NOVATEK

NT93401-04

High Feature Phone LSI

Features

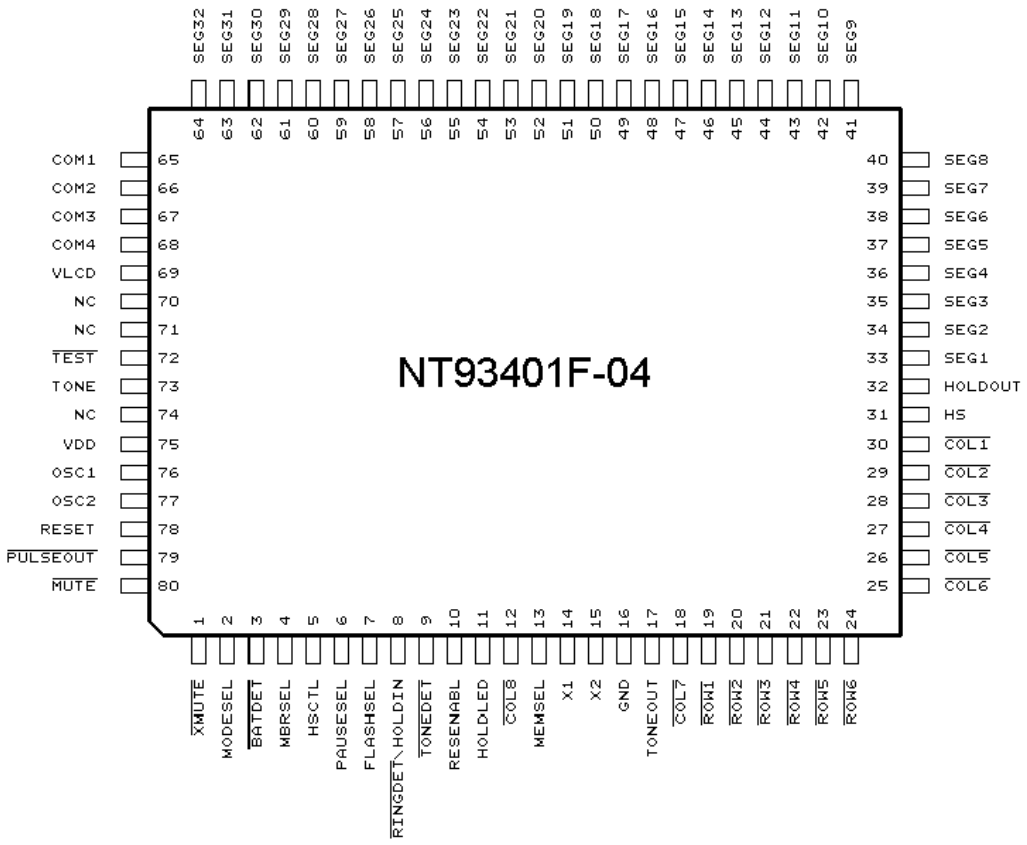
- High feature phone LSI based on a CMOS 4-bit single chip microcomputer with 4096 x 10 bit ROM and 1024 x 4 bit RAM capacity
- Built-in DTMF generator and on-chip pulse dialer
- Bank key function
- 30 or 40 memory locations by pin selection
- Auto-start watch
- Restriction dialing
- If RESENABL pin is logic low, the restriction number 0 is given
- Chain dialing
- Manual dial as many digits as entered
- Redial function (up to 48 digits)
- One touch auto dialing (up to 30/40 locations and up to 24/18 digits each)
- Abbreviated auto dialing (up to 30/40 locations and up to 24/18 digits each)
- Mixture of one touch and abbreviated auto dialing (use the same memory space)
- Switchable tone and pulse dialing
- Dial speed of 10 pps
- Low battery power detect input
- Make/Break ratio of 40/60 or 33/67 (pin selectable)
- Speaker phone control output
- Key-in tone output
- Bank, auto redial, store, alarm, AM, PM, low battery hold, and speaker indicators are assigned to their corresponding LCD display dots
- Manual HOLD key controls HOLDOUT and HOLD LED signal. The HOLDOUT can be reset by HOLDIN pin
- Manual mute key controls $\overline{\text{XMUTE}}$ or $\overline{\text{MUTE}}$ signal. When mute is active, the speaker indicator is flashing
- Programmable pause time from 1 to 5 seconds. (1 sec resolution)
  Initial pause time is pin selectable (2 or 4 seconds)
- Programmable flash time from 90 to 900 msec. (100 msec resolution)
  Initial flash time is pin selectable (90 or 600 msec)
- Programmable auto redial repeating cycle from 1 to 15 times and programmable redial interval from 10 to 60 seconds (10 sec resolution)
  Initial auto redial parameters are 10 times and 30 seconds
- Auto redial key for Italy and UK systems
- Search dial function. User can use this function to search empty or desired memory locations. The searched phone number can be dialed out directly
- Built-in LCD driver and direct interface with 16-digit LCD display
- Calendar and real time clock display with 12-hour format and AM/PM indicator
- Alarm function
- Error display and error beep when key is incorrectly entered
- 6 x 8 matrix keyboard interface
- Partial reset is possible and phone number memory will not be cleared
- Operating Voltage Range: 2.5V - 5.5V

