

Patent Number: 84545 (R.O.C.)

Patent Pending: 08/214, 079 (U.S.A.)

### Features

- Operating voltage: 1.2V~1.7V
- Low operating current: 4 $\mu$ A typ.
- Dialing number and conversation time display
- Conversation timer (59 mins and 59 secs max.)
- 12 or 16 digits LCD display driver; 3V, 1/2 bias, 1/3 duty
- Real time clock
- Stop watch
- Built-in dialer interface
- 12-hour or 24-hour format
- Two-button sequential operation for real time clock setting
- Uses 32768Hz crystal

### Applications

- Timers, clocks and watches
- LCD display drivers
- Telephone display interface
- Instrument display

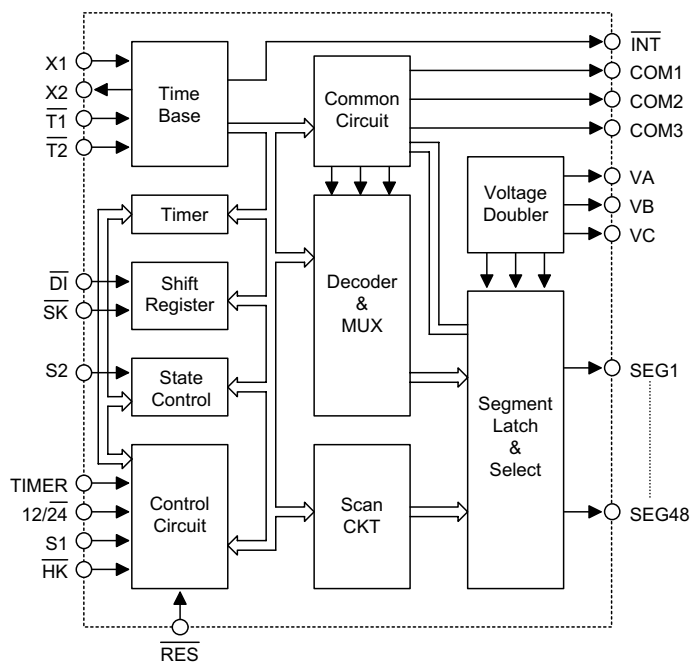
### General Description

The HT1616C is a CMOS chip designed for dialer interfaces driving 12 or 16-digit LCDs. Various functions, such as real time clock, dialing number and conversation time display are provided.

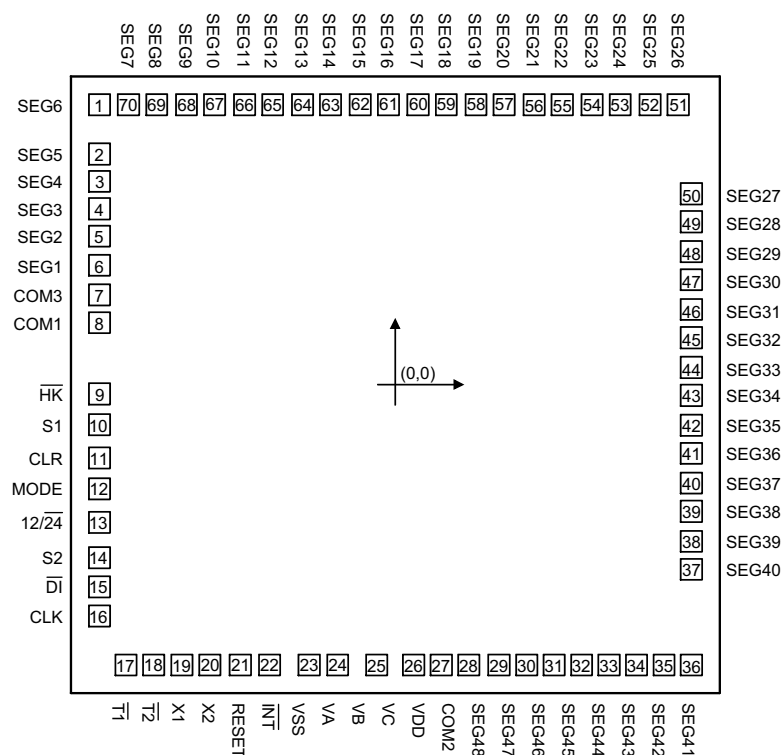
For HT1616C the real time is displayed by default. When answering a telephone call, the timer is activated to tell users how long the conversation has taken. After the telephone is hung up, the total conversation time is

shown for about 5 seconds and the real time is displayed again. When making a phone call, the HT1616C receives dialing data from the dialer and displays the phone number from left to right on the LCD. However, if there is no dialing action within 10 seconds, it restarts the timer again. By adding a TIMER key, the IC can provide stopwatch and timer reset/hold functions. Refer to the functional description for details.

### Block Diagram



## Pad Assignment



Chip size: 140.1 × 137.2 (mil)<sup>2</sup>

\* The IC substrate should be connected to VDD in the PCB layout artwork.

