3·1/2 LCD DISPLAY DIGITAL CLOCK

■ GENERAL DESCRIPTION

The **NJU6351/6354** are 32kHz oscillation 3 1/2 duplex LCD display digital clock LSI with alarm and snooze functions.

It performes 3·1/2 digits hour/minute display and shows other indicators: colon, PM mark, alarm mark, alarm stand-by mark and snooze mark.

NJU6351/6354 realize easy switch operation as they have independent switches of hour and minute setting for present and alarm time, alarm stop, alarm on/off and snooze set.

The difference bitween **NJU6351** and **6354** is only colon blinking, the **NJU6351** is blink and the **NJU6354** is non-blink.

■ PACKAGE OUTLINE

NJU6351C/6354C

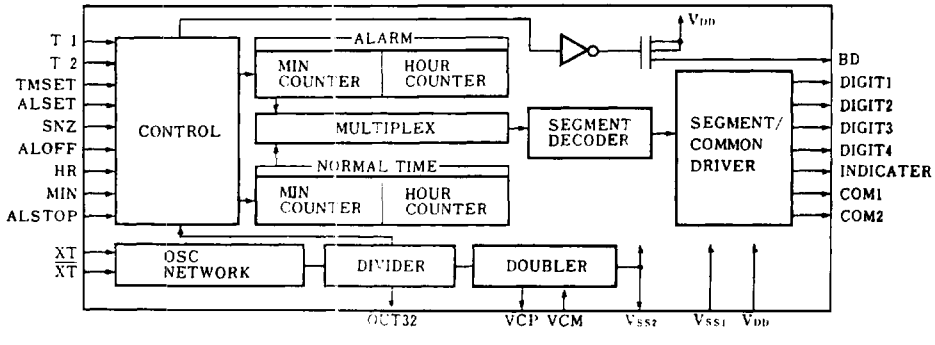
■ FEATURES

- 3 1/2 Hour/Minute Display
- 5 indications :
  Colon, PM Mark, Alarm Mark, Alarm Stand-By Mark, Snooze Mark
- Blink Colon -- **NJU6351**
- Non Blink Colon -- **NJU6354**
- 1/2 Duty LCD Display
- Oscillation Frequency --- 32.768kHz
- Alarm Function
- Alarm Sound Monitor Function
- Snooze Function
- High Voltage Operation Buzzer Output (V_{DD}-12V/2kHz)
- Voltage Doubler On-chip
- Low Operating Current --- 0.8μA typ.
- Operating Voltage --- 1.25V ~ 1.65V
- Package Outline --- CHIP 33
- C-MOS Technology

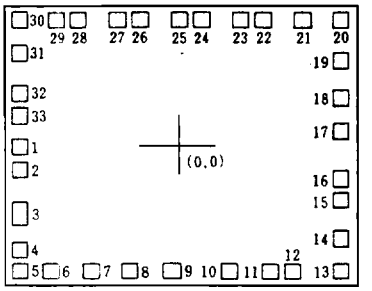
■ LINE-UP TABLE

Type No.	Colon Display
NJU6351	Blink
NJU6354	Non Blink

■ BLOCK DIAGRAM



■ PAD ALLOCATION



CHIP SIZE : 1.87×2.28mm
CHIP THICKNESS : 400μm±30μm

■ PAD COORDINATE

No.	SYMBOL	X	Y	No.	SYMBOL	X	Y	No.	SYMBOL	X	Y
1	V_{DD}	-1041	- 12	12	ALSET	728	-835	23	E4/F4	418	835
2	XT	-1041	-156	13	SNZ	1041	-835	24	C3/B3	160	835
3	$\overline{XT}$	-1041	-450	14	ALOFF	1041	-619	25	G3/AD3	18	835
4	$V_{SS}2$	-1041	-692	15	HR	1041	-361	26	E3/F3	- 240	835
5	$V_{SS}1$	-1041	-835	16	MIN	1041	-219	27	C2/B2	- 382	835
6	OUT32	- 843	-835	17	ALSTOP	1041	95	28	G2/A2	- 640	835
7	T1	- 575	-835	18	BD	1041	311	29	E2/F2	- 783	835
8	T2	- 328	-835	19	D4/ALS	1041	566	30	D2/BC1	-1041	835
9	VCP	- 61	-835	20	ANZ/ALM	1035	835	31	COL/PM	-1041	611
10	VCM	315	-835	21	C4/B4	819	835	32	COM2	-1041	345
11	TMSET	584	-835	22	G4/A4	560	835	33	COM1	-1041	203

