HT3864
5.6 Second Voice Melody

Features

- Operating frequency: 1024kHz
- Operating voltage: 2.4V~5.0V
- 8 keys and 4 banks selection
- Low standby current (1μA for VDD=3V)
- 2 channels of melody and one channel of voices
- Minimal external components
- 32 tempos and 4 octaves of melody playing
- 5.6 seconds of voice capacity (based on a sampling rate of about 6kHz)
- A maximum of 2048 melody notes
- 8 programmable sampling rates of voices
- Programmable key debounce time and pull-high resistors
- Key options:
  - Retriggerable/Non-retriggerable
  - Level hold
  - Repeat/
  - Sequential playing (only for KEY1)
- FLAG options:
  - Busy output
  - 4Hz flash output
  - End-pulse output
  - Volume level display
- 24 DIP/SOP package

Applications

- Toys
- Alarm clocks
- Voice effect generators
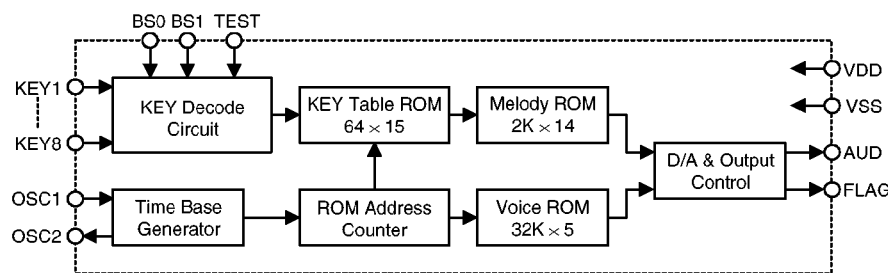- Products with a voice interface

General Description

The HT3864 is a single chip melody and voice synthesis IC implemented in a CMOS technology. It includes an on-chip voice and melody ROM for storing data, a key ROM of key address pointers and a current type of D/A converter for driving an external transistor. All elements are prepared for fabrication except the key option and ROM data. The customer's key function, voice and melody data are all programmable by changing one layer of the masked ROM.
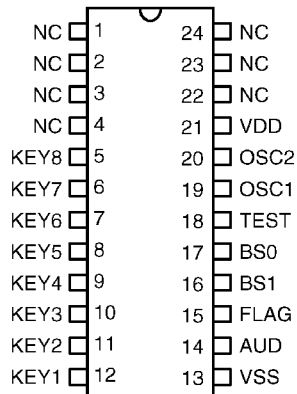
The HT3864 provides 8 key inputs along with 4 banks of key functions. Each bank stores a set of key functions corresponding to KEY1~KEY8, giving the customer a full range of 32 key functions available.
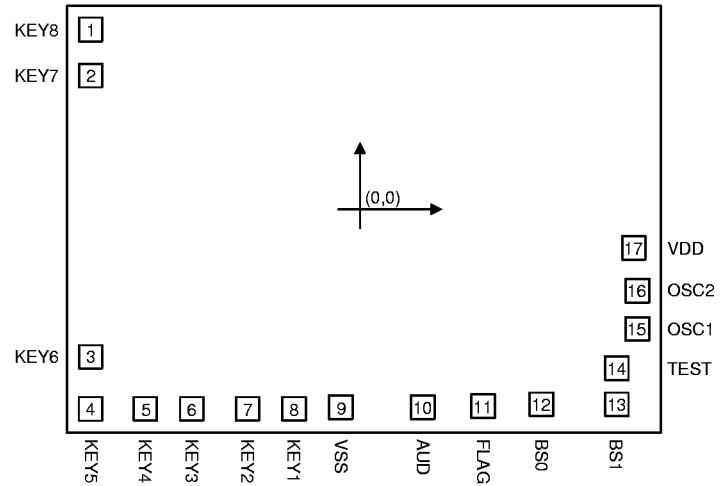
Block Diagram

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Pin Assignment

```
            ┌─────∪─────┐
      NC ┤ 1        24 ├ NC
      NC ┤ 2        23 ├ NC
      NC ┤ 3        22 ├ NC
      NC ┤ 4        21 ├ VDD
    KEY8 ┤ 5        20 ├ OSC2
    KEY7 ┤ 6        19 ├ OSC1
    KEY6 ┤ 7        18 ├ TEST
    KEY5 ┤ 8        17 ├ BS0
    KEY4 ┤ 9        16 ├ BS1
    KEY3 ┤ 10       15 ├ FLAG
    KEY2 ┤ 11       14 ├ AUD
    KEY1 ┤ 12       13 ├ VSS
            └───────────┘
```

