

## Timer with Dialer Interface

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

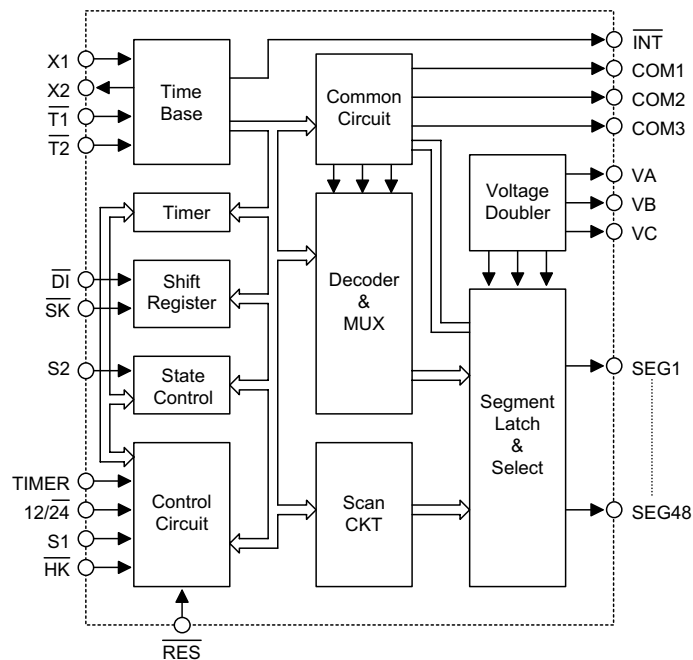
### General Description

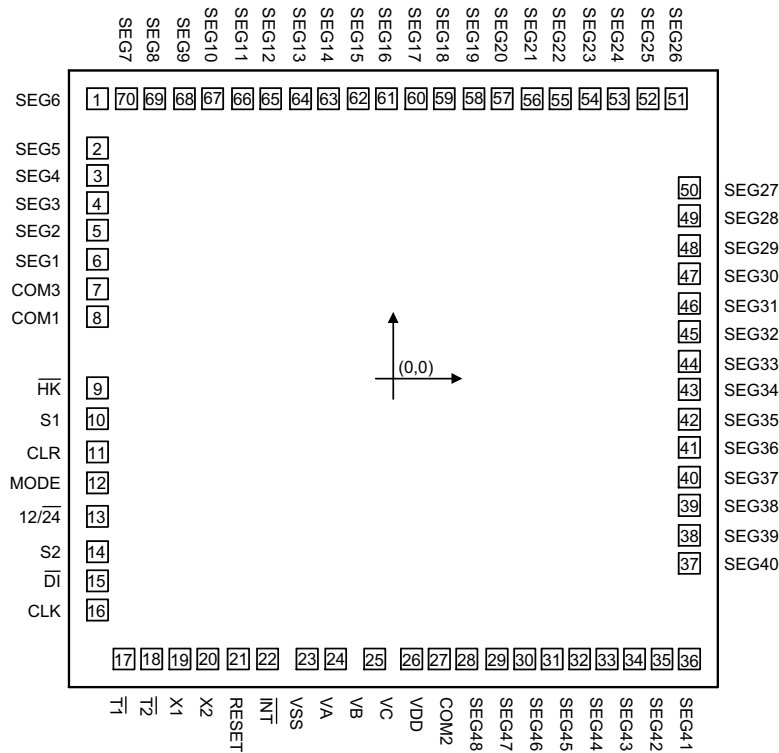
The HT1616C is a CMOS chip designed for dialer interfaces driving 12 or 16-digit LCDs. Various functions, such as real time clock, dialing number and conversation time display are provided.

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.

