

## 1. GENERAL DESCRIPTION

The DL8028 is a CMOS fabricated LSI chip designed to drive a standard 3.5 digit duplexed LCD for a count-up/down timer in watch applications and also as long-term count-down counter. The maximum count-down time is 20 hours with an accuracy of Seconds. The maximum count-up period is 20 hours. When the count-up time is more than 20 minutes the LCD display is in hours and minutes, seconds can be seen by pressing S2 and will revert to previous mode by releasing S2. In the count-up/down mode, the real time can be seen by pressing switch S1 and return to the count-up/down mode by releasing S1. When the user press S4 the status of the long-term count-down counter will be displayed and LCD will return to previous mode when S4 will be pressed again.

Once the count-down is finished, the timer can either automatically recycle the preset time or manually reset the desired time depending on the selected bounding-pad option. The forecast alarm generates 4 alarm sounds at 10 minutes before set time. The DL8028 can be used as a parking timer, an alarm timer, a pill box timer, a kitchen timer, a sports timer, etc.

## 2 FEATURES

- A real time watch
- A 20-hour adjustable range setting count-down timer
- 20-hours of count-up time maximum
- Auto change display mode to hours and minutes when the count-up time is more than 20 minutes.
- Auto recycle or manual reset the count-down timer by bonding option
- Hours and minutes are set independently
- Long-term count-down counter (day count-1999 days can be set maximum)
- Watch, Timer and Counters work independently
- Real time display in timer mode
- 5-minute and 10-minute pre-alarm function
- DC output and piezo output
- Internal voltage doubler
- Busy flag output high in timer counting
- 3.5 digit LCD display
- 32,768Hz crystal oscillator
- Single 1.5V battery operation

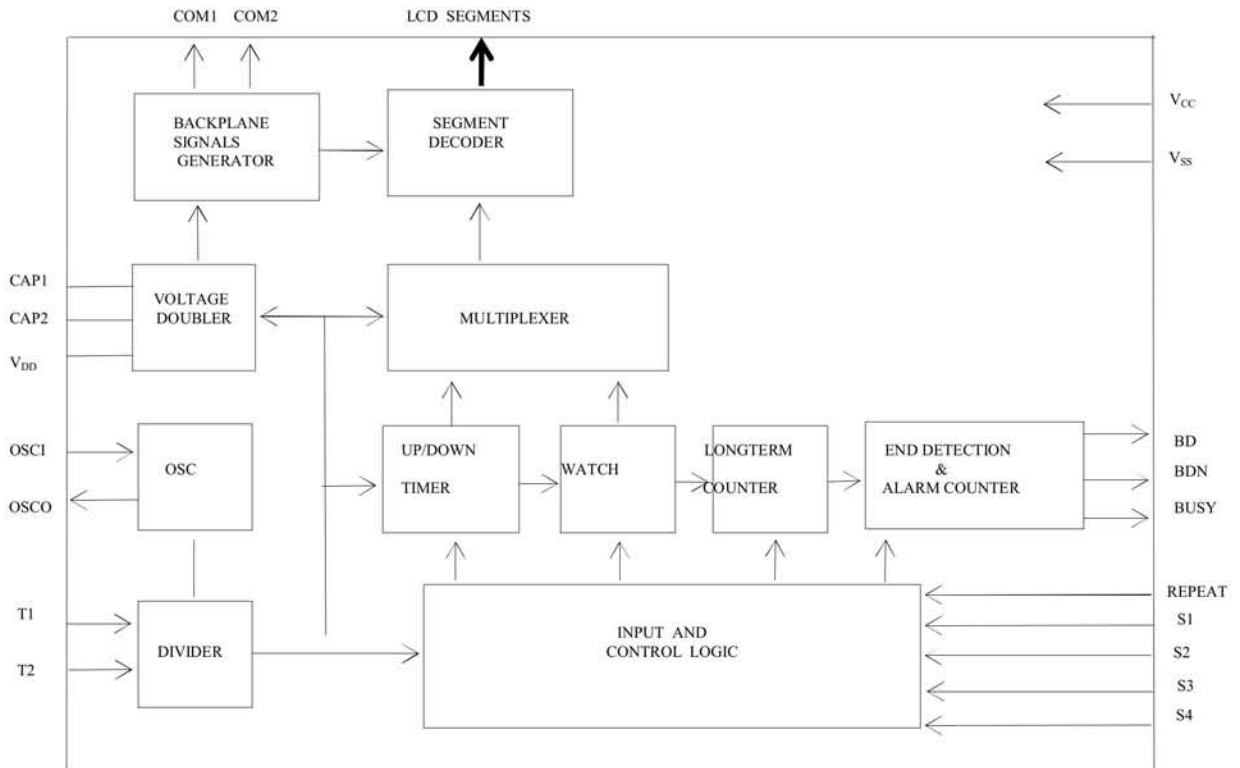
**3. ABSOLUTE MAXIMUM RATINGS (  $T_a = 25^\circ\text{C}$  )**

