

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 μ A (Typ.)
- Dialing number and conversation time display
- Conversation timer (59 min and 59 sec max.)
- 12 or 16 digits LCD display driver (3V, 1/2 bias, 1/3 duty)
- Real time clock with stopwatch
- Built-in dialer interface
- 12-hour or 24 hours format
- Two buttons sequential operation for real time clock setting
- Uses 32768Hz crystal
- Uses 32768Hz buffered output
- Eight ICONs: LOGO1~3, INUSE, HANDFREE, HOLD, ICON1, ICON2
- Four option pads for icon flash
 - Flash or not
 - 1s On/1s Off or 2s On/2s Off
- Quick start of osc when power is on

Applications

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

General Description

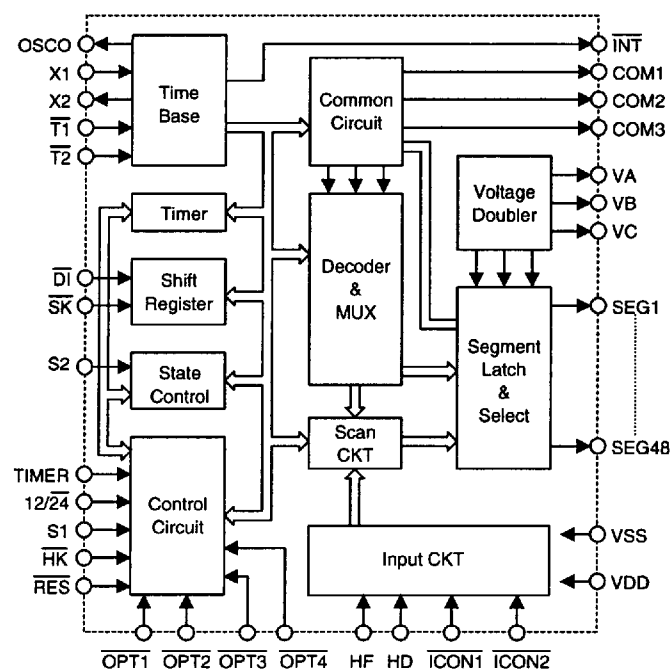
The HT1616A is a CMOS chip designed for dialer interface driving 12 or 16-digit LCDs. Various functions, such as real time clock, dialing number and conversation time display are provided.

When making a phone call, the HT1616A 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

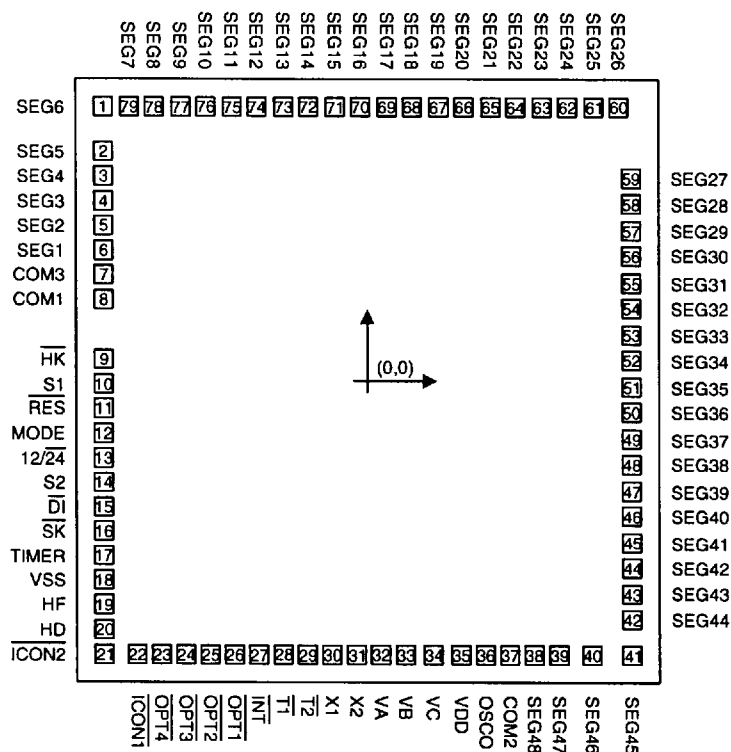
seconds, it restarts the timer again. By adding a TIMER key, the IC can provide stopwatch and timer reset/hold functions (refer to the functional description for details).

The HT1616A supplies eight additional icons, LOGO1~ LOGO3, INUSE, HANDFREE, HOLD and two special icons, for telephone dialer or other applications.