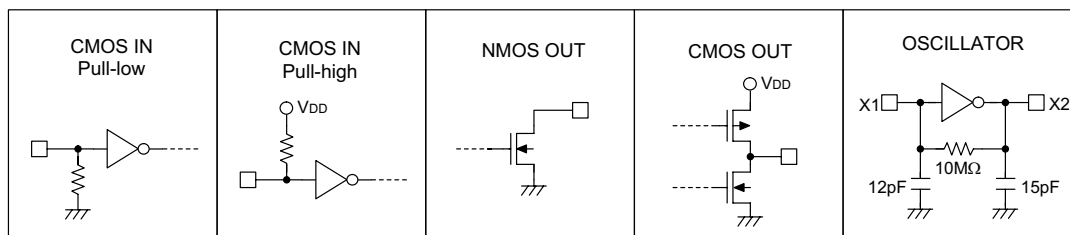
**Pad Coordinates**

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<br>Pull-high | Hook switch detector input   |
| S1                  | I   | CMOS IN<br>Pull-low  | Clock setting switch<br>Hour or minute can be selected for S2 adjustment                                       |
| $\overline{RES}$    | I   | CMOS IN<br>Pull-high | System initialization pin, active low<br>The pull-high resistance is 200k $\Omega$ typ.                        |
| MODE                | I   | CMOS IN<br>Pull-low  | 4 or 5 bits pattern selection pad<br>VDD: 5 bits pattern<br>Floating: 4 bits pattern                           |
| 12/ $\overline{24}$ | I   | CMOS IN<br>Pull-low  | 12-hour or 24-hour format option pad<br>VDD: 12-hour format<br>Floating: 24-hour format                        |
| S2                  | I   | CMOS IN<br>Pull-low  | Clock adjusting switch<br>Hour or minute digits can be adjusted depending upon the S1 selection                |
| $\overline{DI}$     | I   | CMOS IN<br>Pull-high | Serial data input pad<br>Data should be valid at the falling edge of $\overline{SK}$ (connected to the dialer) |
| $\overline{SK}$     | I   | CMOS IN<br>Pull-high | Clock input pad (connected to the dialer), active low<br>Input data is latched at the falling edge of SK       |
| $\overline{T1}$     | I   | CMOS IN<br>Pull-high | Test pad (connected to VSS for production test)  |
| $\overline{T2}$     | I   | CMOS IN<br>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<br>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