Characteristic	Symbol	Value	Unit
Supply Voltage	$V_{CC}$	-0.3 ~ 5.0	V
Input Voltage	$V_{IN}$	$V_{SS}-0.3$ to $V_{CC}+0.3$	V
Operating Temperature	$T_A$	-20 ~ + 70	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	- 55 ~ + 125	$^\circ\text{C}$

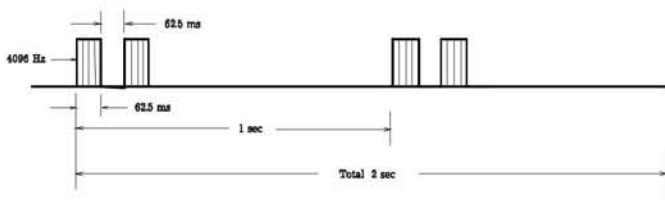
**4. ELECTRICAL CHARACTERISTICS**(  $T_a = 25^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$ ,  $V_{DD} = 1.5\text{V}$ ; unless otherwise specified)

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Voltage	$V_{CC}$		1.25	1.50	1.70	V
Supply Current	$I_{CC}$	No load			2	A
Display Voltage	$V_{DD}$		2.4	3.0	3.4	V
Switch Input Current	$I_{IN}$	$V_{IN} = V_{CC}$	5		50	A
Oscillator Start Voltage	$V_{OSC}$	Within 3 secs	1.35			V
Oscillator Frequency	$F_{OSC}$			32,768		Hz
Frequency Stability	f/f	$V_{CC} = 1.25\text{V} \sim 1.7\text{V}$			10	ppm
Output Drive Current (BD, BDN, BUSY Outputs)	$I_{OH}$	$V_{OH} = 1.35\text{V}$	-500			$\mu\text{A}$
Alarm Output Frequency	$F_{OUT}$			4096		Hz

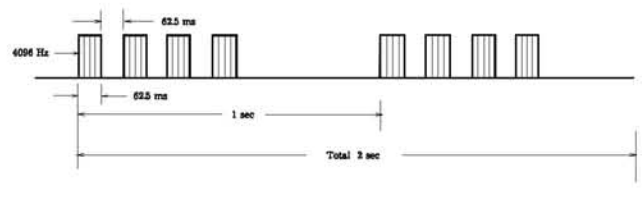
**5. BLOCK DIAGRAM**



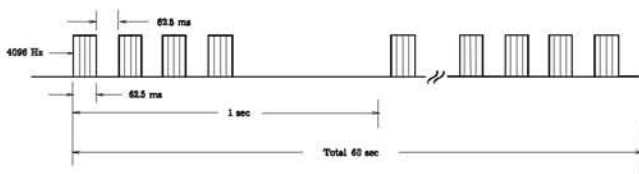
**6. OUTPUT WAVEFORM**



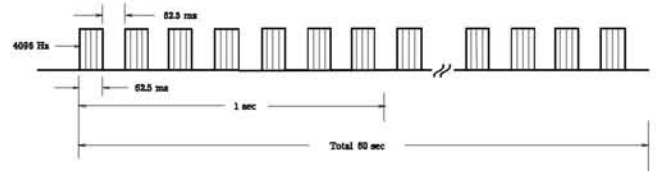
Sends out this signal 10 minutes before the set time is up.