Block Diagram



Pad Assignment



Chip size: 155 × 160 (mil)²

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

Pad Coordinates

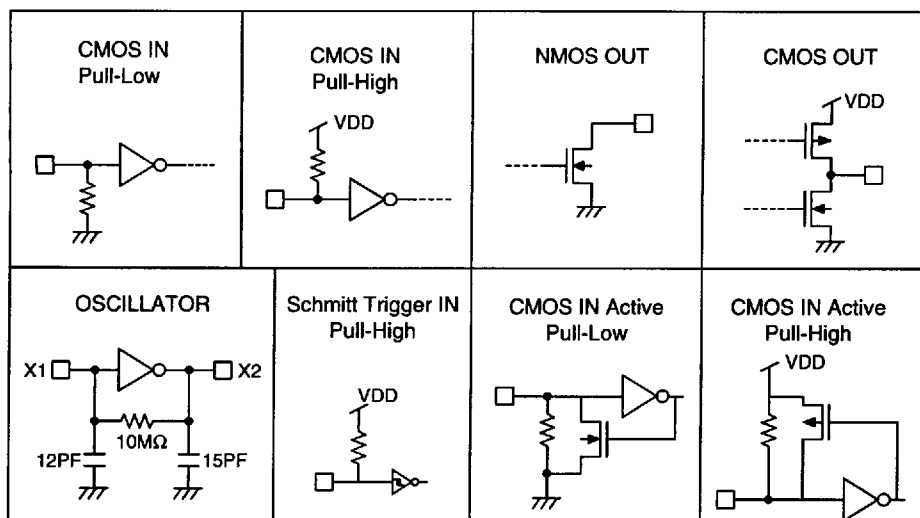
Unit: mil

Pad No.	X	Y	Pad No.	X	Y
1	-71.82	73.86	41	71.61	-73.99
2	-71.82	61.75	42	71.61	-64.35
3	-71.82	55.12	43	71.61	-57.54
4	-71.82	48.49	44	71.61	-50.32
5	-71.82	41.86	45	71.61	-43.52
6	-71.82	35.23	46	71.61	-36.29
7	-71.82	28.60	47	71.61	-29.50
8	-71.82	21.97	48	71.61	-22.27
9	-71.82	5.82	49	71.61	-15.47
10	-71.82	-0.81	50	71.61	-8.24
11	-71.82	-7.44	51	71.61	-1.45
12	-71.82	-14.07	52	71.61	5.78
13	-71.82	-20.70	53	71.61	12.58
14	-71.82	-27.33	54	71.61	19.81
15	-71.82	-33.96	55	71.61	26.60
16	-71.82	-40.59	56	71.61	33.83
17	-71.82	-47.22	57	71.61	40.63
18	-71.82	-53.85	58	71.61	47.85
19	-71.82	-60.56	59	71.61	54.65
20	-71.82	-67.19	60	68.25	73.86
21	-71.82	-73.99	61	61.46	73.86
22	-62.86	-73.99	62	54.23	73.86
23	-56.23	-73.99	63	47.43	73.86
24	-49.60	-73.99	64	40.21	73.86
25	-42.97	-73.99	65	33.40	73.86
26	-36.34	-73.99	66	26.18	73.86
27	-29.71	-73.99	67	19.38	73.86
28	-23.08	-73.99	68	12.15	73.86
29	-16.45	-73.99	69	5.36	73.86
30	-9.82	-73.99	70	-1.87	73.86
31	-3.19	-73.99	71	-8.67	73.86
32	3.44	-73.99	72	-15.90	73.86
33	10.07	-73.99	73	-22.69	73.86
34	17.64	-73.99	74	-29.92	73.86
35	25.08	-73.99	75	-36.72	73.86
36	31.70	-73.99	76	-43.94	73.86
37	38.33	-73.99	77	-50.74	73.86
38	44.97	-73.99	78	-57.97	73.86
39	51.76	-73.99	79	-64.77	73.86
40	60.69	-73.99			

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	Schmitt Trigger IN Pull-High	Hook switch detector input Active low
HF	I	CMOS IN Active Pull-High	Hand free icon input, Low=inactive, High=active
HD	I	CMOS IN Active Pull-High	HOLD icon input, Low=inactive, High=active
$\overline{ICON1}$	I	CMOS IN Active Pull-High	ICON1 icon input, active low
$\overline{ICON2}$	I	CMOS IN Active Pull-High	ICON2 icon input, Active low
S1	I	Schmitt Trigger IN Active Pull-Low	Clock setting switch Hour or minute can be selected (flash when selected) for S2 adjustment
$\overline{RES}$	I	Schmitt Trigger IN Pull-High	System initialization pin (active low) The pull-high resistance is 200k Ω typ.
MODE	I	Schmitt Trigger IN Active Pull-Low	4 or 5 bits pattern selection pad VDD: 5 bits pattern Open or VSS: 4 bits pattern
12/24	I	CMOS IN Active Pull-Low	12-hour or 24-hour format option pad VDD: 12 hours format Open or VSS: 24 hours format
S2	I	Schmitt Trigger IN Active Pull-Low	Clock adjusting switch. The digits of hour or minute can be adjusted with this key depending on the S1 selection
$\overline{DI}$	I	Schmitt Trigger IN Pull-High	Serial data of dialing digit input pad Data should be valid at the falling edge of $\overline{SK}$ (connected to the dialer DO)
$\overline{SK}$	I	Schmitt Trigger IN Pull-High	Serial clock input pad (connected to the dialer CLOCK), active low Input data is latched at the falling edge of $\overline{SK}$ input
$\overline{T1}$	I	CMOS IN Pull-High	Test pad (connected to VSS for chip test)
$\overline{T2}$	I	CMOS IN Pull-High	Test pad (connected to VSS for chip test)
X1	I	OSC	32768Hz crystal oscillator input
X2	O		32768Hz crystal oscillator output