HT3864
– 24 DIP/SOP

Pad Assignment

Chip size: $2960 \times 2330 \ (\mu m)^2$

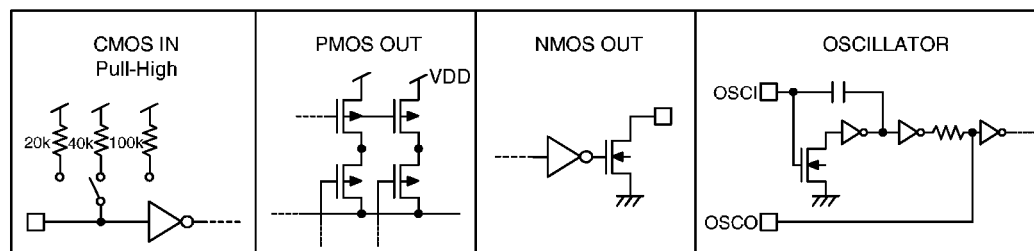* The ic substrate should be connected to VSS in the PCB layout artwork.

Pad Coordinates

Unit: μm

Pad No.	X	Y	Pad No.	X	Y
1	−1309.80	877.90	10	307.00	−962.00
2	−1309.80	653.00	11	599.00	−956.90
3	−1309.60	−716.40	12	882.80	−947.00
4	−1310.20	−970.40	13	1250.70	−947.00
5	−1043.50	−969.10	14	1250.70	−772.00
6	−818.70	−969.10	15	1349.90	−580.50
7	−546.50	−969.00	16	1349.90	−395.50
8	−321.70	−969.00	17	1332.50	−186.50
9	−94.10	−961.50			

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Pad Description

Pad No.	Pad Name	I/O	Internal Connection	Description
1~5,8	KEY8~KEY4 KEY1	I	Pull-High	Trigger key, low active
6~7	KEY3~KEY2	I/O	Pull-High	Trigger key,active low Outputs mode for IC test only
9	VSS	I	—	Negative power supply (GND)
10	AUD	O	PMOS	Voice output for driving an external transistor
11	FLAG	O	NMOS	Active low, programmable display mode (refer to the functional description)
12,13	BS1,BS0	I	Pull-High (push button selection mode) or Floating (Two switch selection mode)	A selection of 4 banks (BANK0~BANK3) of key functions is provided. Each bank stores a set of key functions corresponding to KEY1~KEY8. Two kinds of bank selection mode can be chosen by mask option, namely (refer to the functional description) Mode 1: BS0 push button selection mode Mode 2: BS0/BS1 two switch selection mode
14	TEST	I	Pull-High	For IC test only
15	OSC1	I	—	Oscillator input pin
16	OSC2	O	—	Oscillator output pin
17	VDD	I	—	Positive power supply

Approximate internal connection circuit

Absolute Maximum Ratings*

Supply Voltage ....−0.3V to 6V

Input Voltage................. V_{SS}–0.3V to V_{DD}+0.3V

Storage Temperature.................−50°C to 125°C

Operating Temperature...................−20°C to 70°

*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 extened periods may affect device reliability.

Electrical Characteristics

(Ta=25°C)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.4	3	5	V
I_{DD}	Operating Current	3V	No load, F_{OSC}=1024kHz	—	500	1000	μA
I_{STB}	Standby Current	3V	—	—	1	3	μA
I_{AUD}	Max. AUD Output Current	3V	V_{OH}=0.6V	−1.5	−2	—	mA
I_{OL}	FLAG Sink Current	3V	V_{OL}=0.3V	2.5	5	—	mA
R_{PH1}	Input Pull-High Resistance	3V	—	10	20	30	kΩ
R_{PH2}	Input Pull-High Resistance	3V	—	20	40	60	kΩ
R_{PH3}	Input Pull-High Resistance	3V	—	50	100	150	kΩ
V_{IH}	"H" Input Voltage	—	—	0.8V_{DD}	—	V_{DD}	V
V_{IL}	"L" Input Voltage	—	—	0	—	0.2V_{DD}	V
F_{OSC}	System Frequency	3V	R_{OSC}=36kΩ	920	1024	1150	kHz

Functional Description

The HT3864 is a single chip melody and voice synthesizer with 5.6 second voice capacity at a sampling rate of about 6kHz. A maximum of 2048 notes can be programmed for melody composition.