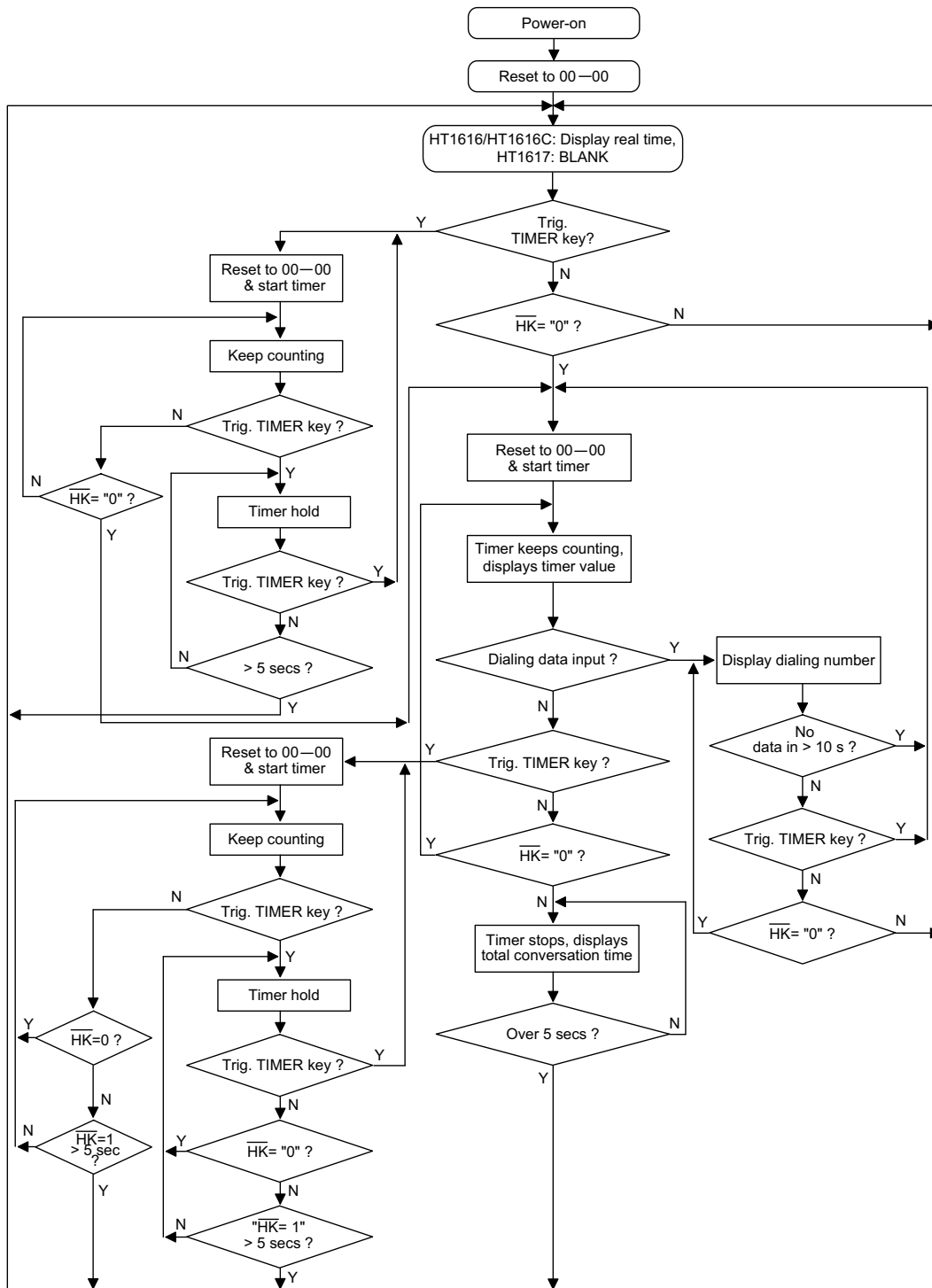
Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions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

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

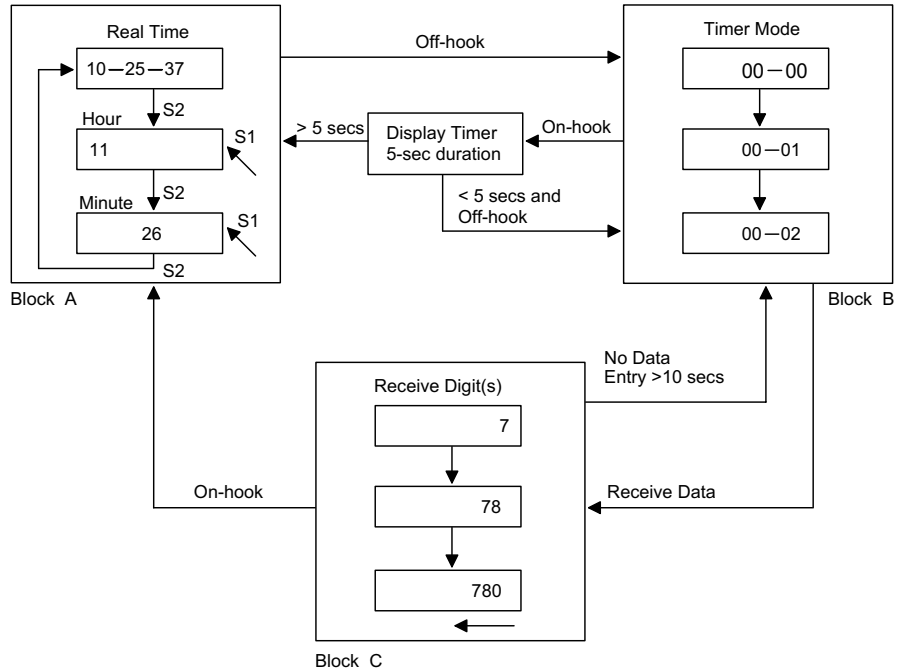
| Symbol    | Parameter  | Test Conditions |   | Min.        | Typ.  | Max.        | Unit      |
|-----------|--|-----------------|---|-------------|-------|-------------|-----------|
|           |  | $V_{DD}$        | Conditions                                  |             |       |             |           |
| $V_{DD}$  | 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            | $\overline{V_{HK}}=Floating$ (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