General Description

NT93401-04 is a CMOS, silicon integrated circuit designed for high feature phones with a high-precision dual tone multi-frequency (DTMF) circuit, LCD driver/ controller, and a 32 KHz watch oscillator circuit.

The device includes one touch dialing, programmable pause, flash, auto redial and real time clock function, and more.

Pin Configuration



Keyboard Configurations

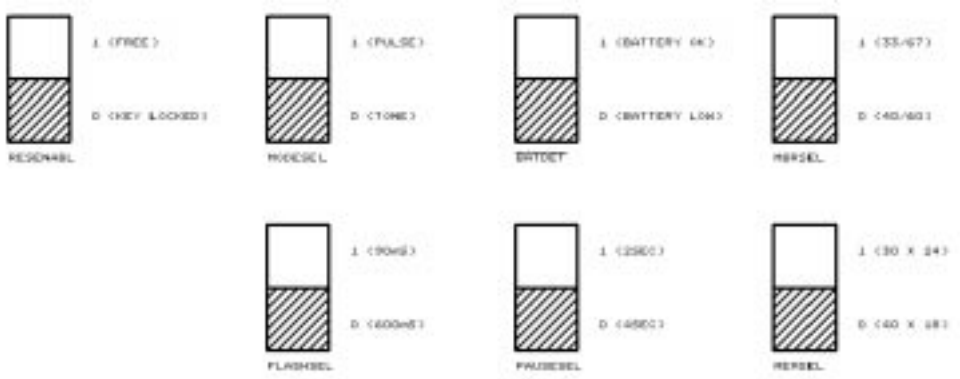
"MEMSEL" = "H" 30 memory locations

1	2	3	M01 M16	M02 M17	M03 M18	SPK/DIAL	REDIAL ONLY	$\overline{ROW1}$
4	5	6	M04 M19	M05 M20	M06 M21	MREDIAL	UK REDIAL	$\overline{ROW2}$
7	8	9	M07 M22	M08 M23	M09 M24	SEARCH	ITALY REDIAL	$\overline{ROW3}$
*/AM	0	#/PM	M10 M25	M11 M26	M12 M27	XHOLD	XMUTE	$\overline{ROW4}$
TONE	PAUSE	FLASH	M13 M28	M14 M29	M15 M30	MHOLD	MUTE	$\overline{ROW5}$
XREDIAL	MEM	STR	SPK	STW	ALARM	BANK	CLOCK	$\overline{ROW6}$
$\overline{COL1}$	$\overline{COL2}$	$\overline{COL3}$	$\overline{COL4}$	$\overline{COL5}$	$\overline{COL6}$	$\overline{COL7}$	$\overline{COL8}$	

"MEMSEL" = "L" 40 memory locations

1	2	3	M01 M21	M02 M22	M03 M23	SPK/DIAL	M16 M36	$\overline{ROW1}$
4	5	6	M04 M24	M05 M25	M06 M26	MREDIAL	M17 M37	$\overline{ROW2}$
7	8	9	M07 M27	M08 M28	M09 M29	SEARCH	M18 M38	$\overline{ROW3}$
*/AM	0	#/PM	M10 M30	M11 M31	M12 M32	XHOLD	M19 M39	$\overline{ROW4}$
TONE	PAUSE	FLASH	M13 M33	M14 M34	M15 M35	MHOLD	M20 M40	$\overline{ROW5}$
XREDIAL	MEM	STR	SPK	STW	ALARM	BANK	CLOCK	$\overline{ROW6}$
$\overline{COL1}$	$\overline{COL2}$	$\overline{COL3}$	$\overline{COL4}$	$\overline{COL5}$	$\overline{COL6}$	$\overline{COL7}$	$\overline{COL8}$	