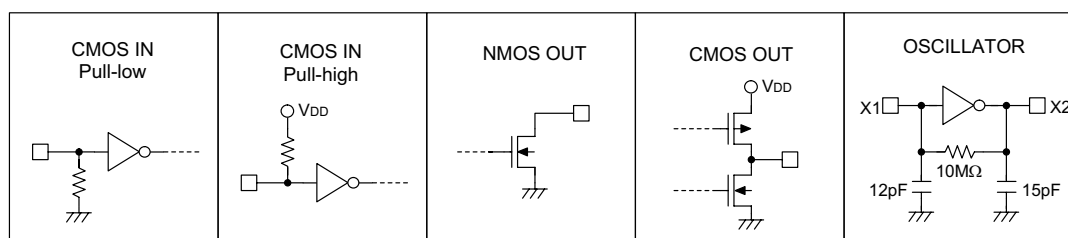
## Pad Coordinates

Unit: mil

Pad No.	X	Y	Pad No.	X	Y	Pad No.	X	Y
1	-64.47	61.01	25	-4.11	-61.01	49	64.47	35.53
2	-64.47	50.26	26	4.03	-61.01	50	64.47	41.65
3	-64.47	44.29	27	10.00	-61.01	51	61.60	61.01
4	-64.47	38.33	28	16.01	-61.01	52	55.48	61.01
5	-64.47	32.36	29	22.59	-61.01	53	48.98	61.01
6	-64.47	26.01	30	28.63	-61.01	54	42.86	61.01
7	-64.47	19.55	31	34.63	-61.01	55	36.36	61.01
8	-64.47	13.50	32	40.60	-61.01	56	30.25	61.01
9	-64.47	-2.03	33	46.57	-61.01	57	23.73	61.01
10	-64.47	-8.72	34	52.54	-61.01	58	17.61	61.01
11	-64.47	-15.99	35	58.50	-61.01	59	11.11	61.01
12	-64.47	-22.68	36	64.47	-61.01	60	4.99	61.01
13	-64.47	-29.99	37	64.47	-40.20	61	-1.51	61.01
14	-64.47	-37.67	38	64.47	-34.08	62	-7.63	61.01
15	-64.47	-43.99	39	64.47	-27.58	63	-14.13	61.01
16	-64.47	-50.37	40	64.47	-21.46	64	-20.25	61.01
17	-58.69	-61.01	41	64.47	-14.95	65	-26.75	61.01
18	-52.65	-61.01	42	64.47	-8.84	66	-32.88	61.01
19	-46.53	-61.01	43	64.47	-2.33	67	-39.38	61.01
20	-40.41	-61.01	44	64.47	3.79	68	-45.50	61.01
21	-33.79	-61.01	45	64.47	10.29	69	-52.00	61.01
22	-27.41	-61.01	46	64.47	16.41	70	-58.12	61.01
23	-18.80	-61.01	47	64.47	22.91			
24	-12.60	-61.01	48	64.47	29.03			

**Pad Description**

Pad Name	I/O	Internal Connection	Description
SEG1~SEG48	O	CMOS OUT	LCD segment signal output pads
COM1~COM3	O	CMOS OUT	LCD common signal output pads
$\overline{HK}$	I	CMOS IN Pull-high	Hook switch detector input
S1	I	CMOS IN Pull-low	Clock setting switch Hour or minute can be selected for S2 adjustment
$\overline{RES}$	I	CMOS IN Pull-high	System initialization pin, active low The pull-high resistance is 200k $\Omega$ typ.
MODE	I	CMOS IN Pull-low	4 or 5 bits pattern selection pad VDD: 5 bits pattern Floating: 4 bits pattern
12/24	I	CMOS IN Pull-low	12-hour or 24-hour format option pad VDD: 12-hour format Floating: 24-hour format
S2	I	CMOS IN Pull-low	Clock adjusting switch Hour or minute digits can be adjusted depending upon the S1 selection
$\overline{DI}$	I	CMOS IN Pull-high	Serial data input pad Data should be valid at the falling edge of $\overline{SK}$ (connected to the dialer)
$\overline{SK}$	I	CMOS IN Pull-high	Clock input pad (connected to the dialer), active low Input data is latched at the falling edge of SK
$\overline{T1}$	I	CMOS IN Pull-high	Test pad (connected to VSS for production test)
$\overline{T2}$	I	CMOS IN Pull-high	Test pad (connected to VSS for production test)
X1	I	OSCILLATOR	32768Hz crystal oscillator input
X2	O		32768Hz crystal oscillator output
TIMER	I	CMOS IN Pull-low	Timer reset-and-start/hold toggle control input pad
$\overline{INT}$	O	NMOS OUT	Interrupt output, 16Hz (default) or 2Hz (by mask option)
VA	O	CMOS OUT	Voltage doubler, connected to the external capacitor
VB	O	CMOS OUT	Voltage doubler, connected to the external capacitor
VC	O	CMOS OUT	Voltage doubler, connected to the external capacitor
VDD	—	—	Positive power supply
VSS	—	—	Negative power supply, ground

**Approximate internal connection circuits**


## Absolute Maximum Ratings

Supply Voltage .....	-0.3V to 5V	Storage Temperature .....	-50°C to 125°C
Input Voltage .....	$V_{SS}-0.3V$ to $V_{DD}+0.3V$	Operating Temperature .....	-20°C to 75°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

