

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

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

### Features

- Operating voltage: 1.2V~1.7V
- Low operating current: 3 $\mu$ A (typ.)
- Dialing number and conversation time display
- Conversation timer (59 mins and 59 secs max.)
- 8 or 10-digit LCD display driver; 3V, 1/2 bias, 1/3 duty (8 digit hand-held calculator LCD used for 8-digit application)
- Real time clock with stopwatch
- Built-in dialer interface
- 12-hour or 24-hour format
- Uses 32768Hz crystal
- Two-button sequential operation for real time clock setting
- Pad options
  - Real time (RT)
  - Auto change to timer mode ( $\overline{\text{ACT}}$ )
  - Extension phone number display ( $\overline{\text{EPN}}$ )
- Blinking cursor waits for dialing number
- Last call time display

### Applications

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

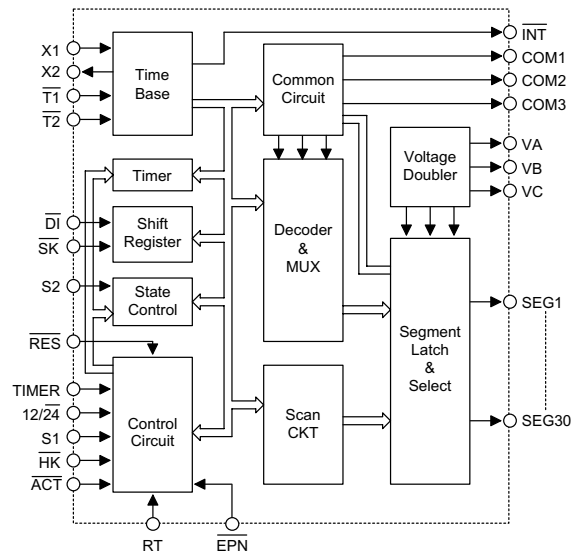
### General Description

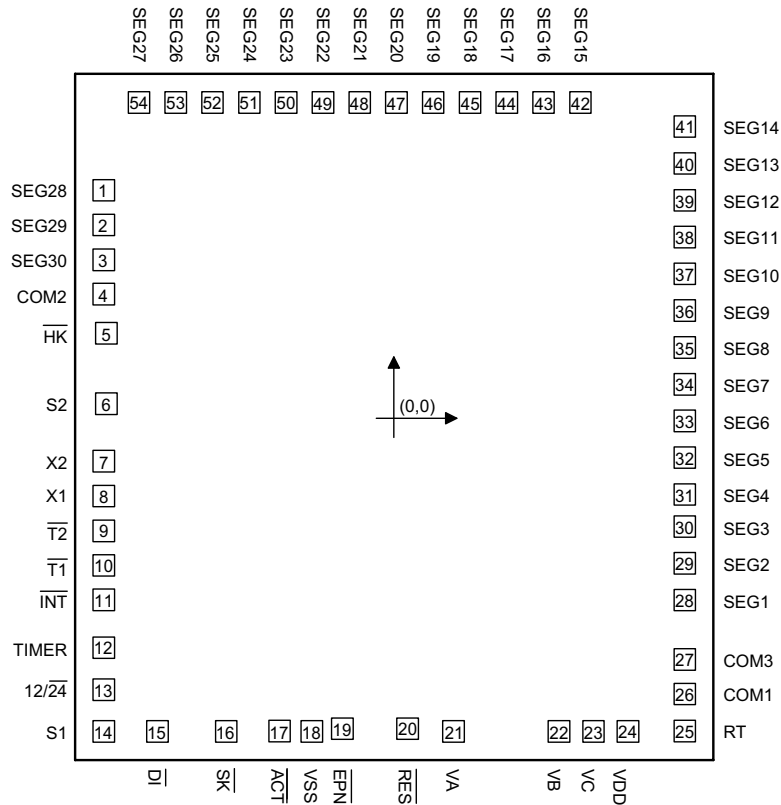
The HT1613C is a CMOS chip designed for dialer interfaces driving 8 or 10 digit LCDs. Various functions, such as real time clock, dialing number and conversation time display are provided.

The HT1613C can display the real time or be blank by default. When answering a telephone call, the timer is activated to tell users how long the conversation has

taken. The HT1613C receives dialing data from the dialer and displays the phone number on the LCD from left to right each time a phone call is made. By adding a TIMER key, the HT1613C can provide the stopwatch and timer reset/hold functions. Refer to the functional description for details.