■ TERMINAL DESCRIPTION

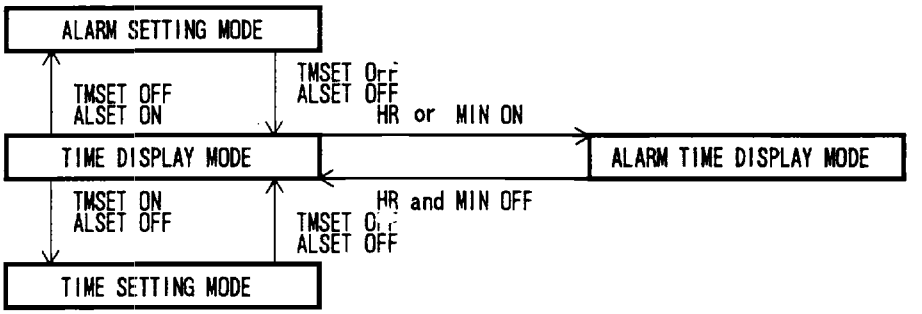
NO.	SYMBOL	F U N C T I O N
1	V_{DD}	Ground
2 3	XT $\overline{XT}$	Quartz Crystal(32.768kHz) Connecting Terminals
4	$V_{SS}2$	LCD Driving Voltage Supplying Terminal (-3V)
5	$V_{SS}1$	Voltage Supply (-1.5V)
6	OUT32	32Hz Frequency Monitor Output Terminal
7 8	T1 T2	Testing Terminals
9 10	VCP VCM	Capacitor for Voltage Doubler Connecting Terminals
11	TMSET	Time-Set Mode Select Input Terminal When the TMSET and ALSET terminals are "H" simultaneously, the LSI test combine with of the HR, MIN and ALSTOP inputs is available.
12	ALSET	Alarm-Time-Set Mode Select Input Terminal When the ALSET and TMSET terminals are "H" simultaneously, the LSI test combine with of the HR, MIN and ALSTOP inputs is available.
13 14	SNZ ALOFF	Alarm Mode Select Input Terminals. Alarm Mode Function is as follows: Alarm Off : When the ALOFF terminal is "H". Alarm Stand-by : When both the ALOFF and SNZ terminals are OPEN. Snooze Stand-by : When the SNZ terminal is "H". Note) In case of the ALOFF and SNZ terminals are "H" simultaneously, only ALOFF is effective.
15	HR	Hour Setting Terminal When the TMSET and ALSET terminals are "H" simultaneously, test for all segments ON is available.
16	MIN	Minute Setting Terminal When the TMSET and ALSET terminals are "H" simultaneously, test for all segments OFF is available.
17	ALSTOP	Enforced stop of Alarm Sound Input Terminal When the TMSET and ALSET terminals are "H" simultaneously, set the time and Alarm Time to be 1:00am.
18	BD	Alarm Output Terminal(Open Drain). Transister driving is available.
19 20 21 22 23 24 25 26 27 28 29 30 31	D4/ALS ANZ/ALM C4/B4 G4/A4 E4/F4 C3/B3 G3/AD3 E3/F3 C2/B2 G2/A2 E2/F2 D2/BC1 COL/PM	LCD Segment Driving Signal Output Terminals
32 33	COM2 COM1	LCD Common Driving Signal Output Terminals

■ FUNCTIONAL DESCRIPTION

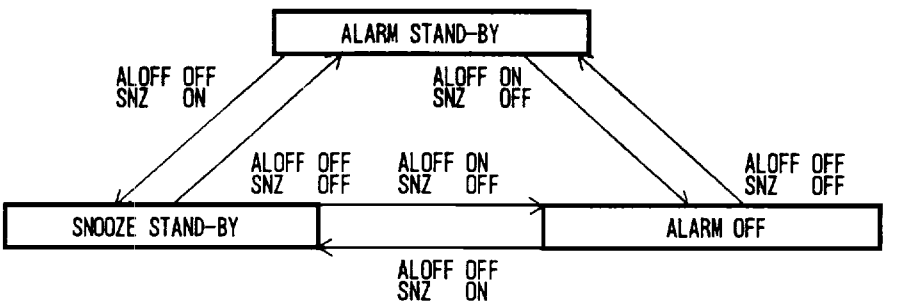
1. Mode Selection

The Time Display Mode and the Time Setting Mode are performed by the switches of the TMSET, ALSET, HR and MIN. And the Alarm Mode is performed by the switches of the ALOFF and SNZ.

