hour display format)

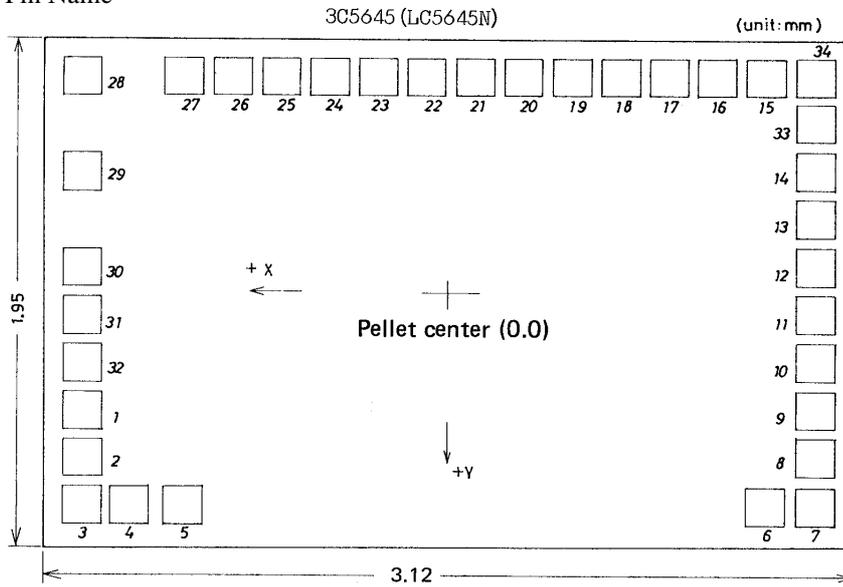


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LCD Format (24 hour display format)



Pad No. and Pin Name



Pad No.	Pin Name	X coordinates (μm)	Y coordinates (μm)	Pad No.	Pin Name	X coordinates (μm)	Y coordinates (μm)
1	V _{DD}	1407	450	18	F4/E4	-585	-822
2	V _{CP} (Cup2)	1407	630	19	B3/C3	-405	-822
3	V _{CM} (Cup1)	1407	822	20	AD3/G3	-225	-822
4	Test2	1225	822	21	F3/E3	-45	-822
5	32Hz	1045	822	22	C _O 1/D4	135	-822
6	Test 1	-1193	822	23	B2/C2	315	-822
7	V _{SS1}	-1407	822	24	A2/G2	495	-822
8	S2	-1407	630	25	F2/E2	675	-822
9	V _{DD}	-1407	450	26	B1/D2	855	-822
10	24H/12H	-1407	270	27	24S/C1	1035	-822
11	V _{SS2}	-1407	90	28	Common 2	1407	-822
12	Test 3	-1407	-90	29	Lamp	1407	-467
13	Test 4	-1407	-270	30	\overline{XT} (Osc Out)	1407	-90
14	S1	-1407	-450	31	10pF	1407	90
15	Common 1	-1125	-822	32	XT (Osc In)	1407	270
16	B4/C4	-945	-822	33	Monitor	1407	-630
17	A4/G4	-765	-822	34	Monitor	1407	-322

* The pad coordinates are such that the pellet center is taken as the origin (0.0).

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Specifications

Absolute Maximum Ratings at Ta = 25°C, V_{DD}=0V

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage 1	V _{SS1}		-4 to +0.3	V
Maximum supply voltage 2	V _{SS2}		-4 to +0.3	V
Input voltage	V _{IN}	S1, S2, LAMP, T1 to T4, XT, 24H/12H	V _{SS1} -0.3 to +0.3	V
Output voltage 1	V _{OUT1}	XT, 32Hz, V _{CP}	V _{SS1} -0.3 to +0.3	V
Output voltage 2	V _{OUT2}	All segments, Common1, Common2, V _{CM}	V _{SS2} -0.3 to +0.3	V
Operating temperature	T _{opr}		-20 to +75	°C
Storage temperature	T _{stg}		-30 to +125	°C

Recommended Operating Conditions at Ta = 25°C, V_{DD}=0V

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V _{SS1}		-1.65 to -1.3	V
Supply voltage 2	V _{SS2}	V _{SS1} =-1.3 to -1.65	-3.3 to -2.4	V
Input high level voltage	V _{IH}	V _{SS1} =-1.55V, S1, S2	-0.2 to +0	V
Input low level voltage	V _{IL}	V _{SS1} =-1.55V, S1, S2	V _{SS1} to +V _{SS1} +0.2	V

Electrical Characteristics at Ta = 25°C, V_{DD}=0V, V_{SS}=-1.3 to -1.65V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Input resistance	R _{IN1}	V _{SS1} =-1.55V, S1, S2, Lamp	200		2000	kΩ
Input resistance	R _{IN2}	V _{SS1} =-1.55V, test input	1		100	kΩ
Input resistance	R _{IN3}	V _{SS1} =-1.55V, "L" level hold Tr, 24H/12H	10		100	kΩ
Input resistance	R _{IN4}	V _{SS1} =-1.55V, "L" level pull-in Tr, 24H/12H	200		2000	kΩ
Output "H" level voltage	V _{OH1}	V _{SS1} =-1.55V, I _{OH} =-0.4μA, segment, colon	-0.2			V
Output "L" level voltage	V _{OL1}	V _{SS1} =-1.55V, I _{OL} =0.4μA, segment, colon			V _{SS2} +0.2	V
Output "H" level voltage	V _{OH2}	V _{SS1} =-1.55V, I _{OH} =-4μA, Common 1, Common 2	-0.2			V
Output "M" level voltage	V _{OM}	V _{SS1} =-1.55V, I _{OH} =-4μA, I _{OL} =4μA, Common 1, Common 2	V _{SS1} -0.2		V _{SS1} +0.2	V
Output "L" level voltage	V _{OL2}	V _{SS1} =-1.55V, I _{OL} =4μA, Common 1, Common 2			V _{SS2} +0.2	V
Input leakage current	I _{off}	V _{SS1} =-2V, V _{SS2} =-4V, 24/12H off mode			0.1	μA
Step-up voltage	V _{SS2}	C ₁ =C ₂ =0.1μF, 3MΩ across V _{DD} -V _{SS2} , f _{opg} =32.768kHz	-3.3		-2.5	V
Supply current	I _{DD}	V _{SS1} =-1.55V, C ₁ =C ₂ =0.1μF, C _O =C _G =20pF, C _I =25kΩ		1.0	2.0	μA
Oscillation start voltage	V _{START}	C ₁ =C ₂ =0.1μF, C _O =C _G =20pF, C _I =25kΩ			-1.45	V
Oscillation hold voltage	V _{HOLD}	C ₁ =C ₂ =0.1μF, C _O =C _G =20pF, C _I =25kΩ			-1.3	V
Oscillation start time	t _{START}	V _{SS1} =-1.55V, C ₁ =C ₂ =0.1μF, C _O =C _G =20pF, C _I =25kΩ			10	s
Oscillation capacitance (10pF pin)	C _O		8		12	pF
Common-segment time lag	t _D	V _{SS2} =-3.3 to -2.5V, C _L =100p	-100		+100	μs
Built-in Capacitance	C _D			20		pF

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