### Block Diagram



**Pad Assignment**

 Chip size: 128 × 141 (mil)<sup>2</sup>

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

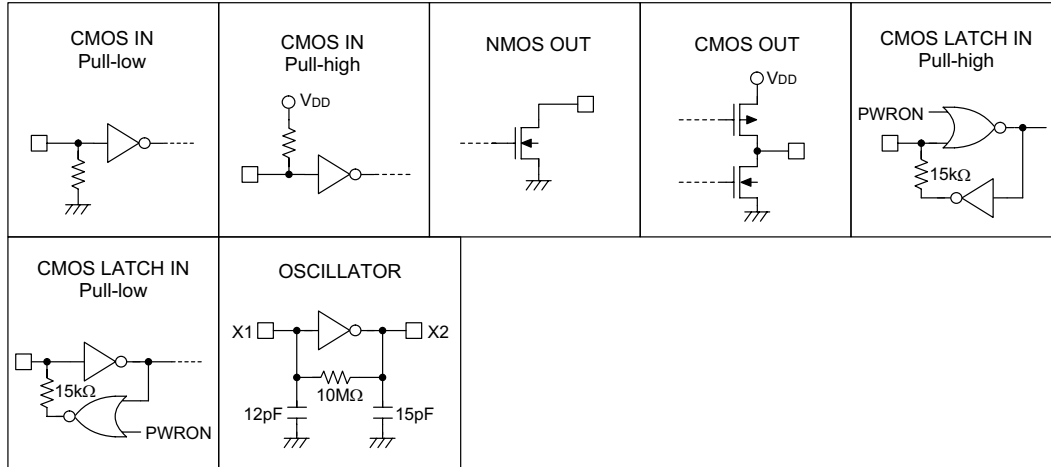
**Pad Coordinates**

Unit: mil

Pad No.	X	Y	Pad No.	X	Y	Pad No.	X	Y
1	-57.91	45.52	19	-10.25	-61.96	37	58.10	28.84
2	-57.91	38.59	20	2.76	-61.96	38	58.10	36.19
3	-57.91	31.67	21	11.94	-62.50	39	58.10	43.53
4	-57.91	24.79	22	32.97	-62.50	40	58.10	50.87
5	-57.37	16.98	23	39.86	-62.50	41	58.10	58.22
6	-57.37	2.91	24	46.74	-62.50	42	37.26	63.04
7	-57.91	-8.60	25	58.10	-62.46	43	29.91	63.04
8	-57.91	-15.53	26	58.10	-55.04	44	22.57	63.04
9	-57.91	-22.49	27	58.10	-48.16	45	15.23	63.04
10	-57.91	-29.38	28	58.10	-36.30	46	7.88	63.04
11	-57.91	-36.26	29	58.10	-28.95	47	0.54	63.04
12	-57.91	-45.82	30	58.10	-21.61	48	-6.81	63.04
13	-57.91	-54.20	31	58.10	-15.22	49	-14.15	63.04
14	-57.91	-62.50	32	58.10	-7.88	50	-21.50	63.04
15	-47.20	-62.50	33	58.10	-0.54	51	-28.84	63.04
16	-33.43	-62.50	34	58.10	6.81	52	-36.18	63.04
17	-22.80	-62.46	35	58.10	14.15	53	-43.53	63.04
18	-16.37	-62.50	36	58.10	21.50	54	-50.87	63.04

**Pad Description**

Pad Name	I/O	Internal Connection	Description
SEG1~SEG30	O	CMOS OUT	LCD segment signal output pads
COM1~COM3	O	CMOS OUT	LCD common signal output pads
$\overline{\text{HK}}$	I	CMOS IN Pull-high	Hook switch detector input Active low
X1	I	OSCILLATOR	32768Hz crystal oscillator input
X2	O		32768Hz crystal oscillator output
$\overline{\text{T1}}$	I	CMOS IN Pull-high	Test pad (connected to VSS for production test)
$\overline{\text{T2}}$	I	CMOS IN Pull-high	Test pad (connected to VSS for production test)
$\overline{\text{INT}}$	O	NMOS OUT	Interrupt output, 8Hz or 16Hz by mask option
TIMER	I	CMOS IN Pull-low	Timer reset and start/hold toggle control input pad
12/ $\overline{24}$	I	CMOS IN Pull-low	12-hour or 24-hour format option pad, connected to VDD for 12-hour format
S1	I	CMOS IN Pull-low	Clock setting switch Active high
S2	I	CMOS IN Pull-low	Clock adjusting switch Active high
$\overline{\text{DI}}$	I	CMOS IN Pull-high	Serial data input pad (connected to the dialer) Data should be valid at the falling edge of $\overline{\text{SK}}$
$\overline{\text{SK}}$	I	CMOS IN Pull-high	Clock input pad (connected to the dialer)
$\overline{\text{RES}}$	I	CMOS IN Pull-high	System initialization pin (active low) The pull-high resistance is 200k $\Omega$ typ.
RT	I	CMOS LATCH IN Pull-low	Real time selection pin VDD: With real time mode Floating: Without real time mode
$\overline{\text{EPN}}$	I	CMOS LATCH IN Pull-high	Extension phone number display selection pin VSS: Without extension phone number display Floating: With extension phone number display
$\overline{\text{ACT}}$	I	CMOS LATCH IN Pull-high	In the dialing number display mode, auto change to timer mode selection VSS: Auto change to timer mode Floating: Manual change to timer mode
VA	O	CMOS OUT	Voltage doubler, connected to external capacitor
VB	O	CMOS OUT	Voltage doubler, connected to external capacitor
VC	O	CMOS OUT	Voltage doubler, connected to 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 <sub>SS</sub> -0.3V to V <sub>DD</sub> +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.