Pad Name	I/O	Internal Connection	Description
OSCO	O	CMOS OUT	Buffered 32768Hz output
TIMER	I	Schmitt Trigger IN Active Pull-Low	Timer reset-and-start/hold toggle control input pad
$\overline{\text{INT}}$	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
$\overline{\text{OPT4}}$	I	CMOS IN Active Pull-High	Pad for flash rate selection, Pull high High=2s On/2s Off, Low=1s On/1s Off
$\overline{\text{OPT3}}$	I	CMOS IN Active Pull-High	Option pad for setting hold-line icon/hand-free icon to flash or not. The default is no flash. Pull high, active low
$\overline{\text{OPT2}}$	I	CMOS IN Active Pull-High	Option pad for setting ICON2 to flash or not. The default is no flash. Pull high, active low
$\overline{\text{OPT1}}$	I	CMOS IN Active Pull-High	Option pad for setting ICON1 to flash or not. The default is no flash. Pull high, active low
VDD	I	—	Positive power supply
VSS	I	—	Negative power supply (GND)

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: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

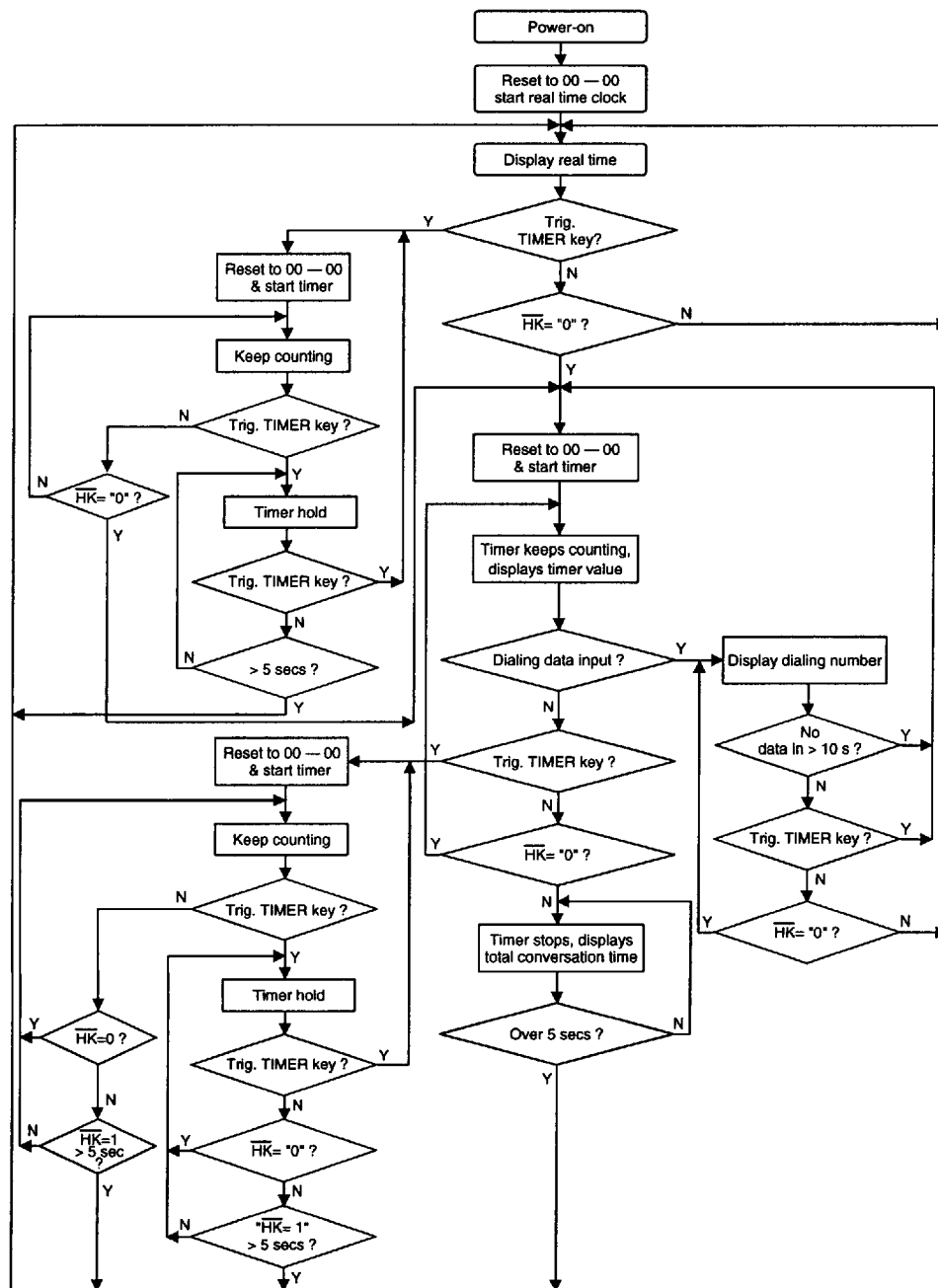
Electrical Characteristics

(FOSC=32768Hz, Ta=25°C)