Pin Selectable Switch



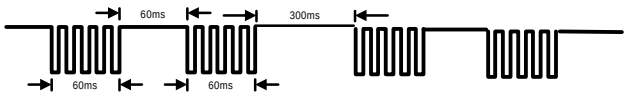
■ Key function

1. "0 ~ 9" key : Number key
2. "*/AM", "#/PM" key : Data key or real time clock setting key
3. "PAUSE" key : Pause key
4. "STR" key : Store key
5. "CLOCK" key : Clock key
6. "SPK" key : Speaker mode (HANDS-FREE mode) select key
7. "TONE" key : Pulse → tone change key
8. "MEM" key : Abbreviated dial recall key
9. "STW" key : Stopwatch start/stop key
10. "ALARM" key : Alarm key
11. "M01 ~ M30" key : One touch dial recall key for 30 memory locations
12. "M01 ~ M40" key : One touch dial recall key for 40 memory locations
13. "BANK" key : One touch dial memory bank select key
14. "FLASH" key : Flash key, which can be stored to memory location
15. "MUTE" key : Mute key used to control the $\overline{\text{MUTE}}$ signal
16. "XMUTE" key : Mute key used to control the $\overline{\text{XMUTE}}$ signal
17. "MHOLD" key : Hold key used to control the HOLDOUT, HOLDLED and $\overline{\text{XMUTE}}$ signals
18. "XHOLD" key : Hold key used to control the HOLDOUT, HOLDLED and $\overline{\text{XMUTE}}$ signal
19. "REDIAL ONLY" key : Redial key designed for feature phone without auto redial function
20. "XREDIAL" key : Redial and autoredial key designed for world area and $\overline{\text{XMUTE}}$ system. That is, $\overline{\text{XMUTE}}$ signal is active during autoredialing.
21. "MREDIAL" key : Redial and autoredial key designed for world area and $\overline{\text{MUTE}}$ system. That is, $\overline{\text{MUTE}}$ signal is active during autoredialing.
22. "UK REDIAL" key : Redial and autoredial key designed for UK area and $\overline{\text{XMUTE}}$ system. That is, $\overline{\text{XMUTE}}$ signal active during autoredialing.
23. "ITALY REDIAL" key : Redial and autoredial key designed for Italy area $\overline{\text{XMUTE}}$ system. That is, $\overline{\text{XMUTE}}$ signal is active during autoredialing.
24. "SEARCH" key : Search key used to search empty memory location or desired phone number. If all the memory locations are occupied, the LCD will show the contents of memory location M01. Otherwise, the LCD will show the empty location. The memory location contents can be cleared by using "SEARCH" and "FLASH" keys.
25. "SPK/DIAL" key : Speaker and search dial key. This key is a speaker key and can be used to dial out the desired phone number which is searched by "SEARCH" key.

Pin Description

Pin No.	Symbol	I/O	Description
1	$\overline{\text{XMUTE}}$	O	XMute Output. Active low when pulse is being dialed. (See additional description for details.)
2	MODESEL	I	DIAL mode select input Low: TONE mode. High: PULSE mode
3	$\overline{\text{BATDET}}$	I	Battery power detect input Low: low battery High: battery ok If $\overline{\text{BATDET}}$ is not used, this pin can be floating.
4	MBRSEL	I	Make/Break ratio select input Low: 40/60 High: 33/67
5	HSCTL	O	Hook switch control. Normal low. When auto redial function is active, this pin will go high level for connecting line. Speaker phone on : high Speaker phone off : low HS pin high $\rightarrow$ low : low
6	PAUSESEL	I	Initial pause time select pin Low: 4 sec High: 2 sec
7	FLASHSEL	I	Initial flash time select pin Low: 600 msec High: 90 msec
8	$\overline{\text{RINGDET}}$ /HOLDIN	I	Incoming call detect input or hold release detect input. See Additional Description for details.
9	$\overline{\text{TONEDET}}$	I	Dial or Busy tone detect input. Normal high. When call progress tone is detected, this pin must be low level.
10	RESENABL	I	Key lock status input Low: Key Locked High: Free
11	HOLDLED	O	Hold LED drive pin 0.5 sec on and 0.5 sec off for HOLD mode
12	$\overline{\text{COL8}}$	I	Keyboard interface
13	MEMSEL	I	Number of memory location select input: Low: M1~M40 High: M1~M30
14 15	X1 X2		Watch Oscillator input A 32.768 KHz crystal is used
16	GND		Ground