The IC provides 8 key inputs (KEY1~KEY8), 4 banks of key functions as well as a FLAG output.
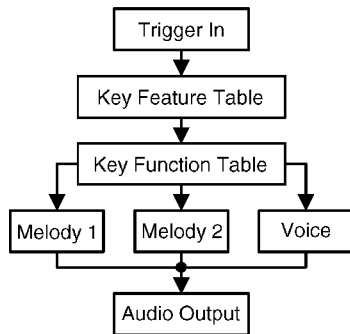
Programming

HOLTEK's engineers will edit the sources, compose the melodies with CAD tools and verify the result in an EV (evolution) board after receiving the customer's voice/melody sources (recorded audio tape, CD or other media) and key function specifications. Then, the edited codes will be recorded into voice ROM by programming a layer of the mask.

Play

The functions of each key specified by the customer are recorded in the key function table. A group of sections and melodies is played according to the instructions of the key function table each time the chip receives a key trigger input.

Trigger signal flow

KEY1~KEY8

The HT3864 provides 8 key inputs (KEY1~KEY8) along with 4 banks of key functions, giving the customer a full range of 32 different key inputs. KEY1~KEY8 are all trigger keys. The 32 different key inputs can be independently programmed as following mode:

- retriggerable
- non-retriggerable
- repeat
- level hold

But KEY1 alone can be selected as a sequential key.

The key-in pull-high resistors are selected by mask option, namely

- 20kΩ
- 40kΩ
- 100kΩ

The key debounce time is also selected by mask option as shown:

- 0 ms for KEY8 only
- 700 μs for all KEYs
- 22 ms for all KEYs
- 45 ms for all KEYs
- 90 ms for all KEYs

The key priority is set as follows:

KEY1>KEY2>....>KEY7>KEY8.

Bank selection

The HT3864 provides 4 banks of key functions.

Each bank can be programmed and stores a set of key functions corresponding to KEY1~KEY8. The voices of a bank comes into play each time a key of KEY1~KEY8 is triggered. A maximum of 4 kinds of voices can be played by selecting different banks of the same key. The total amount of key inputs available is 32.

The BS0 and BS1 pins decide the selection bank mode. Two kinds of bank mode can be selected by mask option:

- Mode 1: BS0 push button selection mode (BS1 not used)

  The bank number beginning at BANK0 is increased by one each time BS0 is pressed. The banks are selected in the following way:
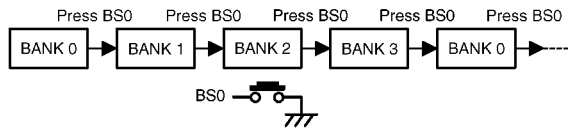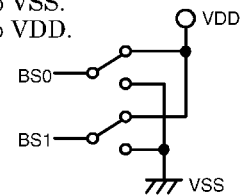

- Mode 2: BS0 and BS1 two switch selection mode

  In Mode 2, banks are selected in the following way:

BANK KEY	BANK 0	BANK 1	BANK 2	BANK 3
BS0	1	0	1	0
BS1	1	1	0	0

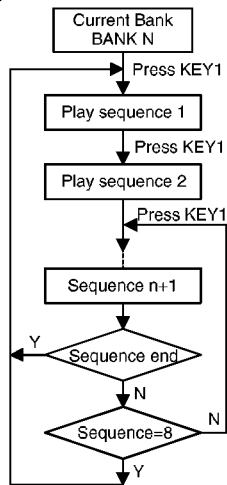Note: 0: Connect to VSS.
1: Connect to VDD.

Bank function

Sequence or direct bank can be selected if KEY1 is set as a sequential key and the mode of bank selection is in the push button mode. On the other hand, only direct bank can be chosen if the mode of bank selection is in the 2 switch mode.
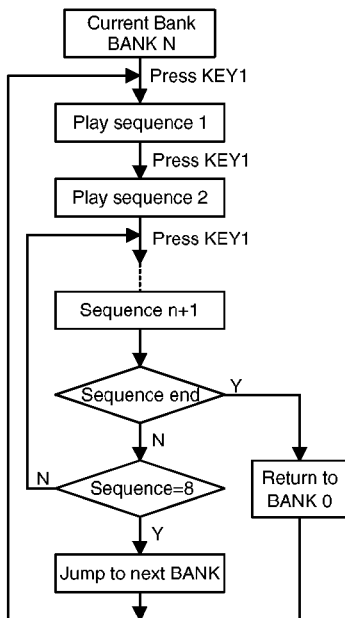
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- Direct bank