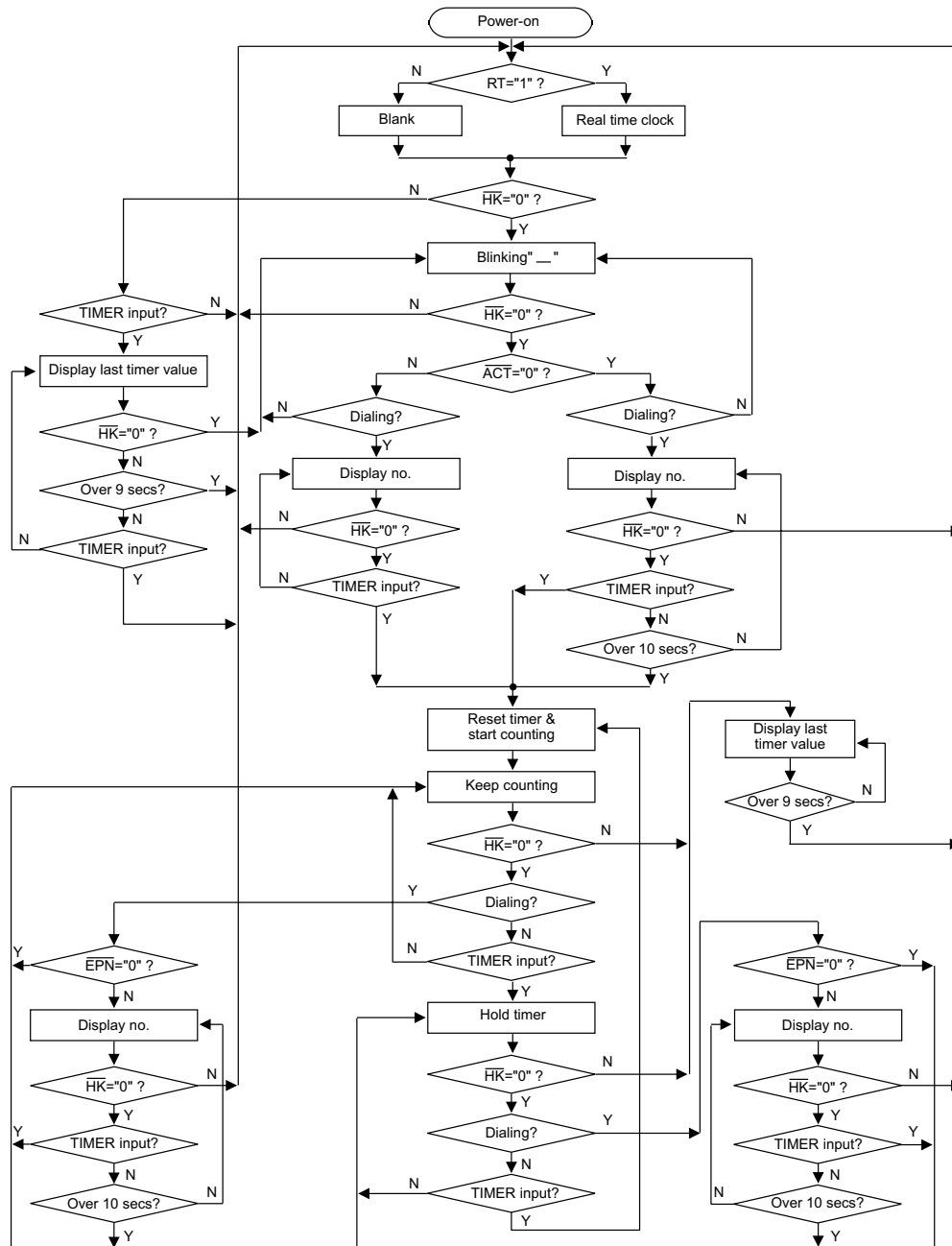
**Electrical Characteristics**

 f<sub>OSC</sub>=32768Hz, Ta=25°C

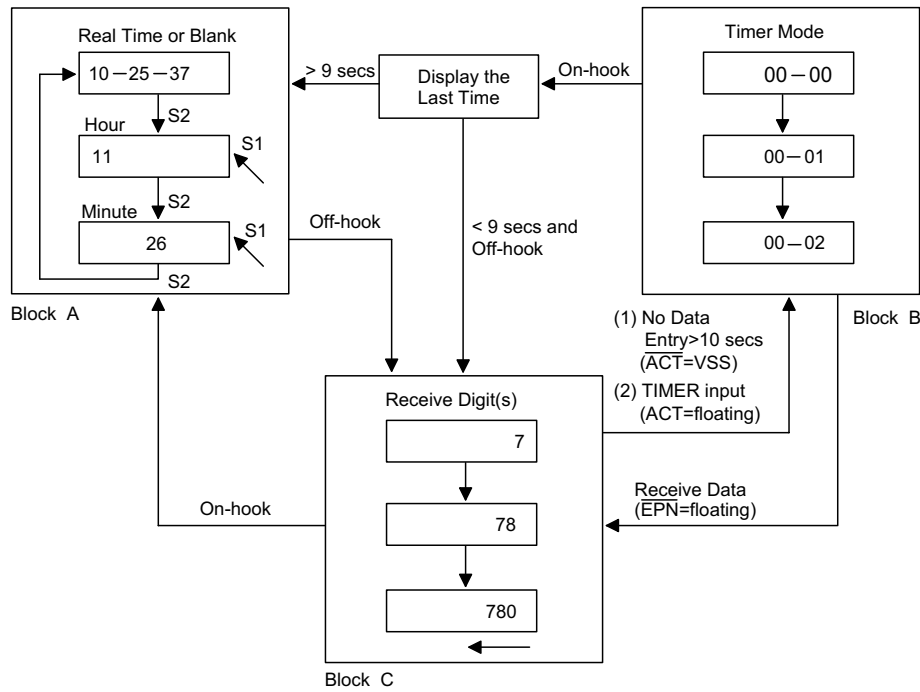
Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V <sub>DD</sub>	Conditions				
V <sub>DD</sub>	Operating Voltage	—	—	1.2	1.5	1.7	V
V <sub>IL</sub>	Input Low Voltage	1.2V~1.7V	—	V <sub>SS</sub>	—	0.2V <sub>DD</sub>	V
V <sub>IH</sub>	Input High Voltage	1.2V~1.7V	—	0.8V <sub>DD</sub>	—	V <sub>DD</sub>	V
I <sub>STB</sub>	Standby Current	1.5V	V <sub>HK</sub> =Floating (or V <sub>DD</sub> )	—	0.1	1	μA
I <sub>DD</sub>	Operating Current	1.5V	No load	—	3	10	μA
I <sub>OL</sub>	Output Sink Current of $\overline{\text{INT}}$	1.5V	V <sub>O</sub> =0.3V	500	1000	—	μA
t <sub>A</sub>	Data Setup Time	1.5V	—	1	—	—	μs
t <sub>B</sub>	Data Hold on Time	1.5V	—	2	—	—	μs
t <sub>C</sub>	Inter Digit Time	1.5V	—	5	—	—	μs
t <sub>DB</sub>	Debounce Time (HK, S1, S2, TIMER)	1.5V	—	—	31.25	—	ms
R <sub>H11</sub>	Pull-high Resistance (HK, $\overline{\text{DI}}$ , SK)	1.5V	V <sub>IN</sub> =0V	—	1	—	MΩ
R <sub>H12</sub>	Pull-high Resistance ( $\overline{\text{RES}}$ )	1.5V	V <sub>IN</sub> =0V	100	200	400	kΩ
R <sub>LO</sub>	Pull-low Resistance ( $\overline{\text{TIMER}}$ , S1, S2, 12/24)	1.5V	V <sub>IN</sub> =1.5V	—	5	—	MΩ
f <sub>OSC</sub>	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 when RT=VDD (Real time mode). S1 and S2 are disabled when RT= floating (Blank mode).