Pin Description (continued)

Pin No.	Symbol	I/O	Description
17	TONEOUT	O	Key-in tone and alarm output Key-in tone is 875 Hz and outputs for about 60 msec. Alarm tone frequency is 1.75 KHz  Alarm waveform
18	$\overline{COL7}$	I	Keyboard interface
19 ~ 24 25 ~ 30	$\overline{ROW1}$/ $\overline{ROW6}$ / $\overline{COL6}$ ~ $\overline{COL1}$	O I	Keyboard interface
31	HS	I	Hook switch input Low: off hook High: on hook
32	HOLDOUT	O	Hold output pin. (See hold function timing for details.)
33 ~ 64 65 ~ 68	SEG1 ~ 32 COM1 ~ 4	O O	LCD Interface
69	VLCD	I	Power supply pin for LCD driver VLCD is referred to driving voltage of LCD
70, 71	NC	I	These pins should be floating.
72	$\overline{TEST}$	I	Connect to VDD, in normal operation
73	TONE	O	DTMF signal output pin. 10K ohm resistor is required to pull low.
74	NC		This pin should be floating
75	VDD		Power supply (2.5 - 5.5V)
76 77	OSC1 OSC2		System Clock Oscillator input A 3.5795 MHz crystal is used
78	RESET	I	Resets the LSI. High active
79	$\overline{PULSEOUT}$	O	Dial pulse output
80	$\overline{MUTE}$	O	Mute output. Active low when tone or pulse is being dialed. See additional description for details.

■ **Additional description for NT93401-04 $\overline{\text{MUTE}}$ and $\overline{\text{XMUTE}}$ signals.**

Definition of $\overline{\text{MUTE}}$ and $\overline{\text{XMUTE}}$ signals:

$\overline{\text{XMUTE}}$ (pin 1):

1. Active low when pulse is being dialed.
2. Active low, if XREDIAL key is used, during auto-redial process.
3. $\overline{\text{XMUTE}}$ has toggle output controlled by XMUTE key.
4. Active low, if XHOLD key is used, during HOLD mode.

$\overline{\text{MUTE}}$ (pin 80):

1. Active low when tone or pulse is being dialed.
2. Active low, if MREDIAL key is used, during auto-redial process.
3. $\overline{\text{MUTE}}$ has toggle output controlled by MUTE key.
4. Active low, if MHOLD key is used, during HOLD mode.

■ **Application of $\overline{\text{MUTE}}$ and $\overline{\text{XMUTE}}$ signals:**

Case I. MUTE, MHOLD and MREDIAL system.

Handset	Microphone	Use $\overline{\text{MUTE}}$
	Speaker	Use $\overline{\text{MUTE}}$
Voice Network	Microphone	Use $\overline{\text{MUTE}}$
	Speaker	Use $\overline{\text{XMUTE}}$

Case ii. XMUTE, XHOLD and XREDIAL system.

Handset	Microphone	Use $\overline{\text{MUTE}} * \overline{\text{XMUTE}}$
	Speaker	Use $\overline{\text{MUTE}}$
Voice Network	Microphone	Use $\overline{\text{MUTE}} * \overline{\text{XMUTE}}$
	Speaker	Use $\overline{\text{MUTE}}$

Where $\overline{\text{MUTE}} * \overline{\text{XMUTE}}$ active if $\overline{\text{MUTE}}$ or $\overline{\text{XMUTE}}$ ctive.

On both systems, busy/ring back tone will not be muted on the speaker output of voice network circuit during auto-redial process.