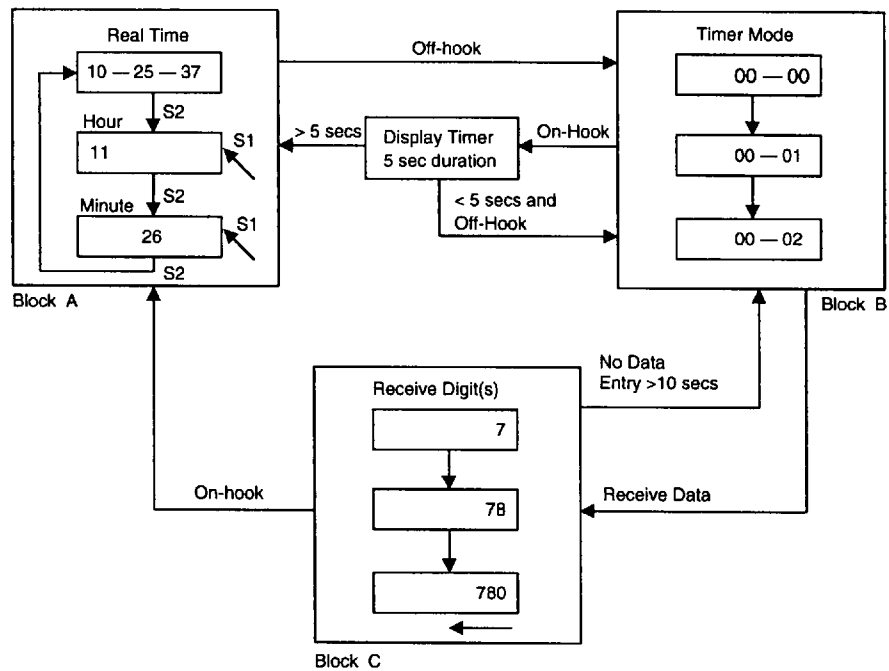
Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
V _{DD}	Operating Voltage	—	—	1.2	1.5	1.7	V
V _{IL}	Input Low Voltage	—	—	V _{SS}	—	0.2V _{DD}	V
V _{IH}	Input High Voltage	—	—	0.8V _{DD}	—	V _{DD}	
I _{DD}	Operating Current	1.5V	No load $\overline{V_{HK}}=V_{SS}$	—	4	10	μA
I _{OL}	Output Sink Current of $\overline{INT}$	1.5V	V _O =0.3V	500	1000	—	μA
T _A	Data Setup Time	1.5V	—	1	—	—	μs
T _B	Data Hold On Time	1.5V	—	2	—	—	μs
T _C	Inter Digit Time	1.5V	—	5	—	—	μs
T _{DB}	Input Debounce Time (S1, $\overline{HK}$, S2, TIMER)	1.5V	—	—	31.25	—	ms
R _{HI1}	Pull-High Resistance ($\overline{HK}$, DI, SK)	1.5V	V _{IN} =0V	—	1	—	MΩ
R _{HI2}	Pull-High Resistance (HF, HD, $\overline{ICON1}$, $\overline{ICON2}$, OPT1, OPT2, OPT3, OPT4)	1.5V	V _{IN} =0V	—	5	—	MΩ
R _{HI3}	Pull-High Resistance (RES)	1.5V	V _{IN} =0V	100	200	400	kΩ
R _{LOW}	Pull-Low Resistance (TIMER, S1, S2, MODE, 12/24)	1.5V	V _{IN} =1.5V	—	5	—	MΩ
FOSC	System Frequency	1.5V	With 32768Hz crystal	—	32768	—	Hz

Functional Description

Operational flow chart



On-hook & Off-hook



Note:

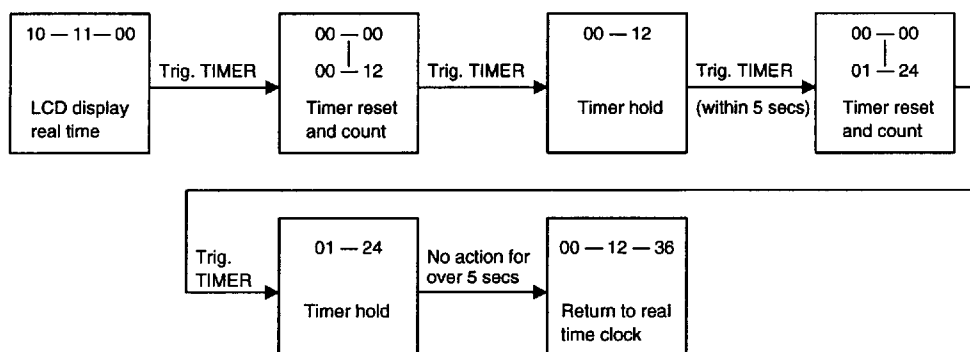
Block A shows the switches S1 and S2 that are used for setting and selecting.

Block B illustrates a timer mode when Off-Hook. When in the timer mode, the timer resets and starts to count the conversation time.

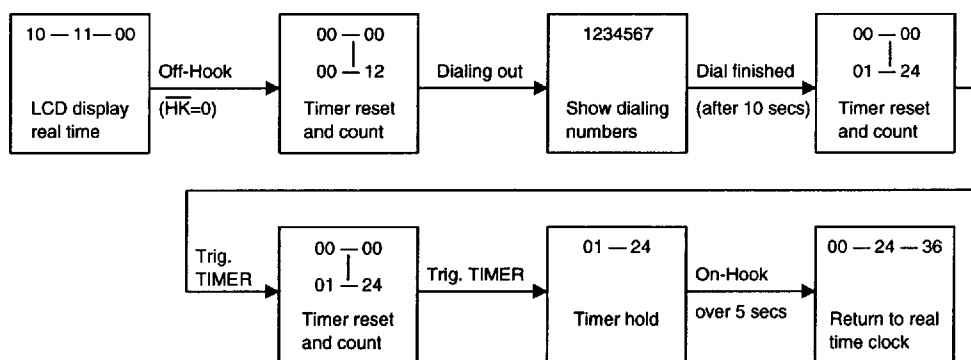
Block C displays blinking "—". After Off-Hook, dialing data is received and displayed on the LCD from left to right. When the entry interval is over 10 seconds, the timer resets and starts to count.

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 HT1616A 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 μ C application

The HT1616A is also capable of displaying BCD data generated from instrument or a μ C system. The corresponding data and timing is shown in the Data Latch Timing diagram. Before the data is transmitted to the HT1616A, the $\overline{HK}$ pin should be pulled-low or continuously kept low. The HT1616A is 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 HT1616A, the $\overline{SK}$ pad should be 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:

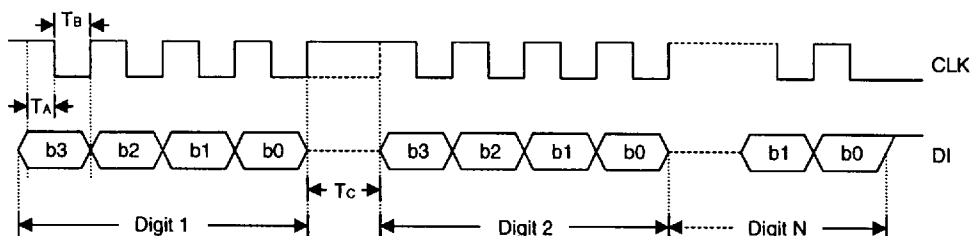
(MODE=1)

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	1
0	1	1	0	0	2
0	1	0	1	1	F
0	1	1	1	0	P
0	1	1	1	1	-

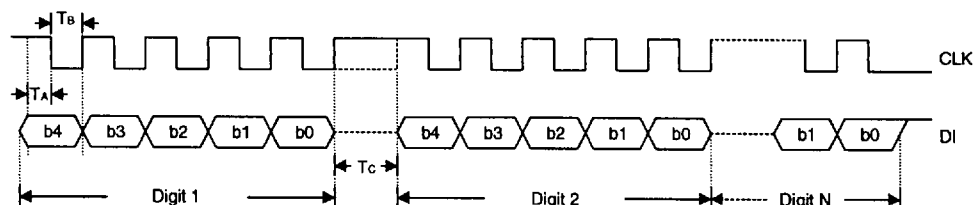
(MODE=1)

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	f
1	0	1	1	0	H
1	0	1	1	1	L
1	1	0	0	0	0
1	1	0	0	1	9
1	1	0	1	0	7
1	1	1	0	1	U
1	1	1	0	0	U
1	1	0	1	1	Y
1	1	1	1	0	7
1	1	1	1	1	7