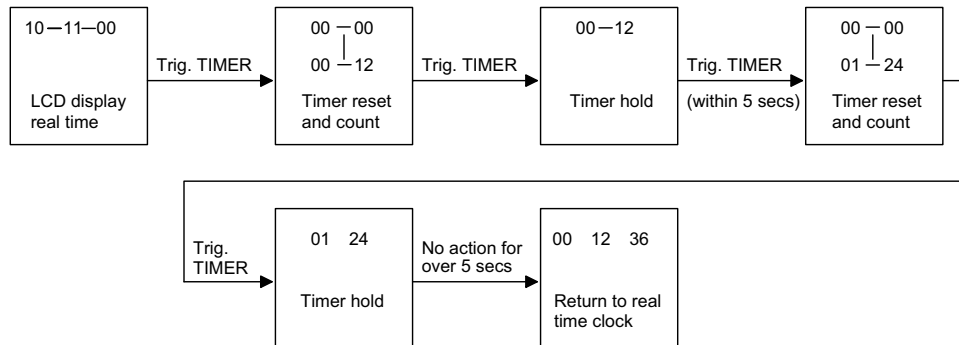
**On-hook & Off-hook**



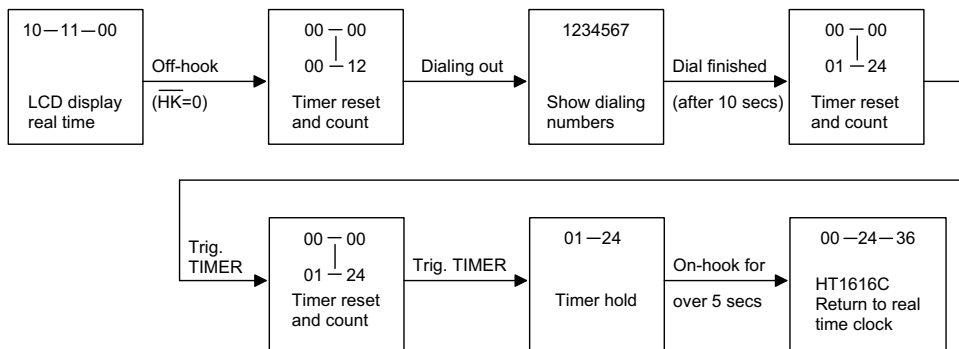
Note: Block A shows the switches S1 and S2 that are used for setting and selecting. Block B illustrates a timer mode when Off-hook; timer resets and starts to count the conversation time. Block C displays blinking "—". After Off-hook, dialing data is received and displayed on the LCD from left to right.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

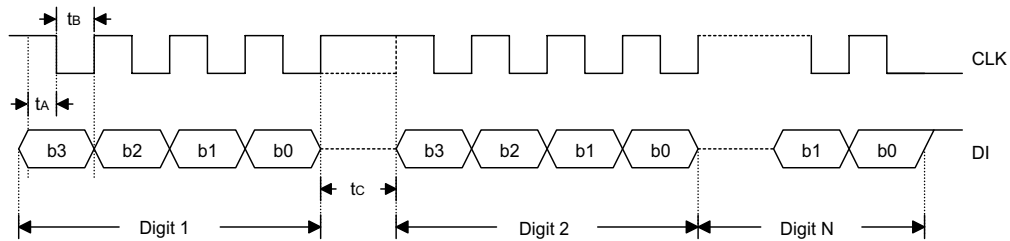
(MODE=1)