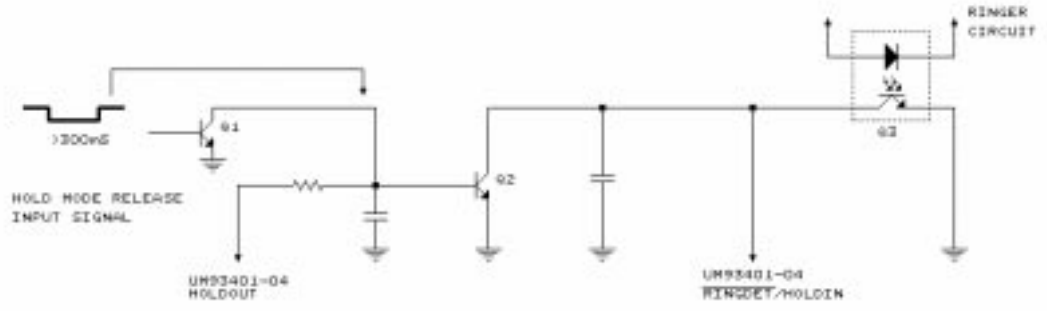
■ **Additional description for $\overline{\text{RINGDET}}$ /HOLDIN input definition of $\overline{\text{RINGDET}}$ /HOLDIN (pin 8):**

During on-line and HOLDOUT high this pin is used as HOLDIN input.

During off-line status, this pin is used as $\overline{\text{RINGDET}}$ input.

LINE CONNECT	On or Off-hook, speaker on or off but holdout high	HOLDOUT high	$\overline{\text{RINGDET}}$ /HOLDIN = HOLDIN Hold release detect input. Normal low. When HOLD mode is released by off-hook or another phone using same telephone line, this pin must be high level.
LINE DISCONNECT	On-Hook and speaker off and holdout low	HOLDOUT low	$\overline{\text{RINGDET}}$ /HOLDIN = $\overline{\text{RINGDET}}$ Incoming call detect input. Normal high. When call progress tone is detected this pin must be low level.

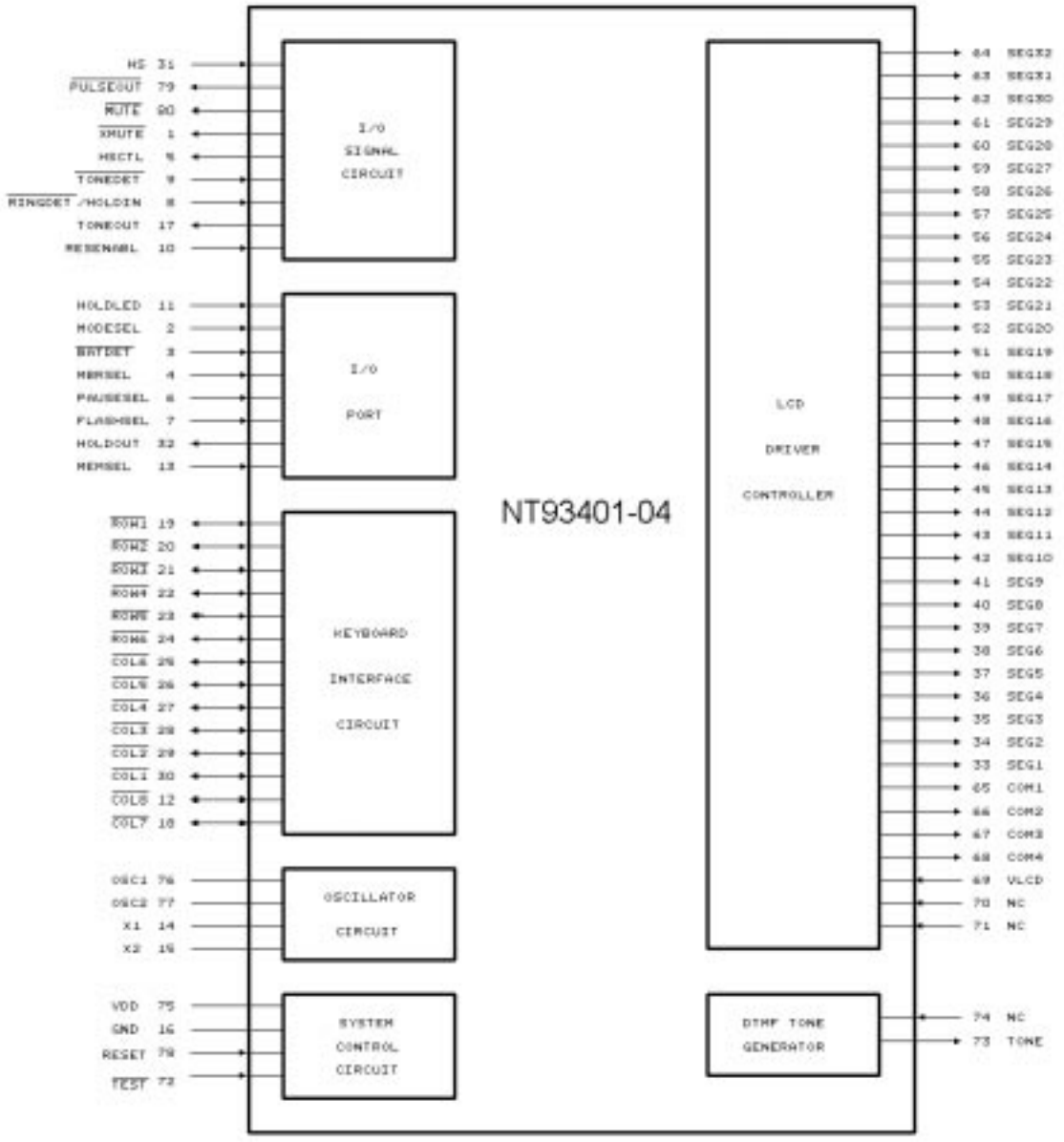
■ **Application for $\overline{\text{RINGDET}}$ /HOLDIN input.**