Block B illustrates a timer mode when  $\overline{\text{TIMER}}$  input = floating or when there's no data entry > 10 secs ( $\overline{\text{ACT}}=\text{VSS}$ ). Once in the timer mode, the timer resets and starts to count the conversation time ( $\overline{\text{ACT}}= \text{floating}$ ).

Block C displays blinking "—" , after Off-hook, dialing data is received and displayed on the LCD from left to right.

**Data & Timing**

- For telephone application

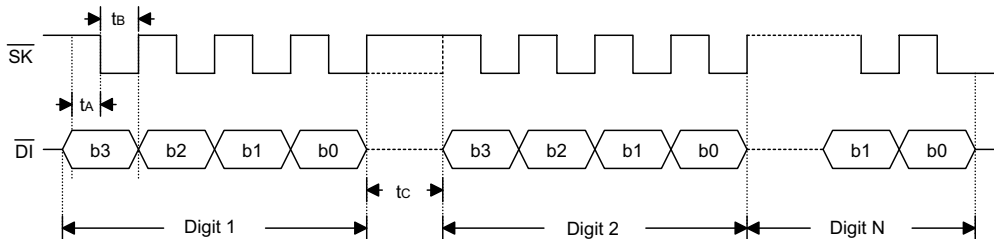
The HT1613C is designed to display telephone numbers derived from the HT93XXX series telephone dialers. The corresponding data is illustrated in the following table.

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

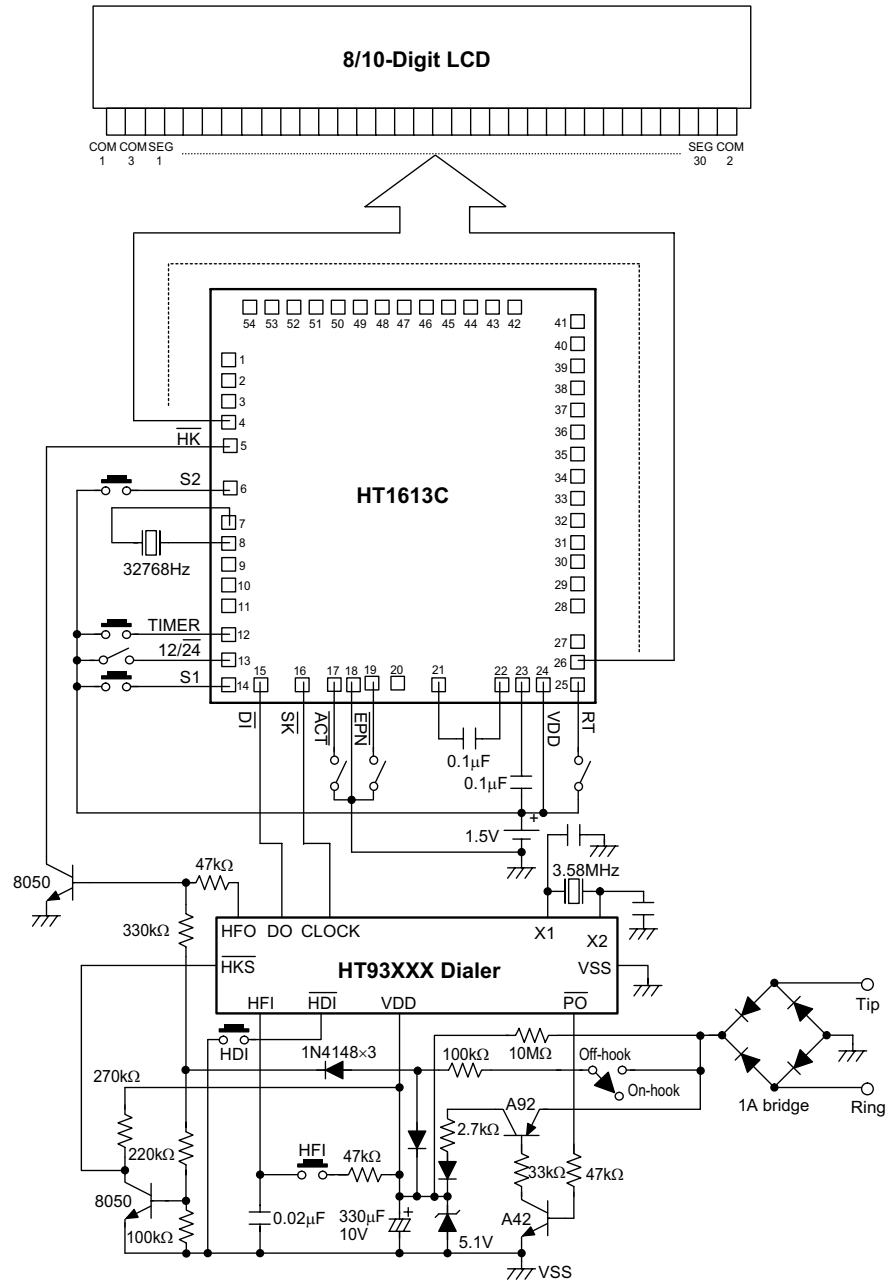
The HT1613C is also capable of displaying BCD data generated from instrument or a  $\mu$ C system. The corresponding data and timing is shown in the Data latch timing diagram. Before the data is transmitted to the HT1613C, the  $\overline{HK}$  pin should be pulled-low or continuously kept low. The HT1613C 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 HT1613C, the  $\overline{SK}$  pin is set low to avoid switching to the timer mode.