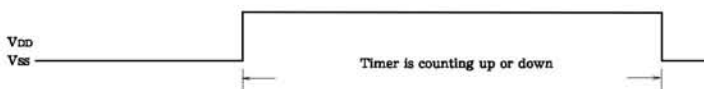
Sends out this signal 5 minutes before the set time is up.



BD output signal will be as this when the count-down reach to zero.



BD output signal will be as this when the longterm. counters reach to zero



Timer BUSY flag output.



## 7. FUNCTIONAL DESCRIPTION

When power is turned on, all the LCD segments are illuminated to display “18:88” and the alarm sounds 2 seconds. Then the circuit automatically moves to the Real Time Setting Mode.

Time is set by the S1 for Hour and S2 for Minute setting. Colon will be on and freeze during the time setting. Depressing S3 will move the circuit to the standard Real Time Mode and Colon will begin to flash (0.5 sec on, 0.5 sec off).

If in Real Time Mode :

- key S3 is depressed more than 5 sec, the circuit will moved to the setting state again.
- press key S1 or S2, the circuit will move to the Timer/Counter Modes.
- depressing S3 will start Count-Up function.
- depressing S1 and S2 will set hour and minute for the Times and then Times will start by key S3.

In the count-down mode, when the time has gone past the set time and the alarm is stopped, the set time will remain at its current state or be reset to 0:00 depending on the bonding of the REPEAT pin to  $V_{CC}$ .

In the timer mode, while the timer is counting, the actual time can be displayed by pressing S1. Once S1 is released, the count-down time will be shown instead.

In the count-up mode, the LCD display is normally in minutes and seconds when the count-up time is less than 20 minutes. If S2 is pressed, the LCD display will revert to hours and minutes and will return to minutes and seconds by releasing S2. The LCD display is normally in hours and minutes when the count-up time is more than 20 minutes. If S2 is pressed, the LCD display will revert to seconds and will return to hours and minutes by releasing S2.