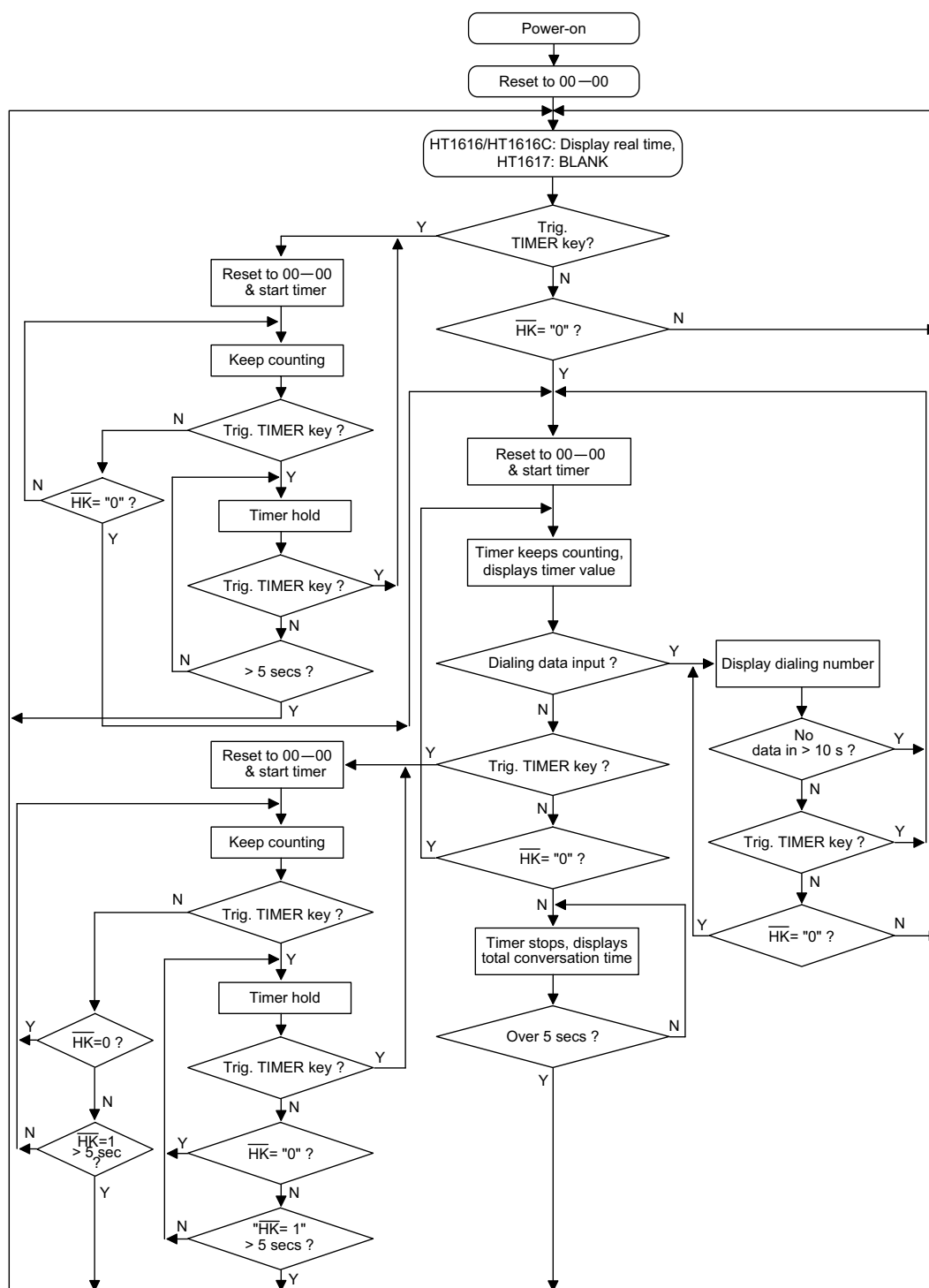
## Electrical Characteristics

 $f_{OSC}=32768Hz$ ,  $T_a=25^{\circ}C$ 

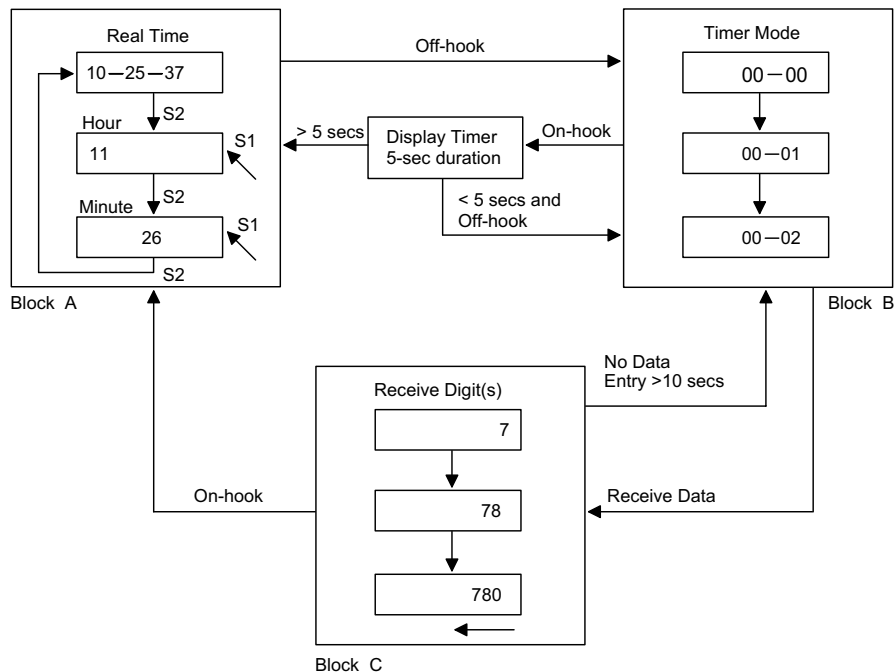
Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		$V_{DD}$	Conditions				
$V_{DD}$	Operating Voltage	—	—	1.2	1.5	1.7	V
$V_{IL}$	Input Low Voltage	—	—	$V_{SS}$	—	$0.2V_{DD}$	V
$V_{IH}$	Input High Voltage	—	—	$0.8V_{DD}$	—	$V_{DD}$	
$I_{STB}$	Standby Current	1.5V	$V_{HK}=\text{Floating (or } V_{DD})$	—	0.1	1	$\mu A$
$I_{DD}$	Operating Current	1.5V	No load	—	4	10	$\mu A$
$I_{OL}$	Output Sink Current of $\overline{INT}$	1.5V	$V_O=0.3V$	500	1000	—	$\mu A$
$t_A$	Data Setup Time	1.5V	—	1	—	—	$\mu s$
$t_B$	Data Hold On Time	1.5V	—	2	—	—	$\mu s$
$t_C$	Inter Digit Time	1.5V	—	5	—	—	$\mu s$
$t_{DB}$	Input Debounce Time (S1, S2, TIMER)	1.5V	—	—	31.25	—	ms
$R_{HI}$	Pull-high Resistance ( $\overline{HK}$ , $\overline{DI}$ , $\overline{SK}$ )	1.5V	$V_{IN}=0V$	—	1	—	$M\Omega$
$R_{LO}$	Pull-low Resistance (TIMER)	1.5V	$V_{TIMER}=1.5V$	—	5	—	$M\Omega$
$f_{OSC}$	System Frequency	1.5V	Crystal=32768Hz	—	32768	—	Hz