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



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



ICON table

Item	On-hook	Off-hook
LOGO1	ON	Flash
LOGO2	Flash	ON
LOGO3	Flash	OFF
INUSE	OFF	ON
HANDFREE	When HF=1, HFICON=On or flash; when HF=0, HFICON=Off	
HOLD	When HD=1, HDICON=On or flash; when HD=0, HDICON=Off	
ICON1	When $\overline{\text{ICON1}}=0$, ICON1=On or flash; when $\overline{\text{ICON1}}=1$, ICON1=Off	
ICON2	When $\overline{\text{ICON2}}=0$, ICON2=On or flash; when $\overline{\text{ICON2}}=1$, ICON2=Off	

Note:

On/Off of LOGO1~3 and INUSE are directly controlled by $\overline{\text{HK}}$ pad.

Other icons are controlled by the corresponding input pads.

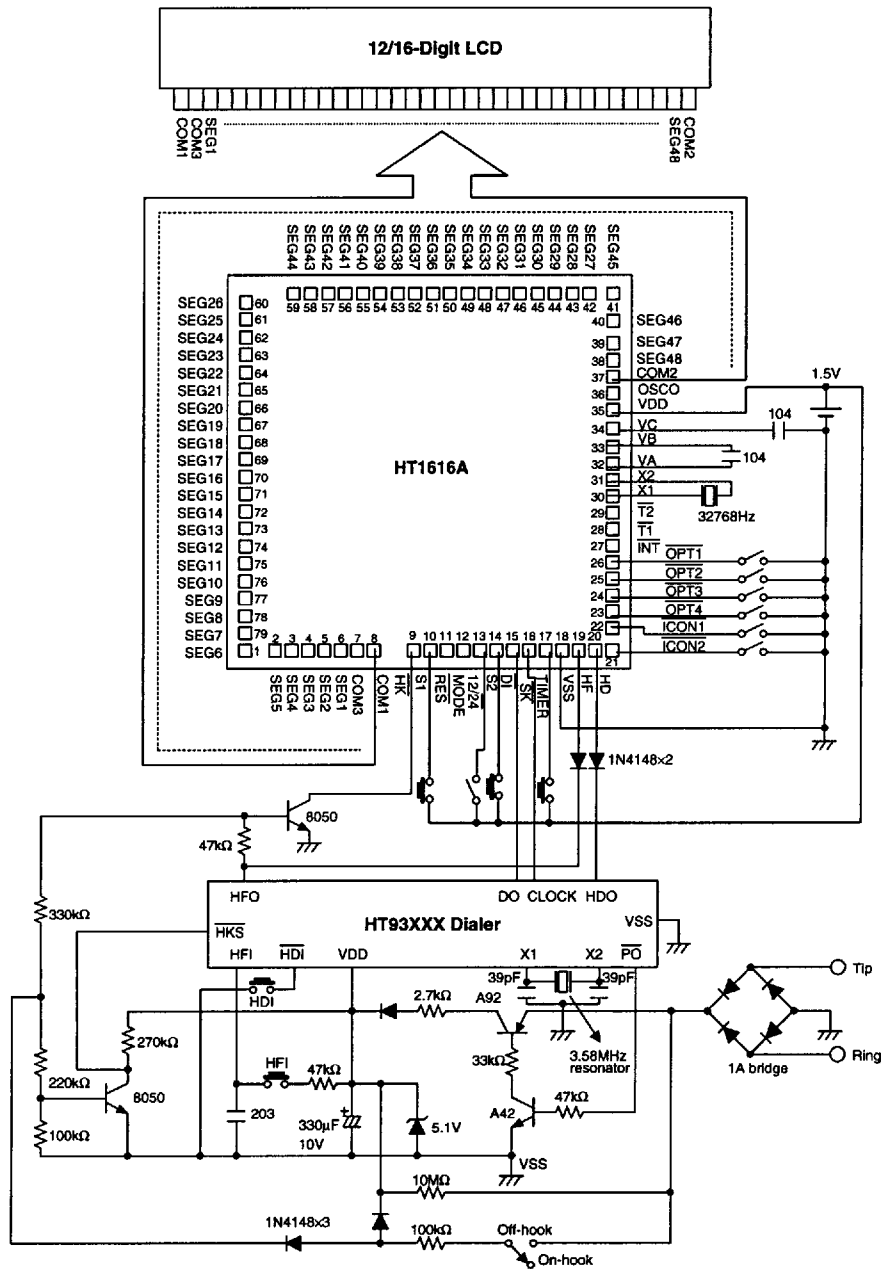
$\overline{\text{OPT1}}\sim\overline{\text{OPT2}}$ pads control the flash of ICON1~2, the default is no flash.

$\overline{\text{OPT3}}$ controls the flash of HOLD and HANDFREE icons, the default is no flash.