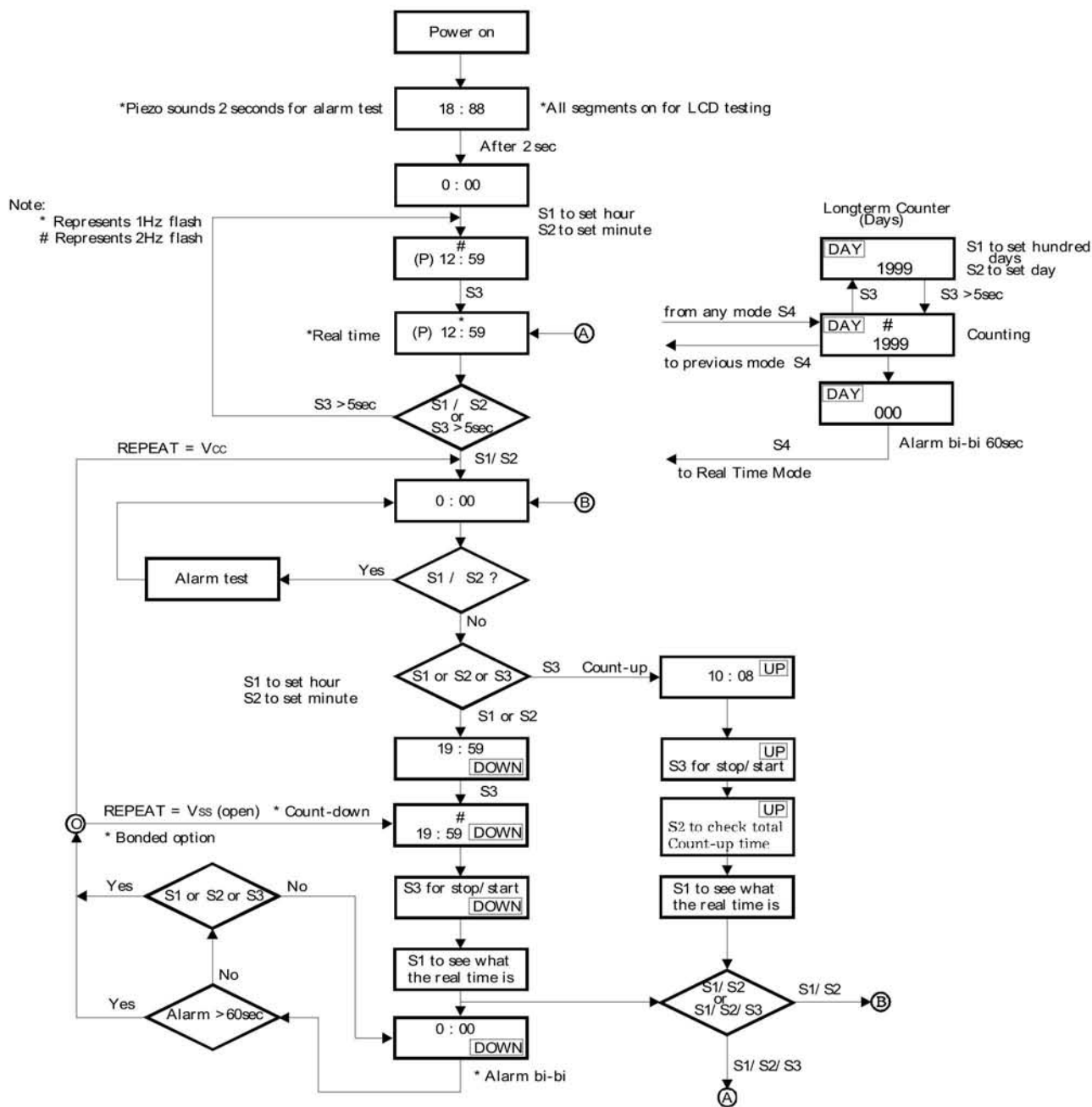
The LCD will display days in the long-term count-down mode if S4 will be pressed. When S4 is pressed again, the LCD will return to previous mode.

In the long-term count-down mode the counter moves in setting region by press S3 more than 5 sec. In the setting region days setting by keys S1 (hundred days) and S2 (days). The counter will return in the long-term count-down mode by pressing S3. Once the set time of the long-term counters is reached, the alarm will sound 60 seconds unless it is stopped by pressing S3.

The timer alarm will sound during the count-down process as listed below:

- 4 sounds are generated at 10 minutes before the set time is up and 8 sounds are generated at 5 minutes before the set time is up.
- Once the set time is reached, the alarm will sound 60 seconds unless it is stopped by users (by pressing S3), in which case the preset time of the timer will remain unchanged or at 0:00 depending on the status of the option pin.
- Pressing any one of the inputs (S1 or S2 or S3) will stop the alarm during the period for which the alarm is sounding.
- At 0:00 in the timer mode, the alarm will sound when S1 and S2 are simultaneously depressed. This is for the alarm test only.
- In Timer mode the LCD will display special icon: “Timer Up”, “Timer Down”. In long-term counter mode the LCD display “Days” icon. In the real time mode can display special symbol “p” for indicate afternoon time.
- In the count-up/down mode the icon “colon” is flashing with frequency 2Hz when timer is counting. The icon “colon” is only displaying when timer is stopped by pressing S3.