• **Display, Setting Mode**

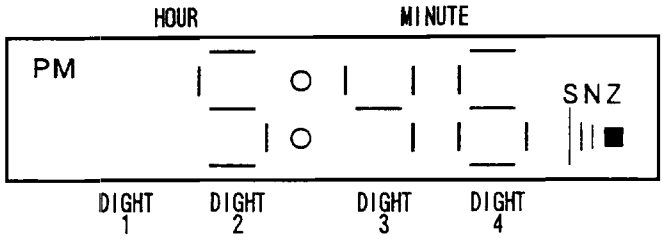


• **Alarm Mode**



2. Time Display Mode

(1) Display



Snooze Stand-By Indicator

Alarm Stand-By Indicator

In this mode, the current time is displayed. If the time is afternoon, the "PM" indicator is also ON. If the HOUR is less than 10, the DIGIT 1 is not dysplaied.

- Colon Display
  NJU6351 ..... Blinking by 1Hz
  NJU6354 ..... Non Blink (Always ON)
- Alarm Standby indicator is ON in all Alarm Mode except Alarm OFF.
- Snooze Standby indicator is ON when Snooze Stand-by is selected, and blinking by 1Hz during snooze function performing.

(2) Switch Operation

- During the HR or MIN switch turn on, the mode is Alarm Time Display Mode and display the preset alarm time.
- During the HR and MIN switch turn on at the same time, the alarm sound is output (only Sound Monitor Funciton activated period). However there are no sound output if the Alarm Off is selected.
- The Alarm Sound can be stopped by ALSTOP switch.

3. Time Setting Mode

(1) Display

Refer to the Time Display Mode.

(2) Switch Operation

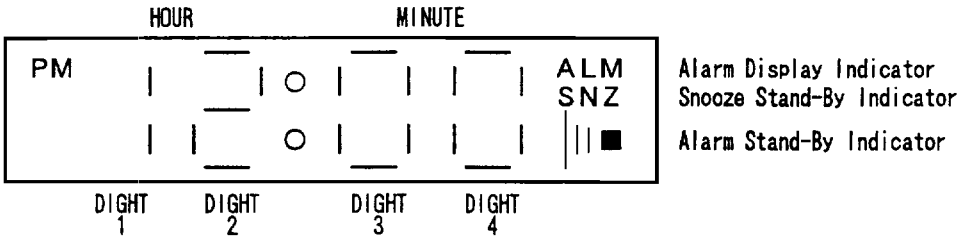
- The Hour Counter is count up 1 when the HR switch is turned on, and the turn on keeps over one or more second, the count up is performed 4 counts per second.
  The display changing as follows:

$$1 : ** \sim 11 : ** \rightarrow {}^{PM}12 : ** \rightarrow {}^{PM}1 : ** \sim {}^{PM}11 : ** \rightarrow 12 : **$$

- The Second Counter is reset to "00" when the MIN switch is terned on, and the turn on keeps over one or more second, the count up is performed 4 counts per second.
  During the MIN switch terns on, the counter stop the operation and starts the count after release the MIN switch.
- The Alarm Sound is stopped by ALSTOP switch.

* There are no carry up from Minute to Hour by the time setting.
* There are no alarm sound output if the setting time coincide with the alarm time.

4. Alarm Time Setting Mode
(1) Display



In this mode, the alarm time is displayed. If the time is afternoon, the "PM" indicator is also ON. If the HOUR is less than 10, the DIGIT 1 is not dysplaied.

- Colon is always ON
- Alarm Display indicator is ON during Alarm Time display.
- Alarm Stand-by and Snooze Stand-by indicator are same operation as Time Display Mode.

(2) Switch Operation

- The Hour Counter is count up 1 when the HR switch is turned on, and the turn on keeps over one or more second, the count up is performed 4 counts per second.
  The display changing as follows:

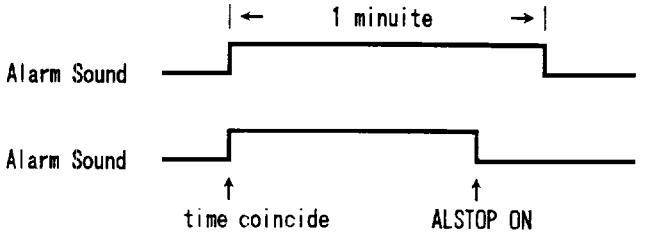
$$1:** \sim 11:** \rightarrow {}^{PM}12:** \rightarrow {}^{PM}1:** \sim {}^{PM}11:** \rightarrow 12:**$$

- The Minute Counter is count up 1 when the MIN switch is turned on, and the turn on keeps over one or more second, the count up is performed 4 counts per second.
- The Alarm Sound is stopped by ALSTOP switch.