## Functional Description

### Operational flow chart



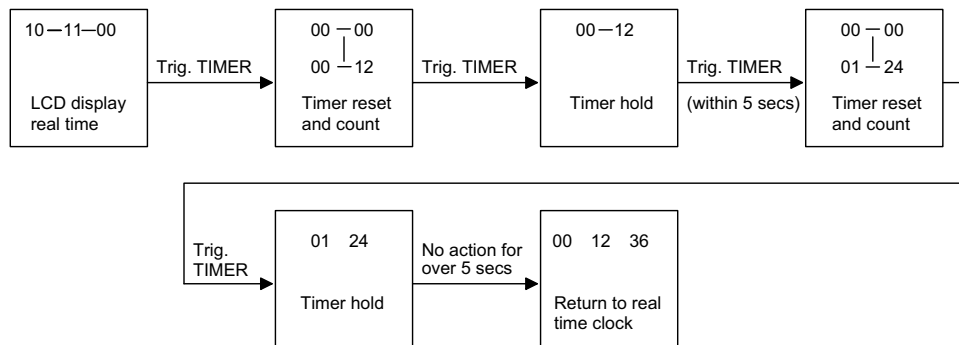
### On-hook & Off-hook



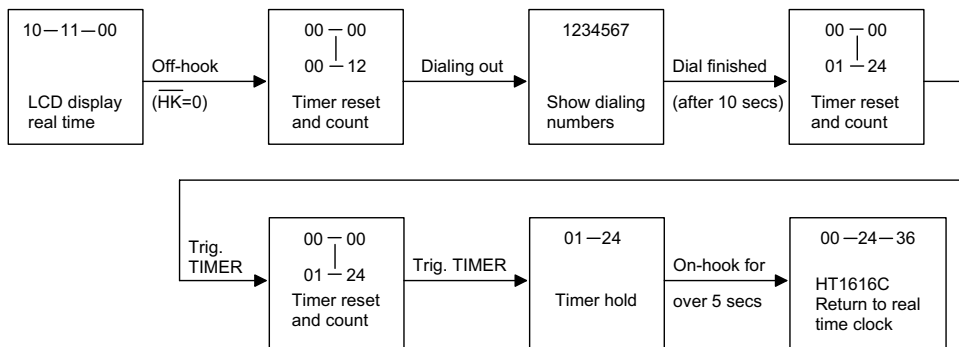
Note: Block A shows the switches S1 and S2 that are used for setting and selecting.  
 Block B illustrates a timer mode when Off-hook; timer resets and starts to count the conversation time.  
 Block C displays blinking "—". After Off-hook, dialing data is received and displayed on the LCD from left to right.  
 When the entry interval is over 10 seconds, the timer resets and starts to count.

### TIMER key function

The TIMER key is used to start/stop the timer (toggle). In real time mode, it can perform a stop- watch function.



In the conversation timer mode, it can reset or hold the timer.



**Data & Timing**

- For telephone application

The HT1616C is designed to display telephone numbers derived from the HT93XXX series telephone dialer ICs. When the MODE pad is connected to VSS, the corresponding data is illustrated in the following table (MODE=0).