$\overline{\text{OPT4}}$ selects the flash rate to be 1s-On/1s-Off or 2s-On/2s-Off, the default is 2s On/2s Off.

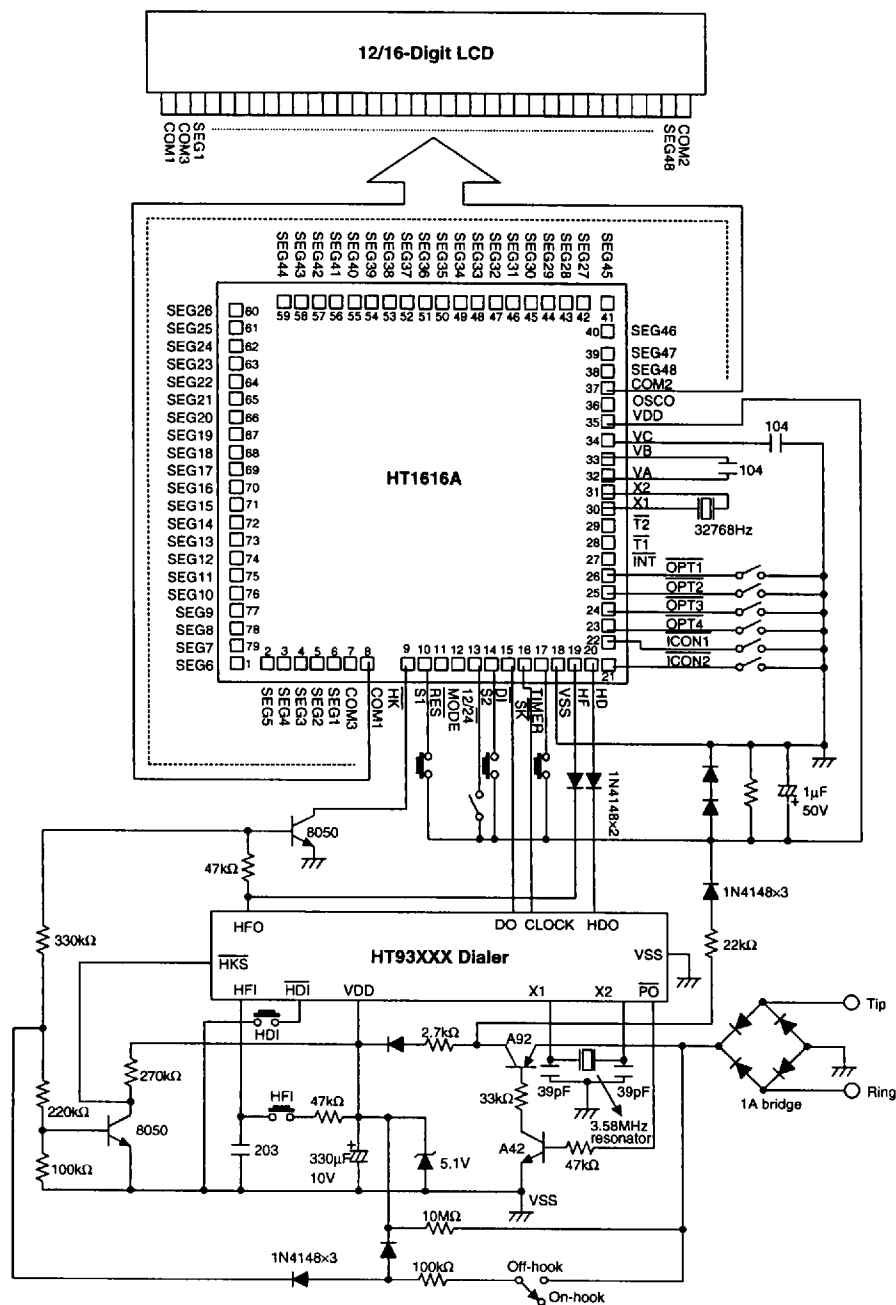
Application Circuits

For telephone interfacing (with batteries)