  The 4 banks of key functions, on the other hand, are independent when the direct bank operation is chosen. In other words, the sequential cycle of KEY1 can be 8 at maximum.

```
        ┌──────────────────┐
        │  Current Bank    │
        │    BANK N        │
        └──────────────────┘
                  │
          ┌───────▼──────── Press KEY1
          │    ┌──────────────────┐
          │    │ Play sequence 1  │
          │    └──────────────────┘
          │              │ Press KEY1
          │    ┌──────────────────┐
          │    │ Play sequence 2  │
          │    └──────────────────┘
          │              │ Press KEY1
          │              ▼
          │    ┌──────────────────┐
          │    │  Sequence n+1    │
          │    └──────────────────┘
          │              │
        Y ◄─────◄ Sequence end ►
          │              │ N
          │              ▼        N
          │        ◄ Sequence=8 ►──┐
          │              │ Y       │
          └──────────────▼─────────┘
```

- Sequence bank

  The 4 banks of key functions are all cascaded when the sequence bank operation is selected. That is to say, the sequential cycle of KEY1 can be 32 at maximum.

```
        ┌──────────────────┐
        │  Current Bank    │
        │    BANK N        │
        └──────────────────┘
                  │
          ┌───────▼──────── Press KEY1
          │    ┌──────────────────┐
          │    │ Play sequence 1  │
          │    └──────────────────┘
          │              │ Press KEY1
          │    ┌──────────────────┐
          │    │ Play sequence 2  │
          │    └──────────────────┘
          │              │ Press KEY1
          │    ┌──────────────────┐
          │    │  Sequence n+1    │
          │    └──────────────────┘
          │              │
          │      ◄ Sequence end ►── Y ──┐
          │              │ N           │
          │              ▼        N  ┌──────────┐
        N ◄──── ◄ Sequence=8 ►──    │Return to │
          │              │ Y         │ BANK 0   │
          │    ┌──────────────────┐ └──────────┘
          └────│ Jump to next BANK│
               └──────────────────┘
```

Oscillator

The HT3864 is built-in with an RC oscillator which requires only one external resistor for normal applications.

The oscillator is turned off when the system is in the standby state. The following diagram demonstrates the way of connecting the circuits:
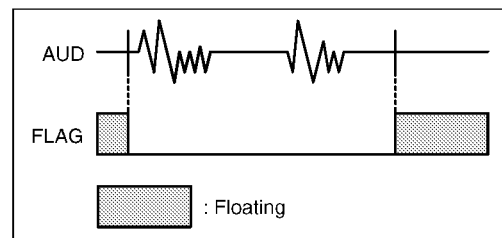
```
      ┌──────────┐
      │      OSC1├──────┐
      │ HT3864   │      ≷ Rosc
      │      OSC2├──────┘
      └──────────┘
```
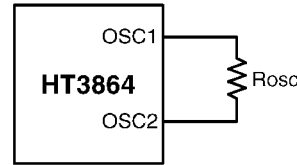
FLAG output

The FLAG pin can be programmed by mask option, giving one of the following 4 kinds of functions:

- Busy output

  The FLAG pin is turned low and the FLAG LED is switched on when a voice output occurs. It becomes floating and the FLAG LED is switched off once the voice output is terminated.
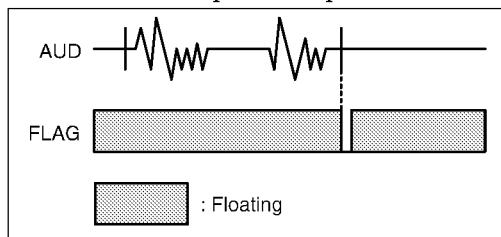
```
  AUD ──┤\/\/\/w───────\/\/\w──┤──────
  FLAG  ▓▓                        ▓▓▓▓▓
        ┌────────┐
        │ ▓▓▓▓▓▓ │ : Floating
        └────────┘
```