Key-In	Data Code				Display
	b3	b2	b1	b0	
Blank	0	0	0	0	Blank
1	0	0	0	1	1
2	0	0	1	0	2
3	0	0	1	1	3
4	0	1	0	0	4
5	0	1	0	1	5
6	0	1	1	0	6
7	0	1	1	1	7
8	1	0	0	0	8
9	1	0	0	1	9
0	1	0	1	0	0
*	1	1	0	1	*
#	1	1	0	0	#
F	1	0	1	1	F
P	1	1	1	0	P
	1	1	1	1	-

- For instrument or  $\mu$ C application

The HT1616C is also capable of displaying BCD data generated from instrument or a  $\mu$ C system. The corresponding data and timing is shown in the Data Latch Timing diagram. Before the data is transmitted to the HT1616C, the  $\overline{HK}$  pin should be pulled-low or continuously kept low. The HT1616C is then ready to receive the data. At the falling edge of the clock the data is shifted in to the IC. After all the data is sent to the HT1616C, the  $\overline{SK}$  pin is set low to avoid switching to the timer mode.

When the MODE pad is connected to "Low", the data code and display patterns are shown in the following table:

Data Code				Display
b3	b2	b1	b0	
0	0	0	0	Blank
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	0
1	1	0	1	*
1	1	0	0	#
1	0	1	1	F
1	1	1	0	P
1	1	1	1	-

On the other hand, when MODE pad is connected to "High" the data code and display patterns are shown in the following table:

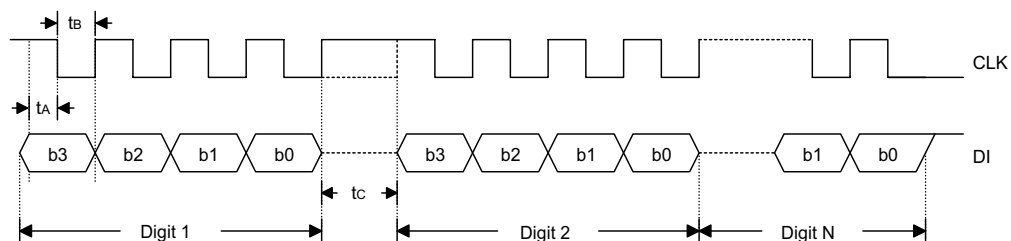
(MODE=1)

Data Code					Display
b4	b3	b2	b1	b0	
0	0	0	0	0	Blank
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	0
0	1	1	0	1	r
0	1	1	0	0	l
0	1	0	1	1	F
0	1	1	1	0	P
0	1	1	1	1	-

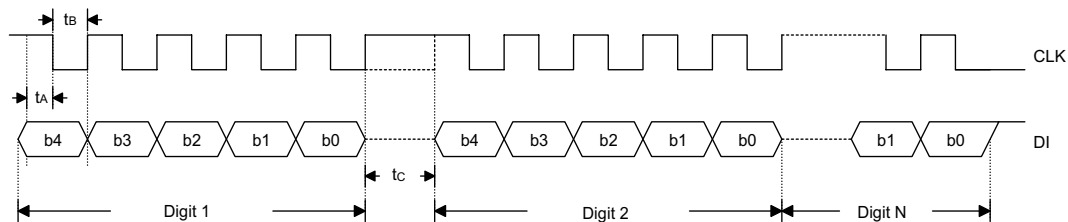
(MODE=1)

Data Code					Display
b4	b3	b2	b1	b0	
1	0	0	0	0	A
1	0	0	0	1	b
1	0	0	1	0	C
1	0	0	1	1	d
1	0	1	0	0	E
1	0	1	0	1	h
1	0	1	1	0	H
1	0	1	1	1	L
1	1	0	0	0	o
1	1	0	0	1	q
1	1	0	1	0	r
1	1	1	0	1	u
1	1	1	0	0	U
1	1	0	1	1	y
1	1	1	1	0	r
1	1	1	1	1	7

- Data latch timing for 4-bit pattern (MODE=0)