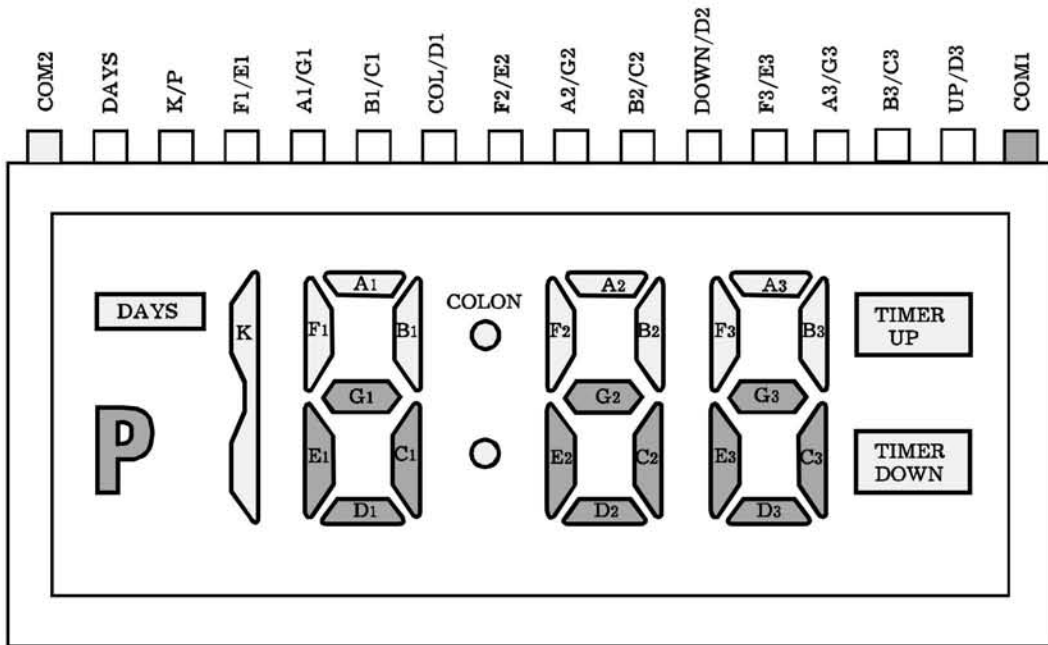
**8. OPERATIONAL FLOW CHART**



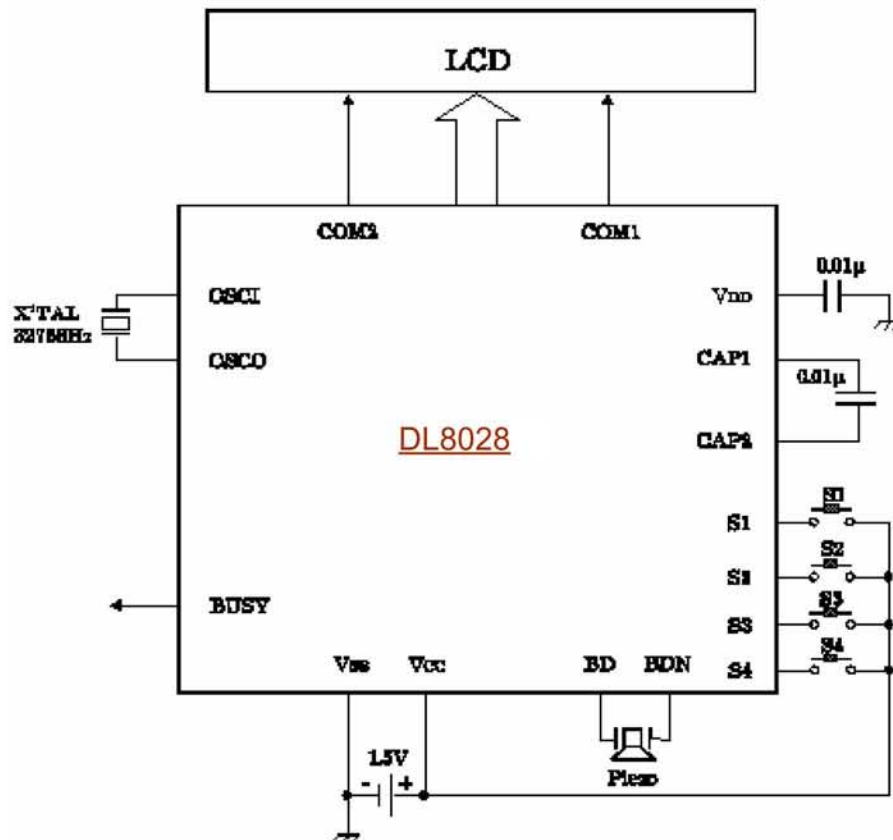
# DL8028

## 三位半正/倒计时, 天数/手表IC

### 9. LCD FORMAT



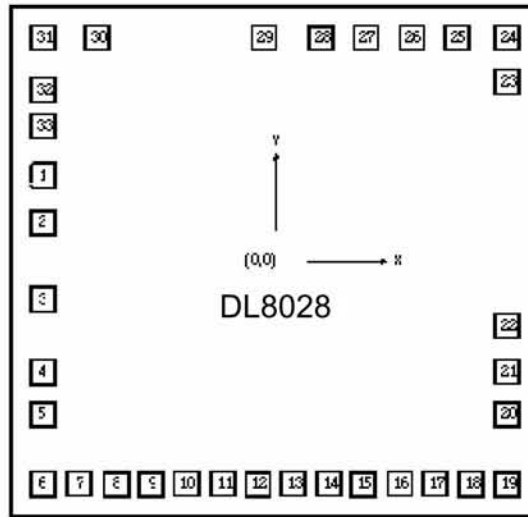
### 10. APPLICATION CIRCUIT



# DL8028

# 三位半正/倒计时, 天数/手表IC

## 11. PAD LAYOUT



Chip size : 2670 x 2590  
 Pad size : 120 x120  
 Unit : μm

## 12. PAD LOCATION

Pad No.	Pad Name	X	Y	Description	Pad No.	Pad Name	X	Y	Description
1	S1	-1175	685	Input for hour setting	18	K/P	995	-1135	Segment drive
2	CAP2	-1175	195	Voltage doubling capacitor	19	DAYS	1175	-1135	Segment drive
3	CAP1	-1175	-190	Voltage doubling capacitor	20	COM2	1175	-785	Common 2 drive
4	V <sub>DD</sub>	-1175	-565	Display Supply	21	OSCI	1175	-565	Oscillator input
5	COM1	-1175	-775	Common 1 drive	22	OSCO	1175	-325	Oscillator output
6	UP/D3	-1175	-1135	Segment drive	23	BUSY	1175	915	Timer busy flag, active high
7	B3/C3	-985	-1135	Segment drive	24	T2	1175	1135	Chip test pin
8	A3/G3	-805	-1135	Segment drive	25	T1	925	1135	Fast-test control pin
9	F3/E3	-625	-1135	Segment drive	26	V <sub>SS</sub>	695	1135	Negative power supply (GND)
10	DOWN/D2	-445	-1135	Segment drive	27	V <sub>CC</sub>	465	1135	Positive power supply
11	B2/C2	-265	-1135	Segment drive	28	REPEAT	235	1135	Option pin for countdown recycle
12	A2/G2	-85	-1135	Segment drive	29	BD	-55	1135	Piezo drive
13	F2/E2	95	-1135	Segment drive	30	BDN	-895	1135	Piezo drive
14	COL/D1	275	-1135	Segment drive	31	S4	-1175	1135	Counter Mode Input
15	B1/C1	455	-1135	Segment drive	32	S3	-1175	875	Start/Stop Input
16	A1/G1	635	-1135	Segment drive	33	S2	-1175	435	Input for minute setting
17	F1/E1	815	-1135	Segment drive					