- Data latch timing



**Application Circuits**

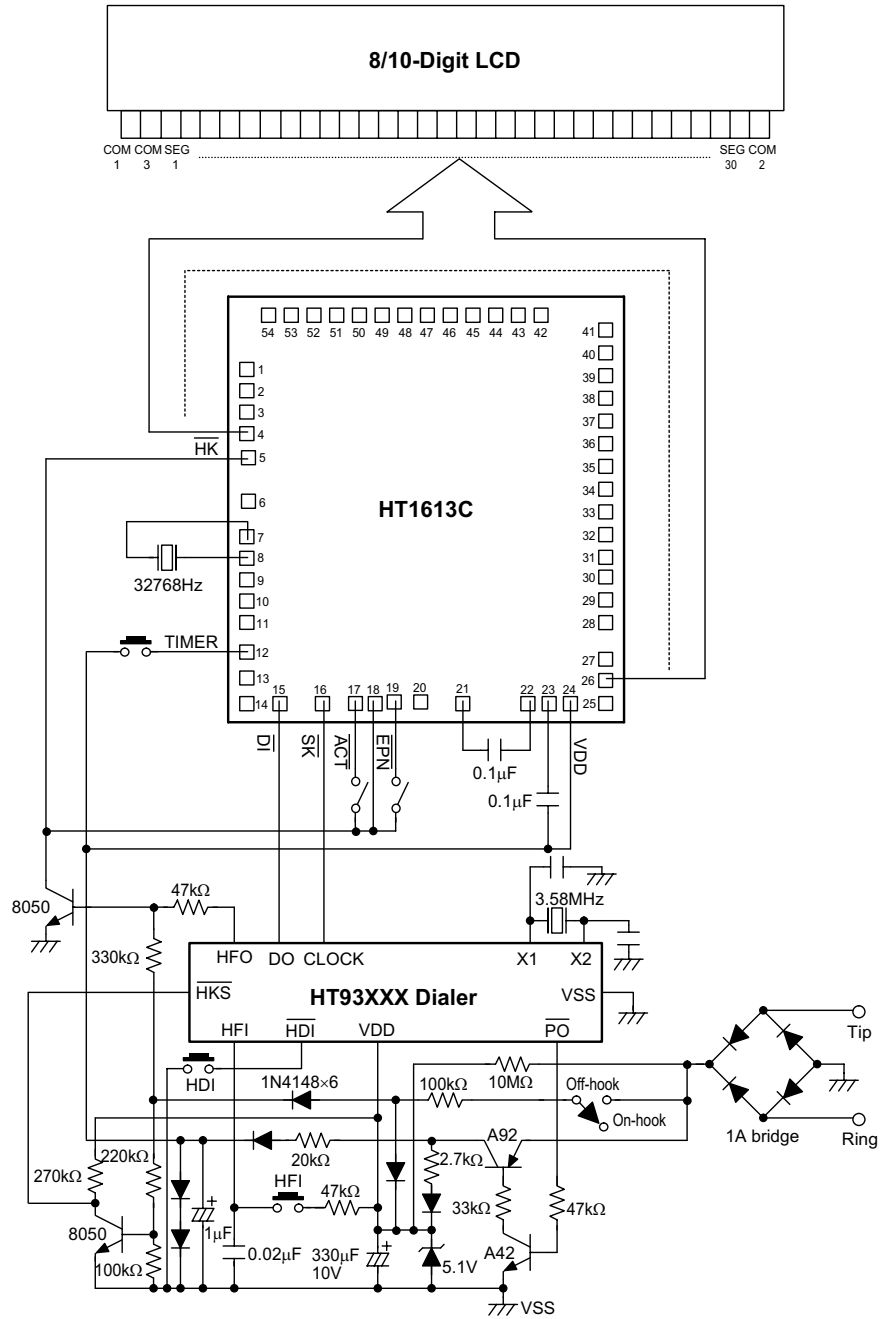
For telephone interfacing (with batteries)