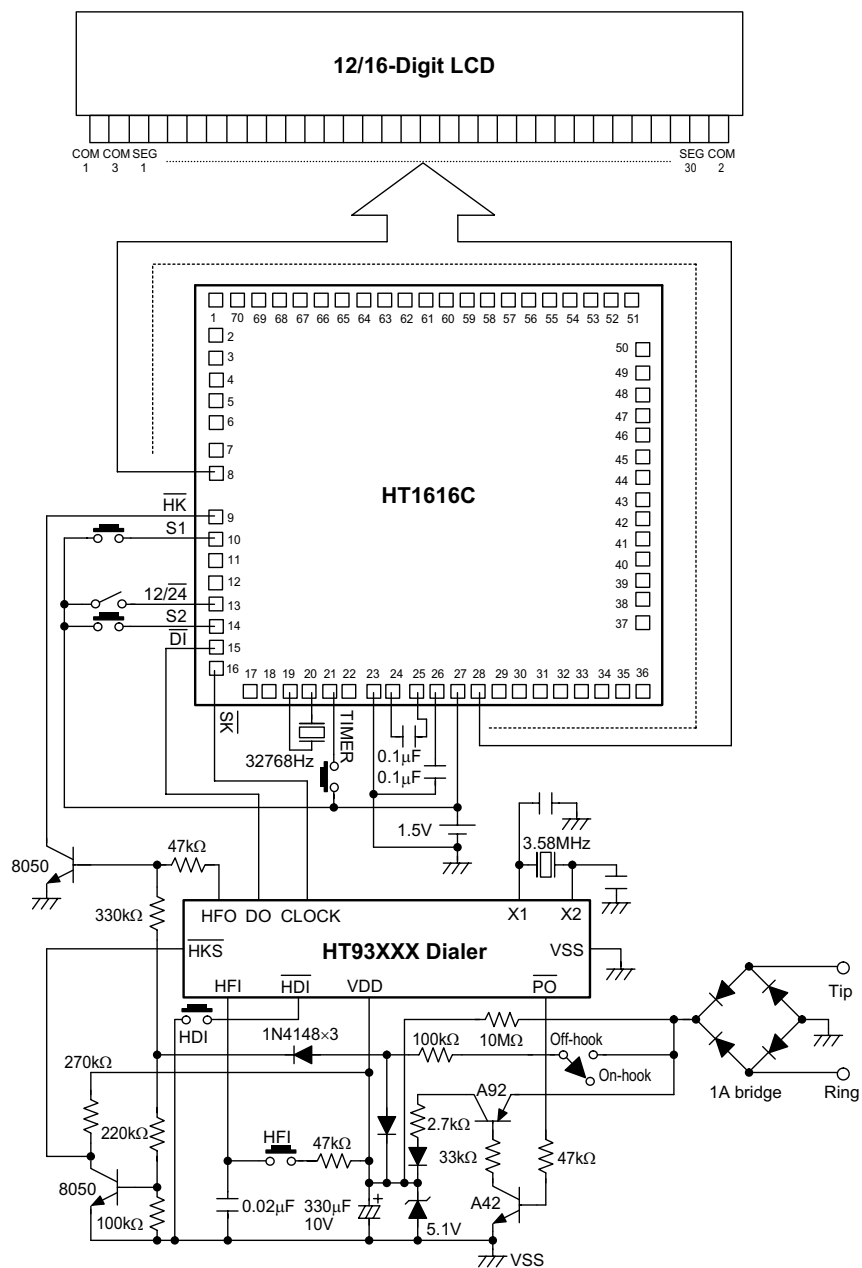
- Data latch timing for 5-bit pattern (MODE=1)