* There are no carry up from Minute to Hour by the time setting.
* There are no alarm sound output if the setting time coincide with the alarm time.

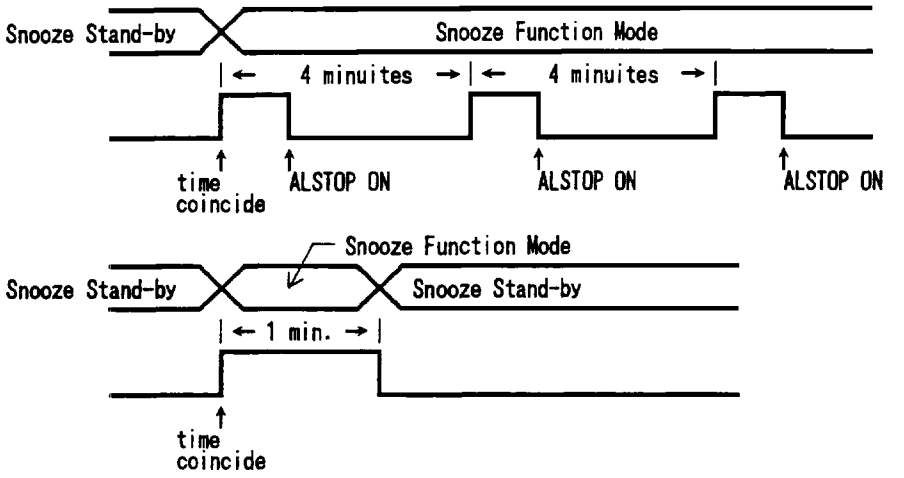
5. Alarm Mode

- The alarm sound output when the present time coincide with the alarm time in Alarm Stand-By Mode. The alarm sound output during 1 minute and stops automatically. It can be half-stopped by ALSTOP switch.



* Alarm function is available for all Display and Setting Mode.
* If the Mode of Display, Setting and Alarm are changed, the alarm sound is stopped.

- In the Snooze Stand-by Mode, the alarm sound output when present time coincide with the alarm time. In this time the snooze standby indicator blinks by 1Hz. The Alarm sound can be stopped by ALSTOP switch, however the alarm sound output again after 4 minutes past. If ALSTOP switch is not operated, the alarm sound stops automatically after one minute past and Snooze function is also released.

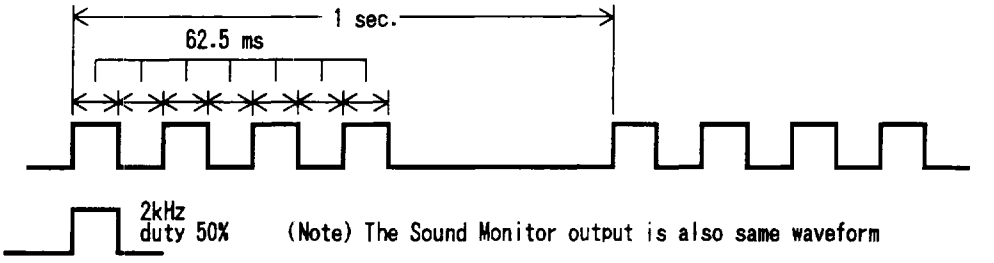


* Snooze function is operated for all Display and Setting Mode.
* Snooze function is released when the Mode of Display, Setting and Alarm are changed.

6. Sound Monitor Function

During the HR and MIN switches turn on at same time, the alarm sound is output. However, if the Alarm Off is selected, no sound output.