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

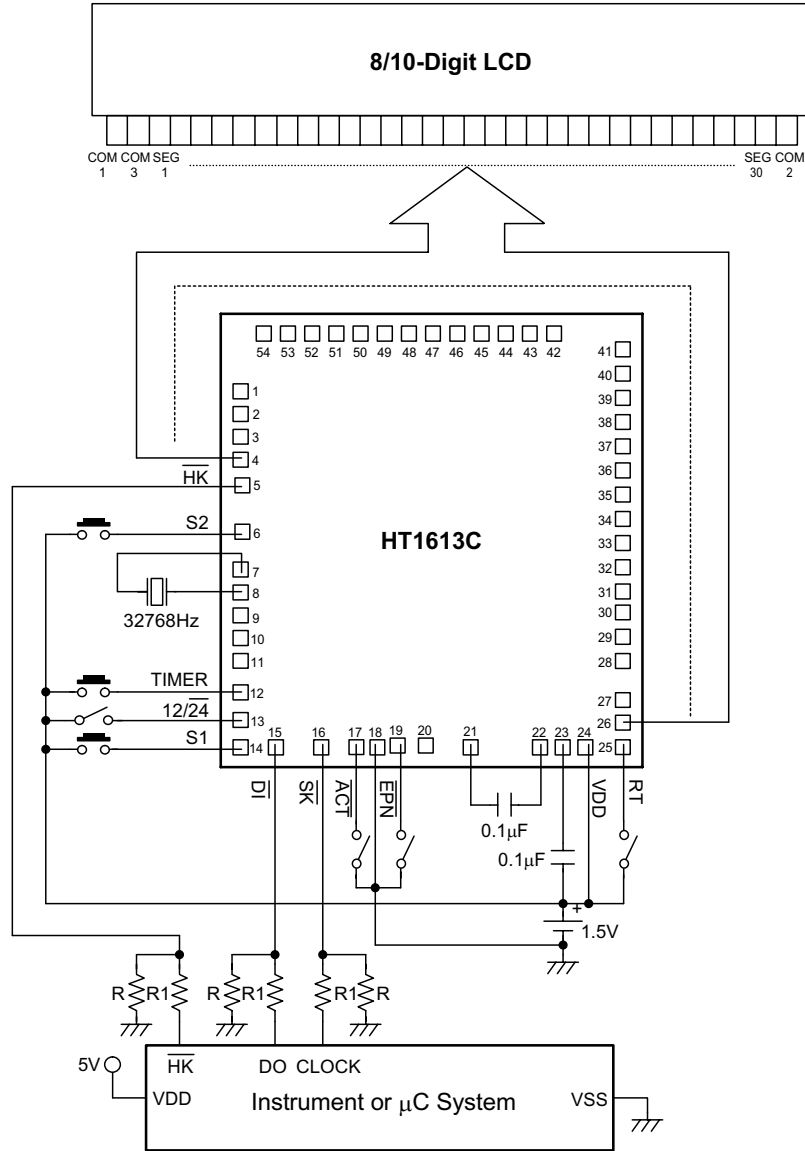


For telephone interfacing (without batteries)



\* 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.

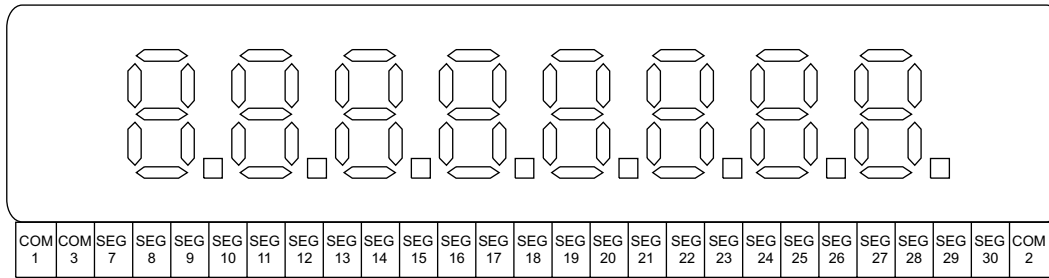
Note: To drive  $\overline{SK}$ ,  $\overline{DI}$ , and  $\overline{HK}$  pin, an open drain NMOS output structure is recommended.