- 4Hz flash output

  The FLAG LED flashes with a 4Hz rate, and the LED turn-on duty is 25% when there are voices output.

```
  AUD ──┤\/\/\/w───────\/\/\w──┤──────
  FLAG  ▓ ▓ ▓ ───────── ▓ ▓ ▓▓▓
        ┌────────┐
        │ ▓▓▓▓▓▓ │ : Floating
        └────────┘
```
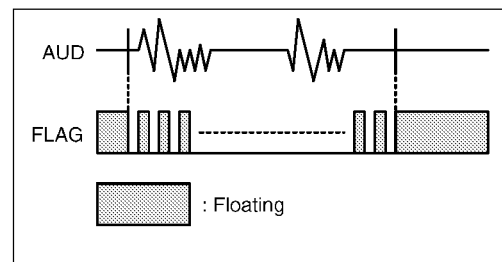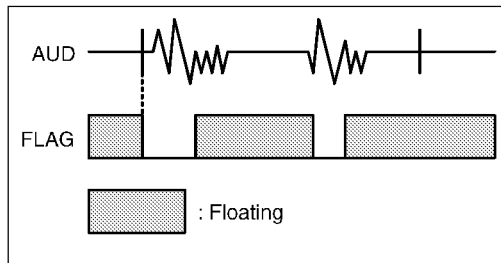
- End-pulse output

  The FLAG pin outputs an active low pulse when the voice output is completed.

- Volume level display

  The brightness of LED varies with the volume.

Melody output

Two independent melody outputs are available with 32 tempos, 4 octaves and 14 beats programmable Four kinds of envelope decay can be selected as shown.

- 32 tempos (Beats/Min.)

60.98	62.50	65.79	69.44	73.55
78.125	83.33	86.21	89.29	92.59
96.15	100	104.17	108.70	113.64
119.05	121.95	125	131.58	138.89
147.06	156.25	166.67	172.41	178.57
185.19	192.31	200	208.33	217.39
227.27	238.10			

- 4 octaves

 $C3^{\#} \sim C4$, $C4^{\#} \sim C5$, $C5^{\#} \sim C6$, $C6^{\#} \sim C7$

- 14 beats

  $0, \dfrac{1}{8}, \dfrac{1}{6}, \dfrac{1}{4}, \dfrac{1}{3}, \dfrac{1}{2}, \dfrac{2}{3}, \dfrac{3}{4}, 1, 1\dfrac{1}{2}, 2, 3, 4, 5$

- Envelope decay

  The envelope decay decides the melody output decay time. It provides four kinds of envelope decay (Fast, Middle, Slow, Slowest) by mask option.

AUD

The AUD pin is a PMOS open drain structure. It outputs voice signals to drive a speaker through an external NPN transistor when the chip is active. Once the chip is in the standby state, this pin becomes floating.
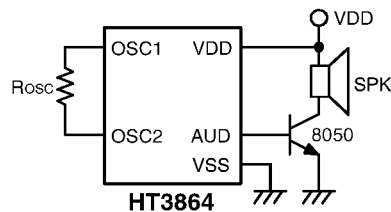
Mask option

- Key options:Retriggerable/non-retriggerable/Level hold/Repeat
  Sequential playing (only for KEY1)
- FLAG options: Busy/4Hz flash/End-pulse/Volume level display
- Envelope decay rate: Fast/Middle/Slow/Slowest
- Pull-high resistor: 20kΩ/40kΩ/100kΩ
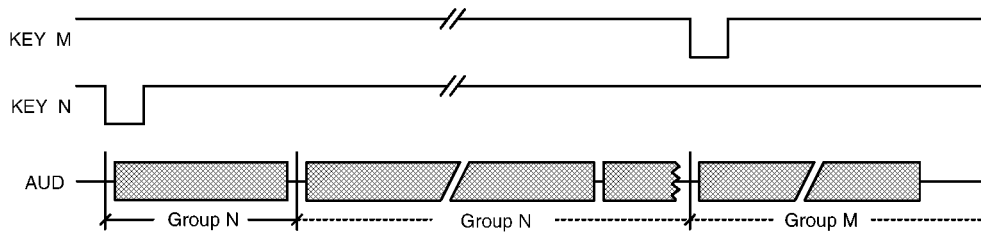- Key debounce time: 700μs/22ms/45ms/90ms
  0μs only for key8