1. If HOLDOUT low, Q1 off, Q2 off, then $\overline{\text{RINGDET}}$ /HOLDIN high.
2. If HOLDOUT high, Q1 off, Q2 on, then $\overline{\text{RINGDET}}$ /HOLDIN low.
3. If HOLDOUT high, Q1 on, Q2 off, then $\overline{\text{RINGDET}}$ /HOLDIN high.
4. If HOLDOUT low, Q1 off, Q2 off, Q3 on, then $\overline{\text{RINGDET}}$ /HOLDIN low.

See Hold Function Timing Diagrams and Application Circuit.

Block Diagram



Functional Description

Real Time Clock

- During normal conditions, the display shows month, date, hour, minute, and second. (Phone number is displayed upon digit entry or corresponding set mode information is displayed).
- Real time can be displayed whenever "CLOCK" key is depressed.
- Real time clock setting procedure
  1. Press "STORE" key.
  2. Press "CLOCK" key.
  3. Enter month, date, AM/PM, hour, minute. (Use */# for AM/PM and 01:00~12:59 for hour & minute).
  4. Press "STR" key once again. (Second start from 00)
  5. Blinking cursor on the position for digit entry is provided.
  6. Key entry must be 2 digits. (ie: 03 for March).
  7. If setting is interrupted half way, previous time will be displayed.
  8. If any key is incorrectly entered, the key is ignored.
  9. If real time clock is not set after power-on reset, clock display will blink. (Pressing "CLOCK" key will stop blinking).

Alarm

- When set time comes, a beep will be produced for a period of 60 seconds then stops automatically.
- Beep can be stopped at any moment by touching "ALARM" key.
- Alarm indicator is assigned to an LCD display dot.
- When alarm beep is sounding, the user still can dial any number.
- Alarm time setting procedure
  1. Press "STORE" key.
  2. Press "ALARM" key.
  3. Enter AM/PM, hour, minute. (Use */# for AM/PM and 01:00 ~ 12:59 for hour & minute).
  4. Press "STR" key once again.
  5. If setting is interrupted half way, previous time will be displayed.
  6. If any key is incorrectly entered, the key is ignored.

Stopwatch

- Stopwatch timer is provided up to 59 minutes and 59 seconds.
- Display shows minutes and seconds at month/date display location.
- Timer will stop by either going on-hook or by depressing "STW" key once.
- Timer start/stop procedure
  1. Press "STW" key to start. The real time will change to 00-00 and start counting.
  2. Real time will be displayed at this time, but only month and date will be replaced by timer.
  3. Press "STW" key once again to stop timer or put hone into on-hook state to stop timer (Display stays approx. 10 seconds after stop and returns to month and date automatically).
  4. Timer display can be forced to return to date and month by touching "CLOCK" key once.