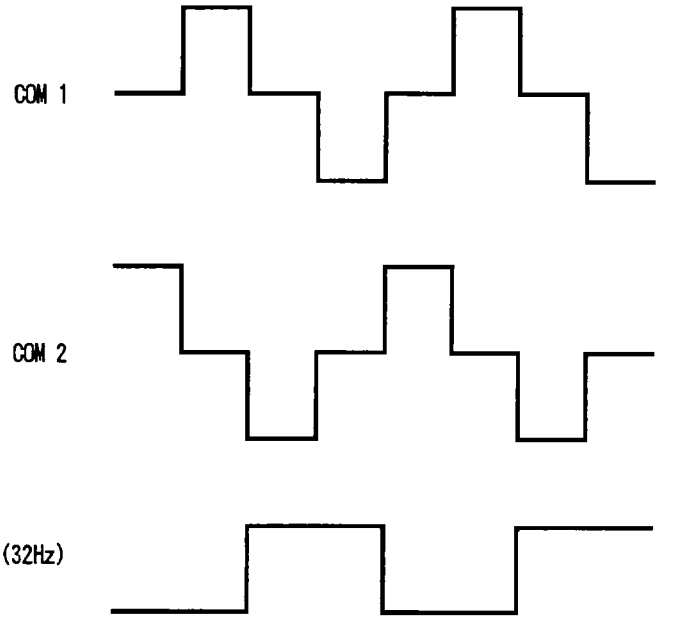
7. Alarm Sound Output Waveform



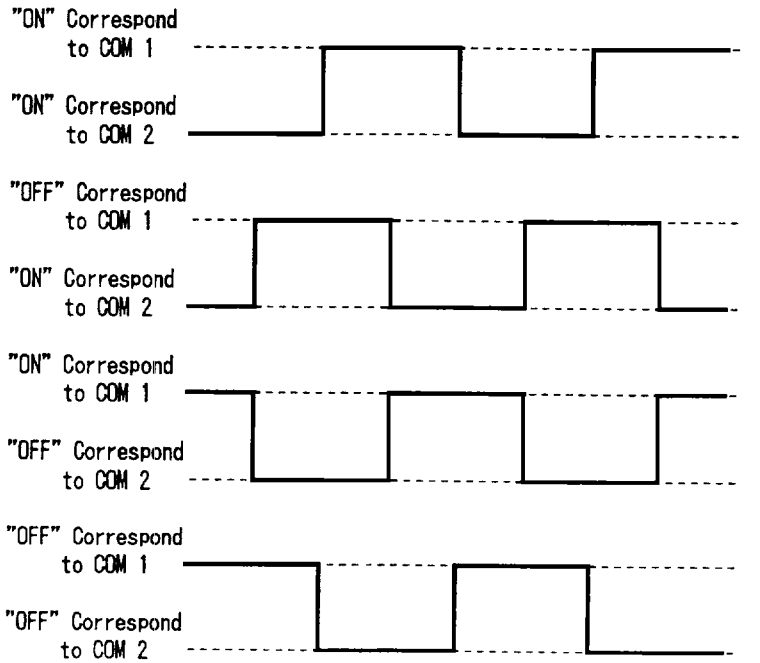
(Note) The Sound Monitor output is also same waveform

8. LCD Driving Waveform

• Common Output



• Segment Output



■ ABSOLUTE MAXIMUM RATINGS

(Ta=25℃)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage (1)	V_{SS1}	- 2.0 ～ + 0.3	V
Supply Voltage (2)	V_{SS2}	- 4.0 ～ + 0.3	V
Input Voltage	V_{IN}	V_{SS1}-0.3 ～ V_{DD}+0.3	V
Output Voltage of V_{SS1}	V_{OUT1}	V_{SS1}-0.3 ～ V_{DD}+0.3	V
Output Voltage of V_{SS2}	V_{OUT2}	V_{SS2}-0.3 ～ V_{DD}+0.3	V
BD Terminal Output Voltage	V_{BD}	V_{DD} - 15 (TYP)	V
Operating Temperature	Topr	- 20 ～ + 75	℃
Storage Temperature	Tstg	- 55 ～ + 125	℃