Mask Option of KEY1~KEY8

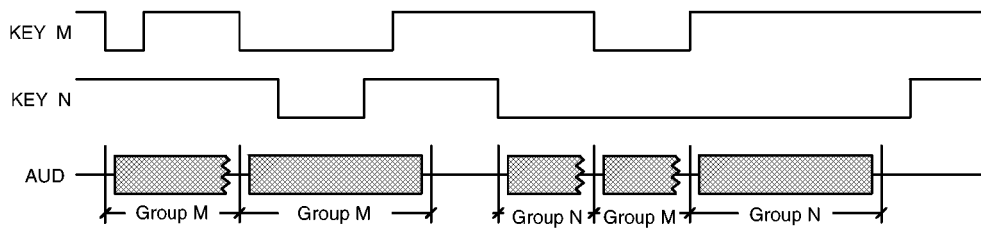| Function / KEY	Sequential Key	Retrigger & Repeat	Retrigger & Non-Repeat	Non-Retrigger	Level Hold	Debounce Time					Pull-High Resistor		
						0	700μs	22ms	45ms	90ms	20KΩ	40KΩ	100KΩ
KEY1													
KEY2													
KEY3													
KEY4	—				—	—							
KEY5													
KEY6													
KEY7													
KEY8													

Note: The 8 KEYs (KEY1~KEY8) of 4 BANKs can all be optioned as a retriggerable/
non-retriggerable, level hold or repeat trigger key independently.
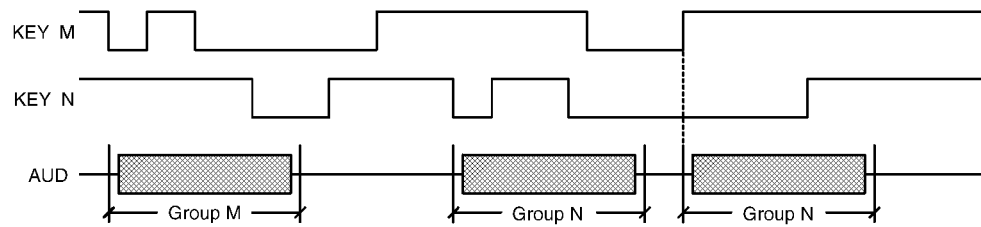"—": Means "inapplicable".
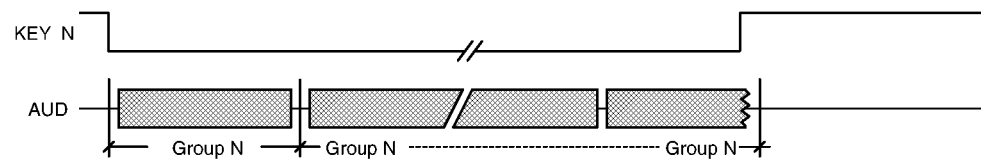
Timing Diagram