To drive  $\overline{SK}$ ,  $\overline{DI}$  and  $\overline{HK}$  pin with a CMOS output structure, a voltage divider is needed ( $R=4.3k\Omega$ ,  $R1=10k\Omega$ ).

**LCD Configurations**

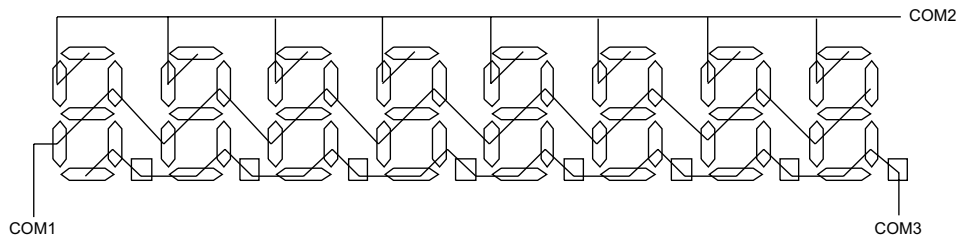
For 8-digit application

- Segment electrode side

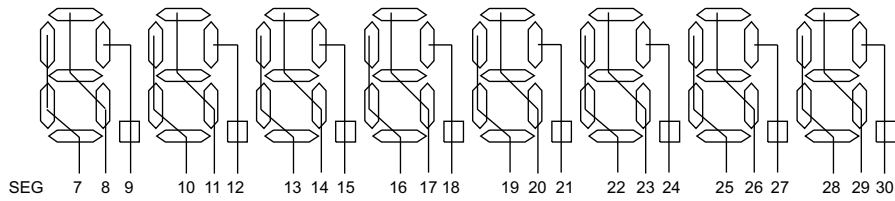


LCD driving system 1/2 bias, 1/3 duty, 3V

- Common electrode side

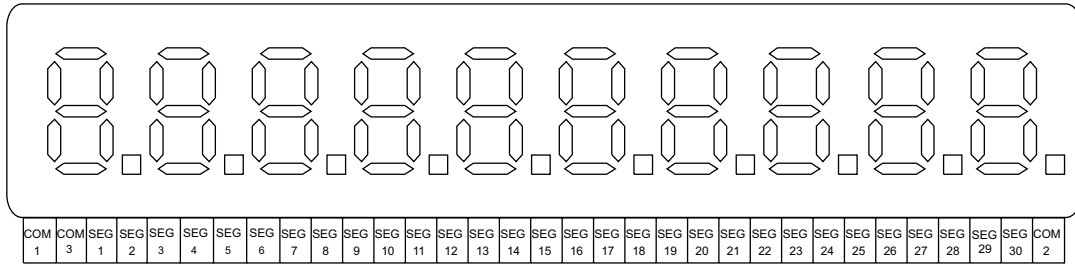


- LCD connection



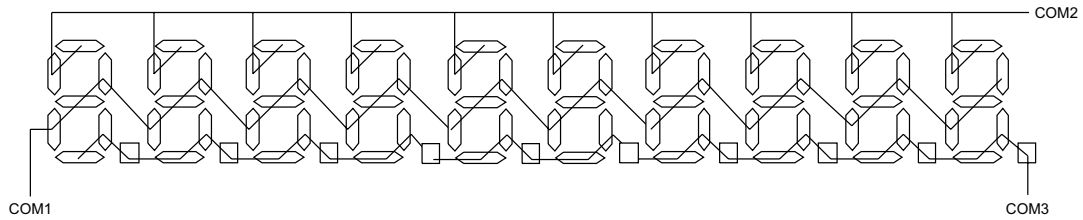
**For 10-digit application**

- Segment electrode side

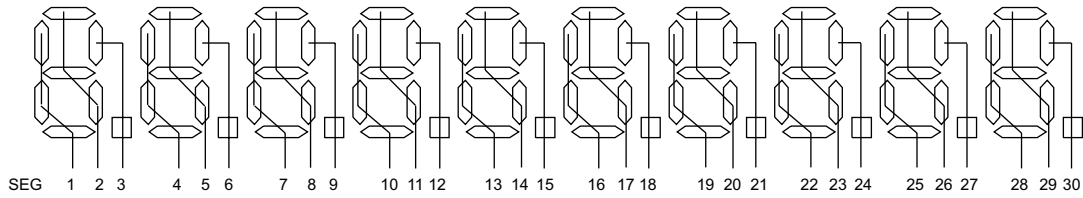


LCD driving system 1/2 bias, 1/3 duty, 3V

- Common electrode side



- LCD connection



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