| 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  | -       |

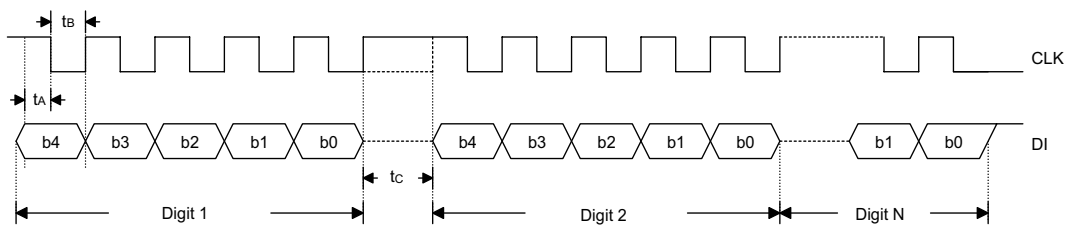
(MODE=1)

| 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)

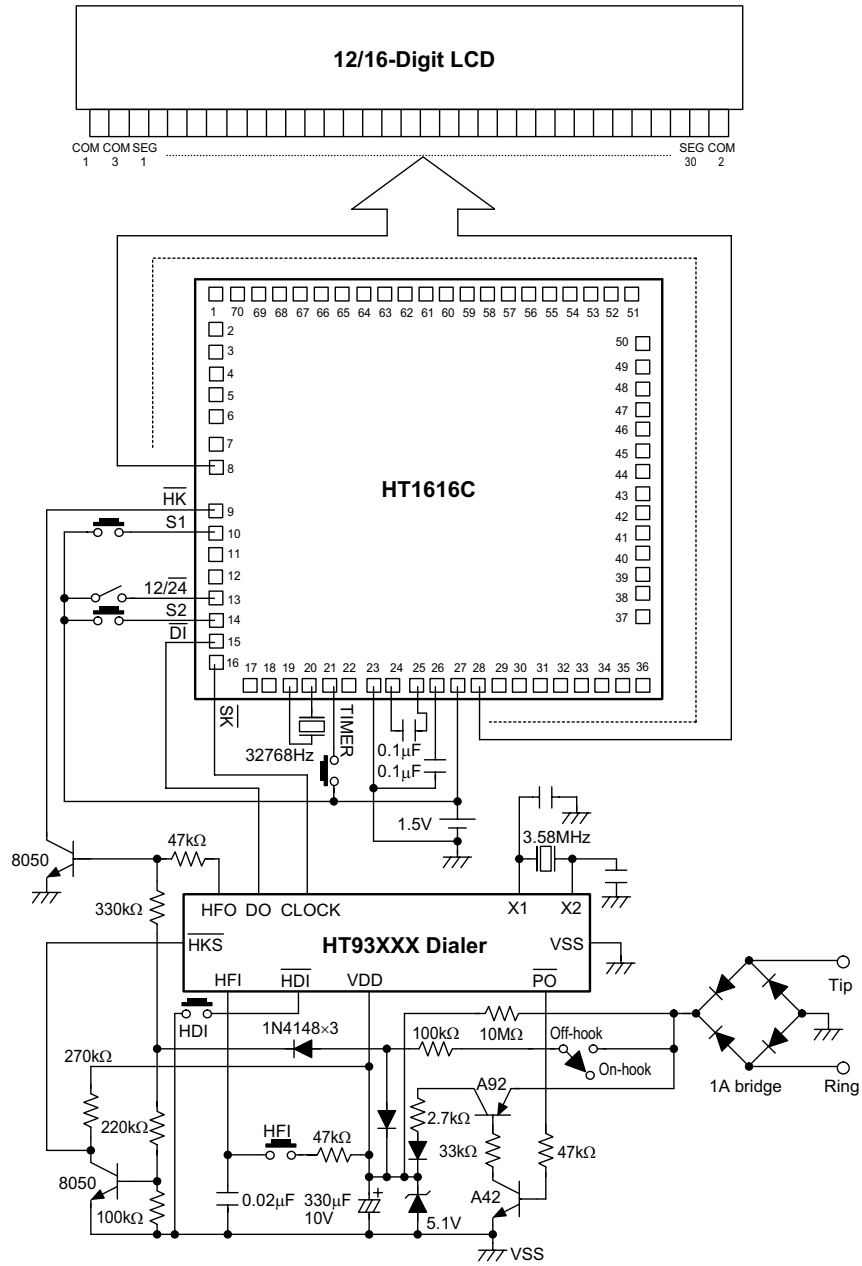


- Data latch timing for 5-bit pattern (MODE=1)