Retriggerable & repeat

KEY M

KEY N

AUD

Group N — Group N — Group M

Retriggerable & non-repeat

KEY M

KEY N

AUD

Group M — Group M — Group N — Group M — Group N

Non-retriggrable

KEY M

KEY N

AUD

Group M — Group N — Group N
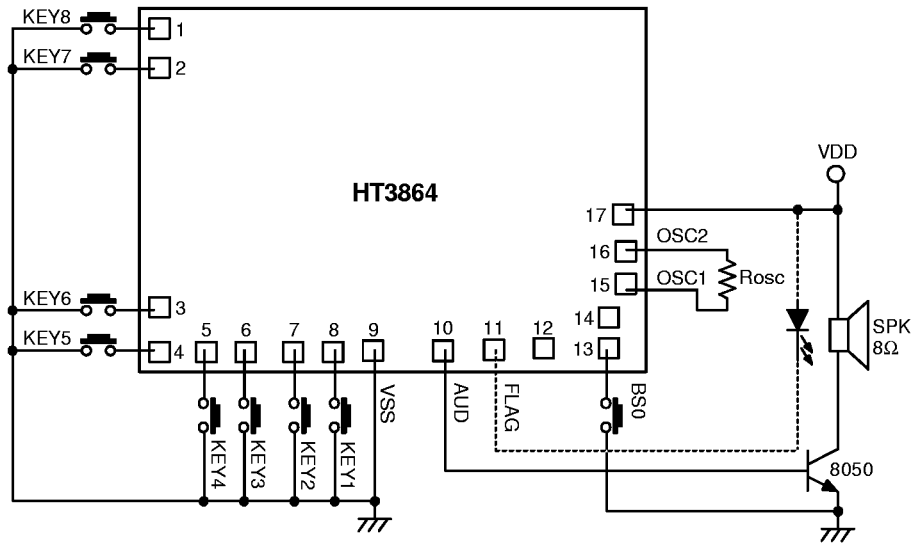
Level-hold

KEY N

AUD

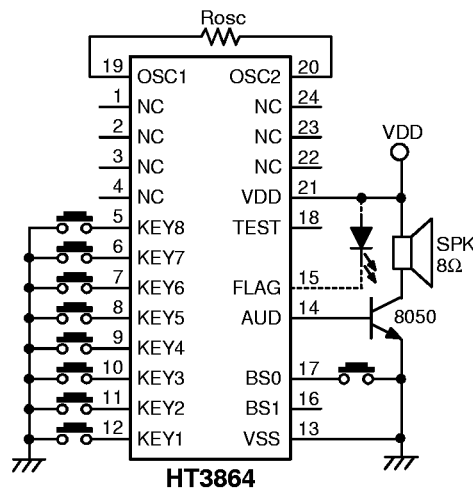Group N — Group N — Group N

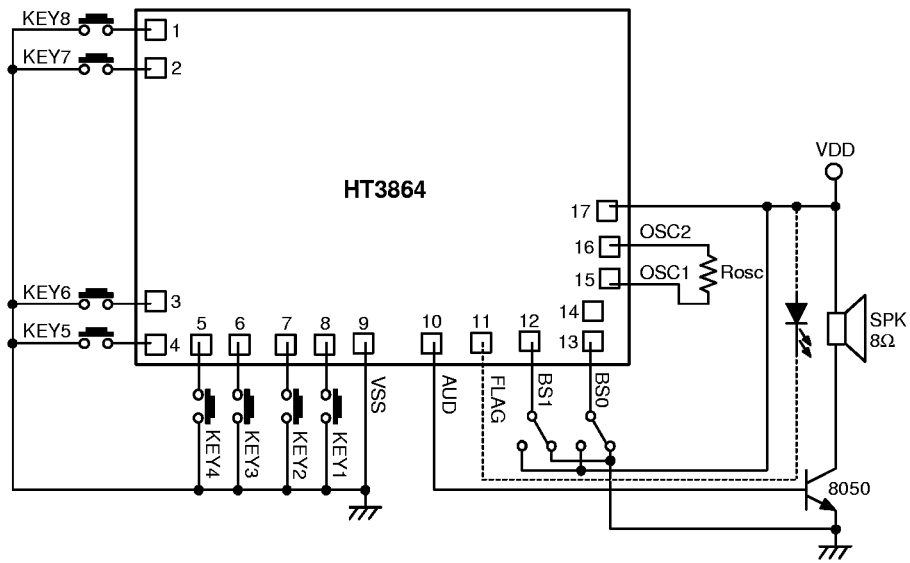* Note: The key priority: KEY M > KEY N.

Application Circuits

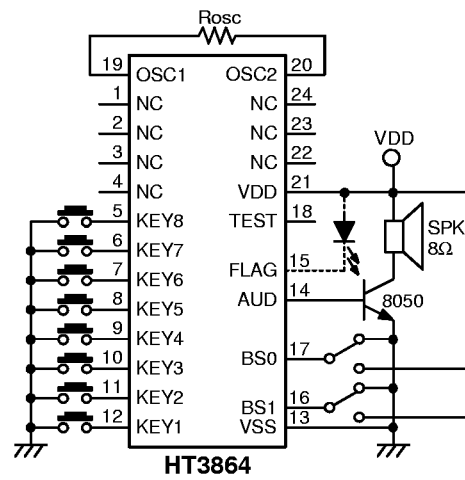**MODE 1: BS0 push button bank selection mode**

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

MODE 2: BS0 and BS1 two switch bank selection mode

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

Standard Item List

HT3864A (Melody voice for child song)

BANK0	KEY Name
KEY1	If You Are Happy
KEY2	Old MacDonald
KEY3	Mary Had A Little Lamb
KEY4	The Old Folks At Home
KEY5	Stagecoach
KEY6	Song Of Joy
KEY7	Yankee Doodle
KEY8	Picnic

BANK1	KEY Name
KEY1	Row Row Row Your Boat
KEY2	London Bridge Is Falling Down
KEY3	Symphony No.9
KEY4	Jingle Bell
KEY5	A_tiskey, A_taskey
KEY6	This Old Man
KEY7	Twinkle Twinkle Little Star
KEY8	Rudolph The Red_nosed Reindeer