Normal Dialing

- Phone goes to off-hook state (or press "SPK" key)
- Enter desired number from the keyboard including pause, flash and tone keys.
- The display shows *, #, pause, flash and tone with different symbols.
- The number will be dialed out in TONE mode or PULSE mode depending on the MODESEL pin. The dialing mode may be changed from PULSE to TONE mode by pressing the "TONE" key.
  1. Tone dialing rate: real time dialing.
  2. Pulse dialing rate: 10 pps
     33/67, 40/60 M/B ratio. (depending on MBRSEL pin)
- "*" and "#' are not dialed out in PULSE mode.
- DTMF tone output duration depends on how long the key is pressed down, but the minimum tone duration and inter digit pause times are 90ms.

Bank Key Function

- Default bank select is for M01~M15 or M01~M20.
  When "BANK" key is pressed, the M16~M30 or M21~M40 area is selected and effective only for the next location selection.
  The "BANK" has toggle function. If M16~M30 or M21~M40 area is selected, then lower bank LCD indicator will be displayed.

■ Example

Key Sequence	Memory Contents
"STORE" "M01/16" "0" "1" "STORE"	M01=01
"STORE" "BANK" "M01/16" "1" "6" "STORE"	M16=16
"STORE" "BANK" "BANK" "M01/16" "1" "6" "STORE"	M01=16

Auto-Start Watch

- Phone goes to off-hook state.
- Enter desired number from keyboard.
- After 6 seconds, the timer display will start automatically.

Redial

- Phone goes to off-hook state.
- Press "REDIAL" key once, then the number stored in the redial buffer will be dialed including pause, tone.
- The user can not redial if digits exceed 48. (including pause, tone) In this case, "FULL" will be displayed on LCD.

Auto-Redial

- Phone goes to off-hook state.
- Enter desired number from keyboard and press "REDIAL" key.
  or
- Press the "REDIAL" key twice.
- After 30 seconds, the line will be connected (SPEAKER mode on) and check dial tone.
- When dial tone is detected, phone numbers are displayed and dialed out.
- If the busy tone is detected, the line will be disconnected (SPEAKER mode off) and wait 30 seconds (auto redial interval) for next cycle.
- The auto redial function will be terminated in the following cases.
  1. Phone goes to off-hook manually during auto redial.
  2. When receiving incoming calls.
  3. After 10 redials are completed.

Dial Restriction

- Digit "0" is the only restriction number.
- If the first digit of the dialed number after off hook matches the restriction number(0), this chip goes to the
  flash state.

"RESENABL" Pin

- "RESENABL" is used as key lock status input. If pin "RESENABL" is high (key not locked), no number is locked. Otherwise, digit "0" is locked.

"HOLD" Key

- Provides HOLD functions. The HOLD function is implemented by an internal latch whose output pin "HOLDOUT" can be toggled on the pressing of the "HOLD" key. The HOLDOUT can be reset to low by HSCTL going positive or HS going negative. Also, the HOLDOUT can be reset by HOLDIN. The HOLD LCD indicator will be displayed and flashing on LCD during HOLD mode.
- If HOLD mode is on, normal dialing is not permitted.
- If HOLD mode is on, HOLDLED will be flashing.

"FLASH" Key

- A FLASH code will not be stored in the redial buffer if this key is pressed. But, a FLASH code can be stored in memory locations. During the execution of FLASH code the $\overline{\text{PULSEOUT}}$ and $\overline{\text{MUTE}}$ are pulled low for 90~900 ms and then pause for 0.8sec before the next digit executes. Programmable FLASH time from 90 to 900 msec. (100 msec resolution). Initial FLASH time is pin selectable (90 or 600 msec).

- During normal dialing, the FLASH forces a line disconnect and it initializes the dial buffer. The "FLASH" key can be used to cancel AUTO REDIAL mode and stop any dialing (including redial, one touch dial. . . . .)
  For Example,
  Off-hook + "222333" + "FLASH" (pause 0.8sec) + "444555" + On-hook
  :Redial buffer = "444555"
  For Example,
  Off-hook + "FLASH" + "735" + On-hook
  :Redial buffer = "735"
- Phone goes off-hook state.
- Enter desired number from keyboard.
- If wrong number is entered, press "FLASH" key and user can dial the new number again. After "Break 90~900 msec" and "Pause 0.8 sec", the new number will be dialed out.
- Pressing of "FLASH" key can be used to execute on-off-hook change.
- If "FLASH" key is entered, the display is cleared when next number is entered.