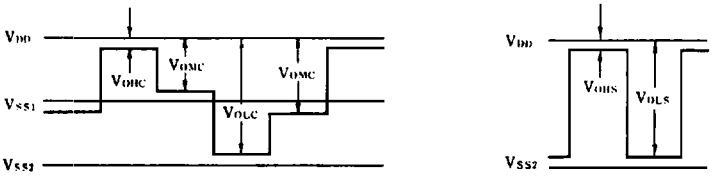
■ ELECTRICAL CHARACTERISTICS

DC Characteristics

(Ta=25℃, V_{DD}=0V, V_{SS1}=-1.55V, V_{SS2}=-3V)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT
Operating Voltage(1)	V_{SS1}			- 1.25	- 1.55	- 1.65	V
Operating Voltage(2)	V_{SS2}	V_{SS1}=-1.25～-1.65V		- 2.3	- 3.0	- 3.3	V
Operating Current	I_{DD1}	C1,C2=0.1μF			0.8	1.6	μA
Osc. Start Voltage	V_{OSC}	Within 10 seconds		- 1.4			V
Osc. Hold Voltage	V_{HLD}			- 1.2			V
Oscillation Capacitor	C_D				20		pF
Doubler Output Voltage	V_{DBL}	V_{SS1}=-1.25V, R_L=3MΩ		- 2.3			V
Input Voltage	V_{IL} V_{IH}			V_{SS1}+0.3 0		V_{SS1} - 0.3	V
Input Current 1	I_{IL1} I_{IH1}	HR, MIN, ALSTP	V_{IL}=-1.55V V_{IH}=0V	- 200 1	15	100	nA μA
Input Current 2	I_{IL2} I_{IH2}	TM, ALSET, ALOFF, SNZ		- 200 1	15	100	nA μA
Input Current 3	I_{IL3} I_{IH3}	T1, T2		- 200 1	15	100	nA μA
COM Output Voltage	V_{OLC} V_{OMC} V_{OHC}	I_{OLC}=1μA I_{OMC}=±1μA I_{OHC}=-1μA		V_{SS1}-0.05 - 0.05	V_{SS1}	V_{SS2}+0.05 V_{SS1}+0.05	V
COM Output Current	I_{OLC} I_{OMC} I_{OHC}	V_{OLC}=V_{SS2}+0.2V V_{OMC}=V_{SS1}±0.2V V_{OHC}=-0.2V		4 4		- 4 - 4	V
SEG Output Voltage	V_{OLS} V_{OHS}	I_{OHS}=0.1μA I_{OLS}=-0.1μA		- 0.05		V_{SS2}+0.05	V
SEG Output Current	I_{OLS} I_{OHS}	V_{OLS}=V_{SS2}+0.2V V_{OHS}=-0.2V		0.4		- 0.4	μA
Buzzer Output Voltage	V_{OLB} V_{OHB}	I_{OLB}=-5μA I_{OHB}=-2.5mA		- 12		- 3.0	V
Buzzer Output Current	I_{OLB} I_{OHB}	V_{OLB}=-12V V_{OHB}=-3.0V		- 2.5		- 5	uA

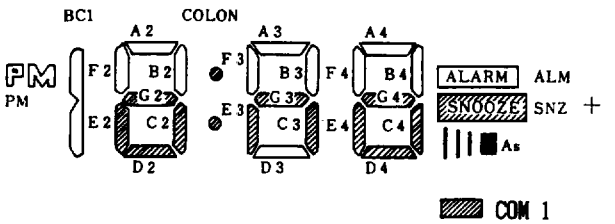
* Specified value are in sampling mode(The smapling frequency is 16Hz). Except the sampling mode, the pull-down resistance is released.



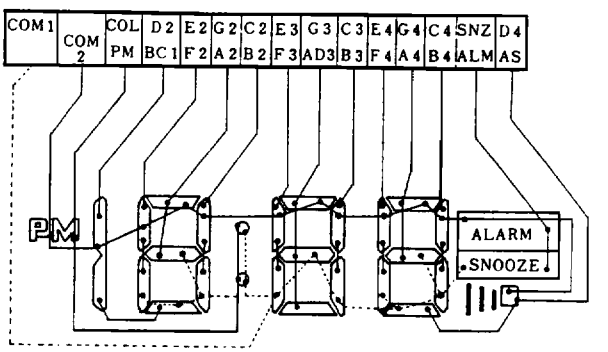
AC Characteristics (Ta=25℃, V_{DD}=0V, V_{SS1}=-1.5V, V_{SS2}=-3V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Oscillation Frequency	f_{OSC}	C_G=C_D=20pF		32.768		kHz
DC-DC Convert Freq.	f_{CNV}	C1, C2 = 0.1μF		512		Hz
LCD Frequency	f_{LCD}			32		Hz
Rise Time	t_{TLH}	C_L=100pF			5	μs
Fall Time	t_{THL}	C_L=100pF			5	μs
Switching Chatter Free Time	t_{ct}				65	ms

LCD SEGMENT ASSIGNMENT



LCD FORMAT



■ APPLICATION CIRCUITS