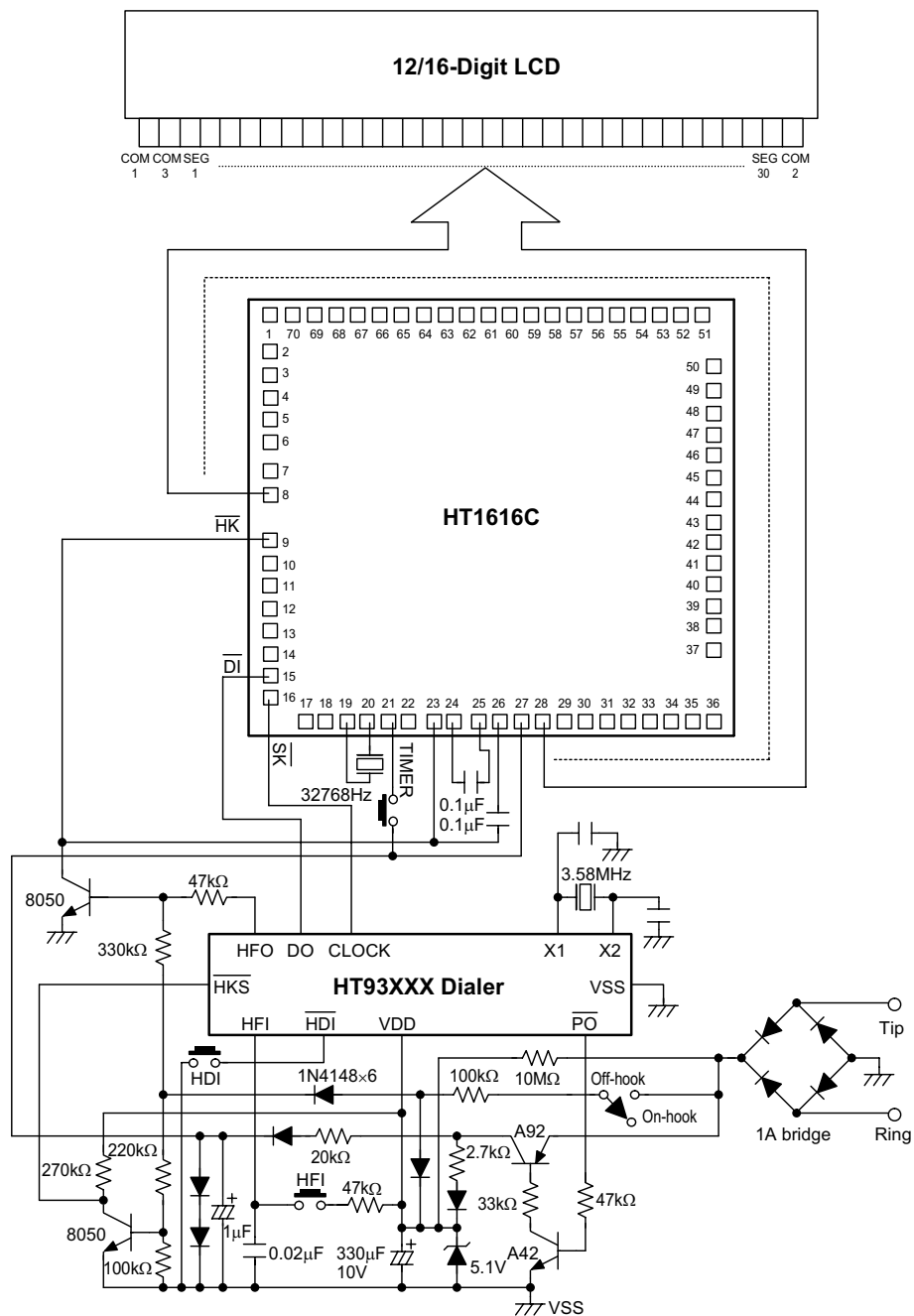
## Application Circuits

For telephone interfacing (with batteries)



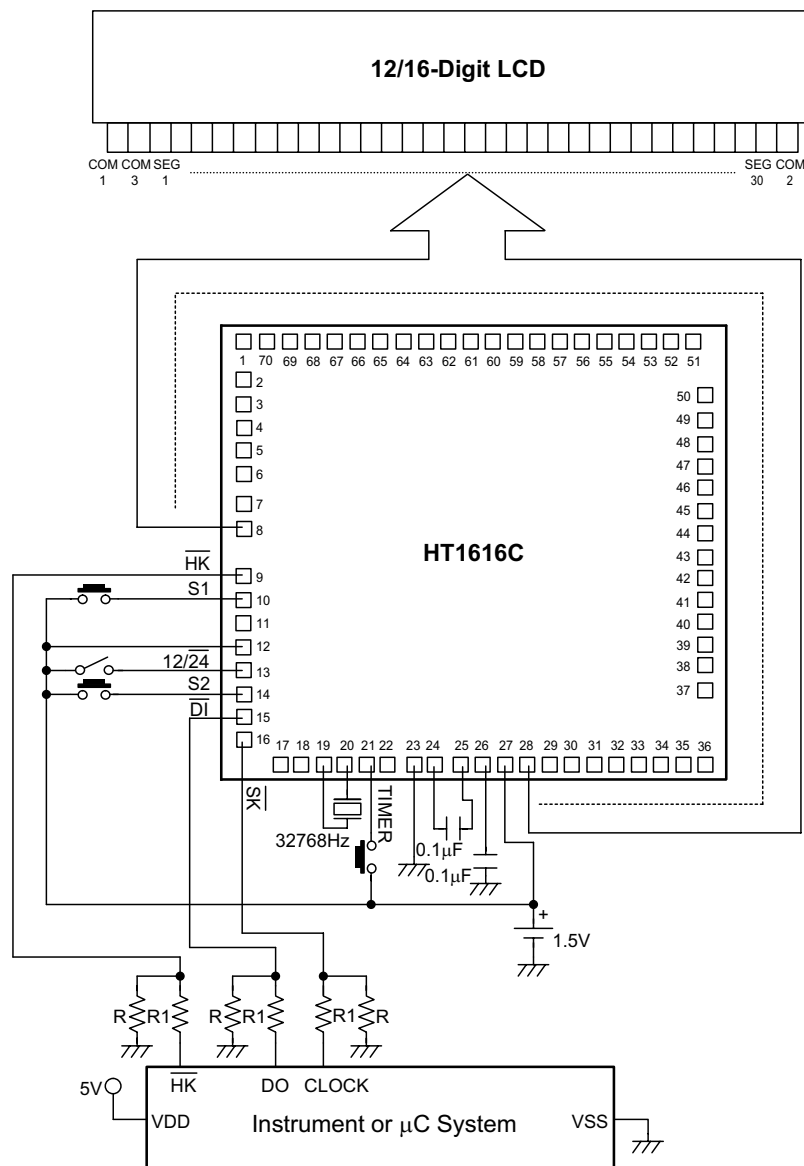
\* The IC substrate should be connected to VDD in the PCB layout artwork.

For telephone interfacing (without batteries)



\* The IC substrate should be connected to VDD in the PCB layout artwork.

For instrument or  $\mu$ C use



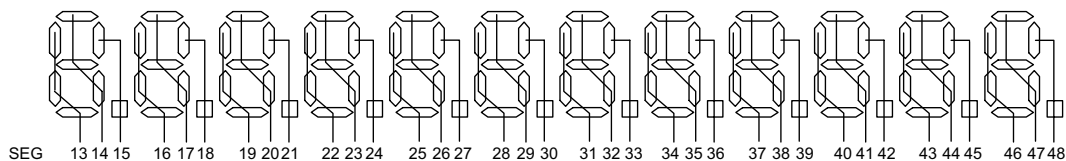
\* The IC substrate should be connected to VDD in the PCB layout artwork.

Note: To drive  $\overline{SK}$ ,  $\overline{DI}$  and  $\overline{HK}$ , an open drain NMOS output structure is recommended.  
To drive  $\overline{SK}$ ,  $\overline{DI}$  and  $\overline{HK}$  with a CMOS output structure, a voltage divider is needed ( $R=4.3k\Omega$ ,  $R1=10k\Omega$ ).