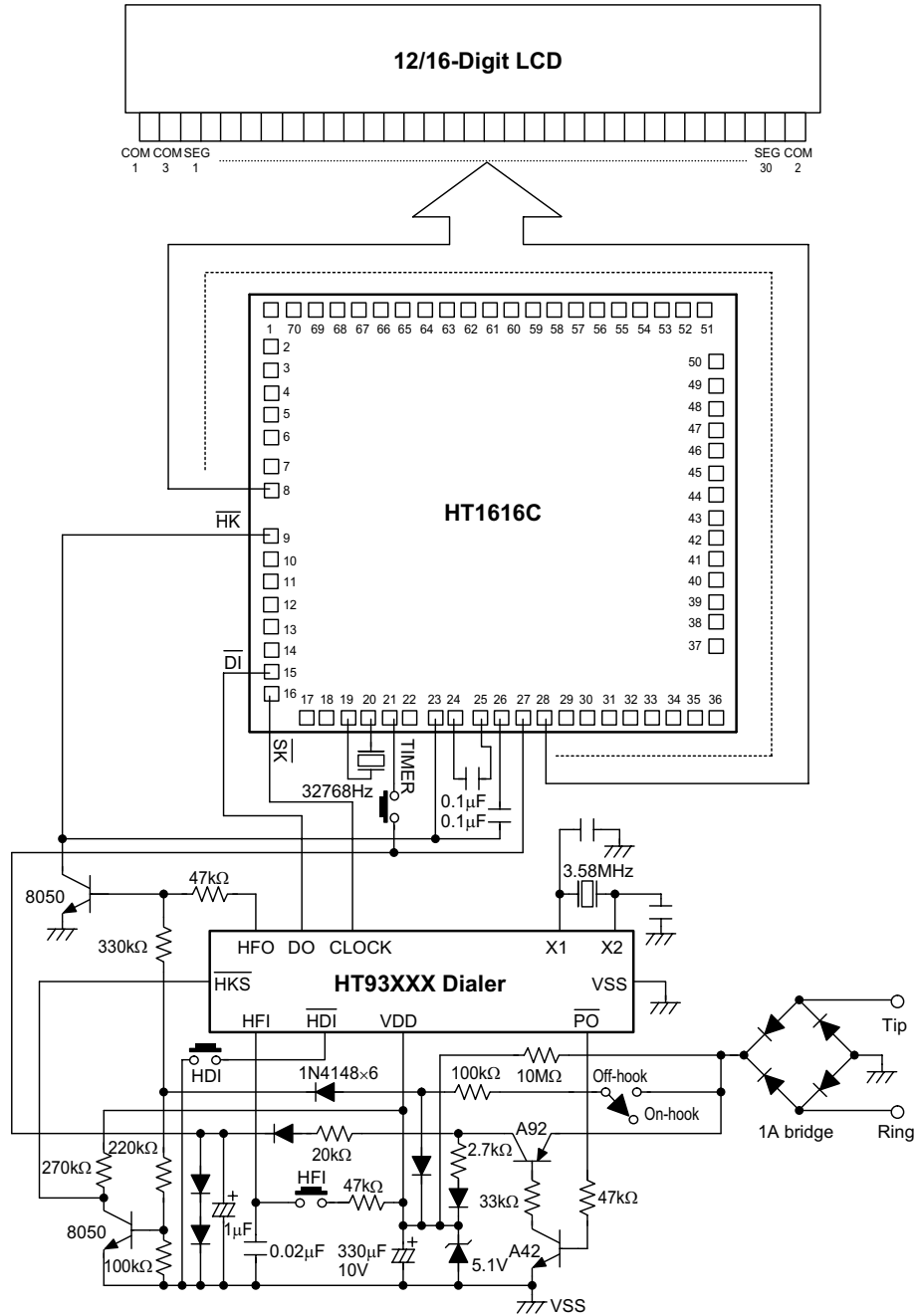
Application Circuits

For telephone interfacing (with batteries)



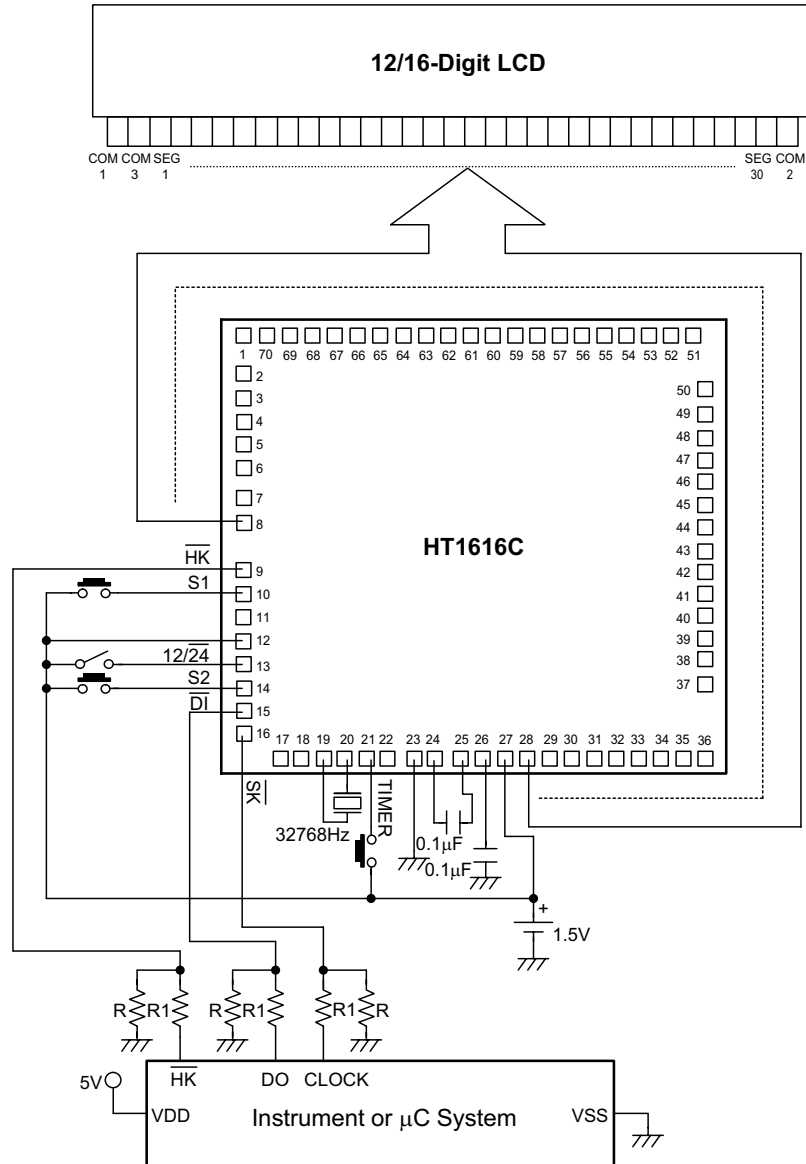
\* The IC substrate should be connected to VDD in the PCB layout artwork.

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 ( $R=4.3k\Omega$ ,  $R1=10k\Omega$ ).



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