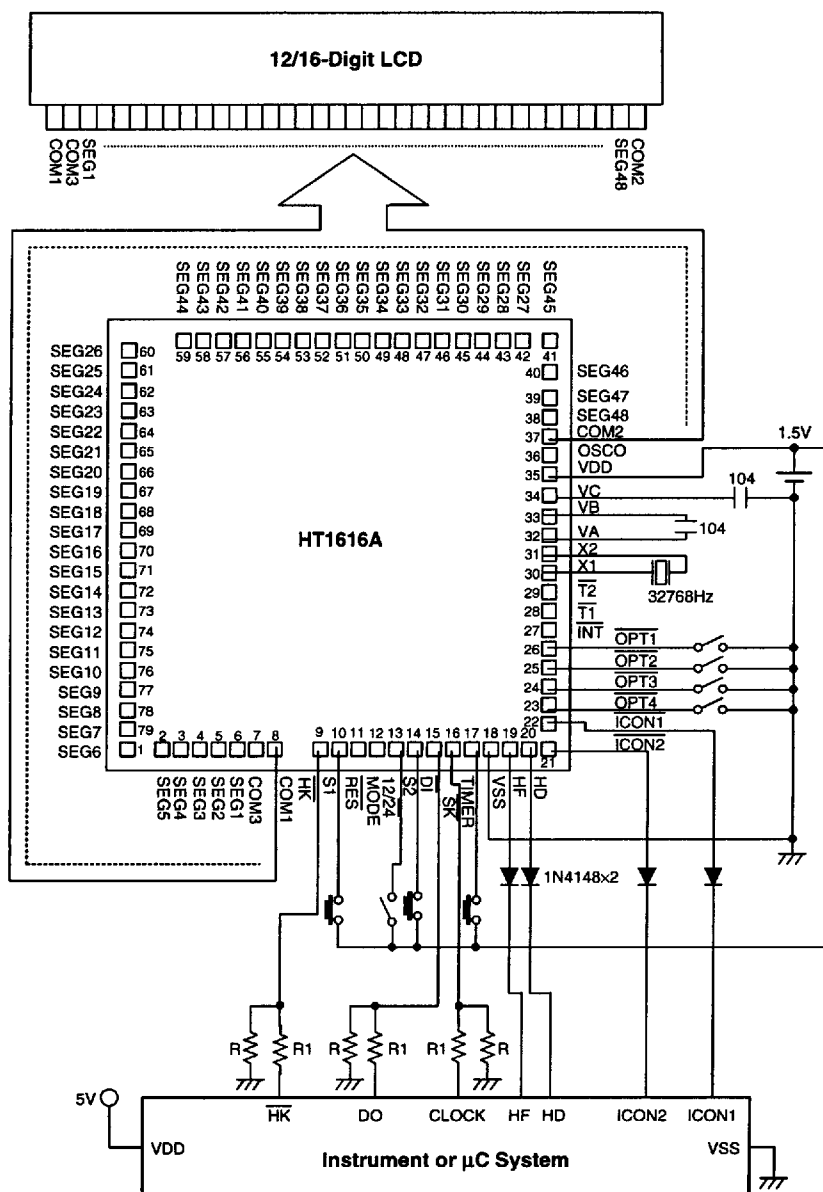
* The IC substrate should be connected to VDD in the PCB layout artwork.

For telephone interfacing (without batteries)



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

For instrument or μ C use

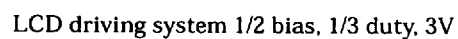


* The IC substrate should be connected to VDD in the PCB layout artwork.

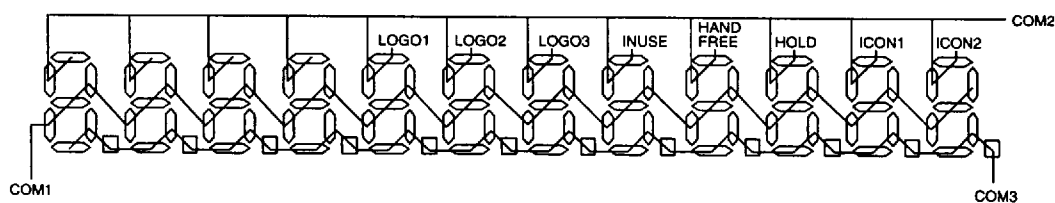
Note: To drive $\overline{SK}$, $\overline{DI}$ and $\overline{HK}$, an open drain NMOS output structure is recommended.
To drive $\overline{SK}$, $\overline{DI}$ and $\overline{HK}$ with a CMOS output structure, a voltage divider is needed ($R=4.3k\Omega$, $R1=10k\Omega$).

For 12-digit application

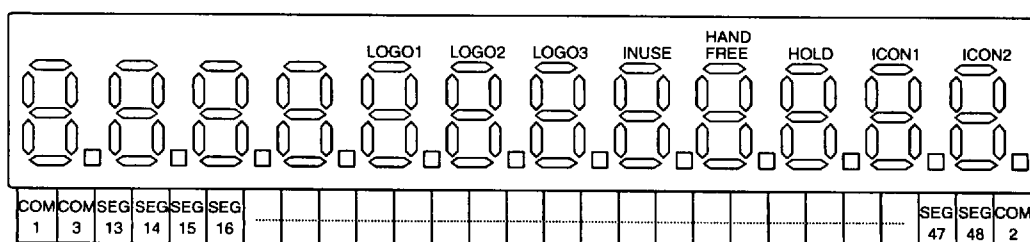
- Segment electrode side



- Common electrode side



- LCD connection



- Segment electrode side