## LCD Configurations

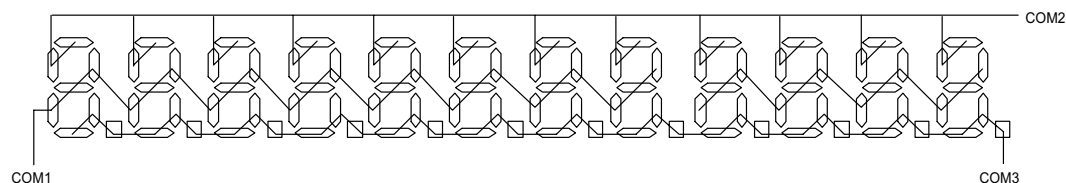
### For 12-digit application

- Segment electrode side

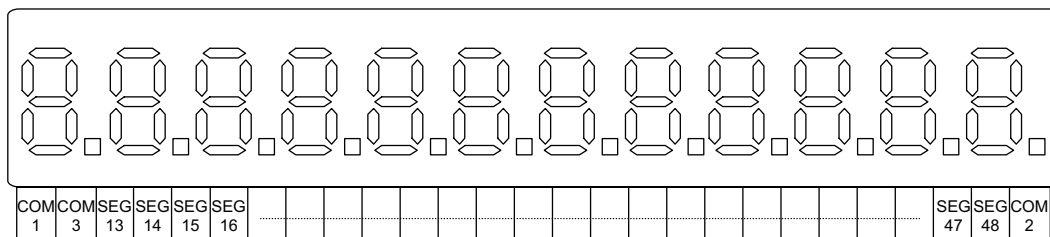


LCD driving system 1/2 bias, 1/3 duty, 3V

- Common electrode side

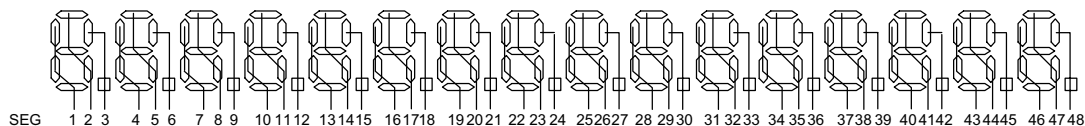


- LCD connection



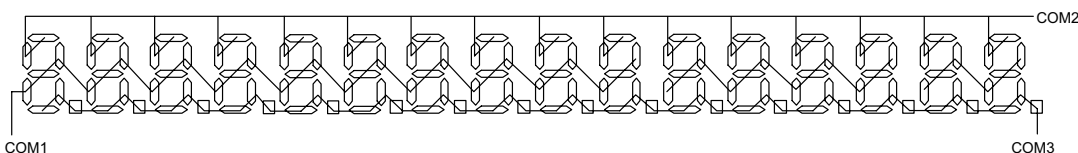
### For 16-digit application

- Segment electrode side

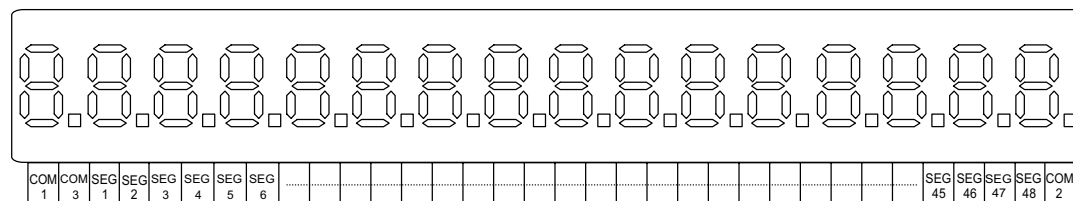


LCD driving system 1/2 bias, 1/3 duty, 3V

- Common electrode side



- LCD connection



**Holtek Semiconductor Inc. (Headquarters)**

No.3, Creation Rd. II, Science Park, Hsinchu, Taiwan  
Tel: 886-3-563-1999  
Fax: 886-3-563-1189  
<http://www.holtek.com.tw>

**Holtek Semiconductor Inc. (Taipei Sales Office)**

4F-2, No. 3-2, YuanQu St., Nankang Software Park, Taipei 115, Taiwan  
Tel: 886-2-2655-7070  
Fax: 886-2-2655-7373  
Fax: 886-2-2655-7383 (International sales hotline)

**Holtek Semiconductor Inc. (Shanghai Sales Office)**

7th Floor, Building 2, No.889, Yi Shan Rd., Shanghai, China 200233  
Tel: 021-6485-5560  
Fax: 021-6485-0313  
<http://www.holtek.com.cn>

**Holtek Semiconductor Inc. (Shenzhen Sales Office)**

43F, SEG Plaza, Shen Nan Zhong Road, Shenzhen, China 518031  
Tel: 0755-8346-5589  
Fax: 0755-8346-5590  
ISDN: 0755-8346-5591

**Holtek Semiconductor Inc. (Beijing Sales Office)**

Suite 1721, Jinyu Tower, A129 West Xuan Wu Men Street, Xicheng District, Beijing, China 100031  
Tel: 010-6641-0030, 6641-7751, 6641-7752  
Fax: 010-6641-0125

**Holmate Semiconductor, Inc. (North America Sales Office)**

46712 Fremont Blvd., Fremont, CA 94538  
Tel: 510-252-9880  
Fax: 510-252-9885  
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