BANK2	KEY Name
KEY1	Dog
KEY2	Cat
KEY3	Sheep
KEY4	Cow
KEY5	Pig
KEY6	Duck
KEY7	Horse
KEY8	Chicken

BANK3	KEY Name
KEY1	Do4
KEY2	Re4
KEY3	Mi4
KEY4	Fa4
KEY5	So4
KEY6	La4
KEY7	Si4
KEY8	Do5

Notes: Pull-high resistor: 100K
Key option: All key are retriggerable
Flag display: 4Hz flash flag
Bank selection: Two switch selection

HT3864B (X'mas on the farm)

BANK0	KEY Name
KEY1	Angels We Have Heard on High
KEY2	The First Noel
KEY3	Joy To The World
KEY4	Santa Claus Is Coming To Town
KEY5	Silver Bells
KEY6	Wewish You A Merry Christmas
KEY7	HARK! The Herald Angels Sing
KEY8	O Christmas Tree

BANK1	KEY Name
KEY1	Winter Wonderland
KEY2	Jingle Bells
KEY3	Jesus Loves Me
KEY4	Holy Night
KEY5	Angels We Have Heard On High
KEY6	Up On The Housetop
KEY7	The First Noel
KEY8	Joy To The World

BANK2	KEY Name
KEY1	Chicken
KEY2	Dog
KEY3	Cow
KEY4	Turkey
KEY5	Sheep
KEY6	Cat
KEY7	Duck
KEY8	Pig

BANK3	KEY Name
KEY1	Do
KEY2	Re
KEY3	Mi
KEY4	Fa
KEY5	So
KEY6	La
KEY7	Si
KEY8	Do

Notes: Pull-high resistor: 100K
           Key option: All key retriggerable
           Flag display: Sound level flag
           Bank selection: Two switch selection

HT3864C (Brass Session)

• Trumpet

BANK0	KEY Name
KEY1	Camptown Races
KEY2	Do
KEY3	Mi
KEY4	So
KEY5	Do
KEY6	When The Saints Go Marching In
KEY7	Comin' Round The Mountain
KEY8	Little Beer In The Woods

• Saxphone

BANK1	KEY Name
KEY1	London Bridge Is Falling Down
KEY2	Do
KEY3	Mi
KEY4	So
KEY5	Do
KEY6	Did You Ever See a Lassie?
KEY7	Joyous Farmer
KEY8	Skip To My Lou

• Clarinet

BANK2	KEY Name
KEY1	Are You Sleeping
KEY2	Do
KEY3	Mi
KEY4	So
KEY5	Do
KEY6	Sur Le Pont d'Avignon
KEY7	Lightly Row
KEY8	Where, Oh Where Has My Little Dog Gone?

• Trombone

BANK3	KEY Name
KEY1	This Old Man
KEY2	Do
KEY3	Mi
KEY4	So
KEY5	Do
KEY6	If Your Are Happy
KEY7	Row, Row, Row Your Boat
KEY8	Bow Belinda

Notes: Pull-high resistor: 40K
Key option: Key1 is non-retriggerable, other are retriggerable and non-repeat
Flag display: Sound level
Bank selection: Two switch selection

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HT3864D (Simple Guitar)

• Solo

BANK0	KEY Name
KEY1	Solo 1
KEY2	Solo 2
KEY3	Solo 3
KEY4	Solo 4
KEY5	Solo 5
KEY6	Solo 6
KEY7	Solo 7
KEY8	Solo 8

• Note

BANK1	KEY Name
KEY1	Do
KEY2	Re
KEY3	Mi
KEY4	Fa
KEY5	So
KEY6	La
KEY7	Si
KEY8	Do

• Rhythm

BANK2	KEY Name
KEY1	Rhythm 1
KEY2	Rhythm 2
KEY3	Rhythm 3
KEY4	Rhythm 4
KEY5	Rhythm 5
KEY6	Rhythm 6
KEY7	Rhythm 7
KEY8	Rhythm 8

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• Melody

BANK3	KEY Name
KEY1	London Bridge Is Falling Down
KEY2	Oh, Susanna
KEY3	If You Are Happy
KEY4	Stagecoach
KEY5	Turkey In The Straw
KEY6	Old Macdonald Had a Farm
KEY7	The Yellow Rose of Texas
KEY8	Down by the Riverside

Notes: Pull-high resistor: 100K
Key option: On Bank0, all key are level hold, other banks are retriggerable and non-repeat
Flag display: Sound level flag
Bank selection: Two switch selection