One Touch Auto-Dial

- Phone goes to off-hook state.
- Press "BANK" key if necessary.
- Press desired one touch auto-dial key.
- The number will be dialed out.

Abbreviated Auto-Dial

- Phone goes to off-hook state.
- Press "MEM" key once.
- Enter desired location number from 01 to 30/40.
- The number will be dialed out.

Chain Dialing

- Phone goes to off-hook state.
- Press the one touch dial key or abbreviated auto dial key in sequence for continuous dialing.

Tone Key Function

- During PULSE DIALING mode, the DTMF signal can be produced if TONE key is depressed.
- The tone information can be stored into memory for auto-dial and redial functions.

Store One-Touch Auto-Dial

- Phone may be in on-hook or off-hook state.
  1. Press "STR" key once.
  2. Press "BANK" key if necessary.
  3. Enter desired location key.
  4. The numbers will be displayed upon key entry.
  5. Press desired phone number.
  6. Press "STR" key once again.
- If you do not want to change the contents, skip 5. or press "CLOCK" key.
- If the incorrect key is entered, repeat the entire sequence again.

Store Abbreviated Auto Dial

- Phone may be in on-hook or off-hook state.
  1. Press "STR" key once.
  2. Press "MEM" key.
  3. Enter desired location number from 01 to 30/40.
  4. The location number will be displayed upon key entry.
  5. Press desired phone number.
  6. Press "STR" key once again.
- If you do not want to change the contents, skip 5. or press "CLOCK" key.
- If the incorrect key is entered, repeat the entire sequence again.
- Common memory space is used for both one touch auto dialing and abbreviated auto dialing.

One touch auto-redial location	01	02	03	. . . . .	29/39	30/40
Abbreviated auto-dial location	01	02	03	. . . . .	29/39	30/40

If the number of one touch and abbreviated auto-dial locations is equal, they use the same memory space.
For example, one touch location 03 and abbreviated location 03 have the same content.

Programmable Pause

- Initial pause timing is 2 or 4 seconds per push. (by PAUSESEL pin.)
- Pause timing can also be programmed from key entry, if necessary.
- Pause time can be set from 1 to 5 seconds with 1 second resolution.
- Pause time setting procedure
  1. Press "STR" key once.
  2. Press "PAUSE" key.
  3. Press desired time 1~5 seconds.
  4. Press "STR" key once again to complete.
  5. Pause timing can be displayed upon successful entry.
- If you do not want to change the contents, skip 4. or press "CLOCK" key.
- If incorrect key is entered, repeat the entire sequence again.

Programmable Flash

- Initial flash timing is 90 or 600 msec per push. (by FLASHSEL pin.)
- FLASH timing can be programmed from key entry, if necessary.
- FLASH time can be set from 90, 100 msec to 900 msec with 100 msec resolution.
- FLASH time setting procedure
  1. Press "STR" key once.
  2. Press "FLASH" key.
  3. Press desired number 0, 1~9 (corresponding to 90, 100~900 msec).
  4. Press "STR" key once again to complete.
  5. FLASH timing will be displayed upon successful entry.
- If you do not want to change the contents, skip 4. or press "CLOCK" key.
- If incorrect key is entered, repeat the whole sequence again.

Programmable Auto-Redial Repeating Cycle and Interval

- Initial repeating cycle is up to 10.
- Initial repeating interval is 30 seconds.
- Repeating cycle and interval can be programmed from key entry, if necessary.
- Repeating cycle and interval setting procedure
  1. Press "STR" key once.
  2. Press "REDIAL" key.
  3. Press number 00~15 for repeating cycle. Next, press number 1 ~ 6 (10 ~ 60sec) for repeating interval.
  4. Press "STR" key once again to complete.
  5. Repeating cycle and interval can be displayed upon successful entry.
- If you do not want to change the contents, skip 4. or press "CLOCK" key.
- If incorrect key is entered, repeat the entire sequence again.

Pulse Dial Option

- This function changes the number of pulses to be generated corresponding to the dial number for special area.

Dial number	0	1	2	3	4	5	6	7	8	9
Pulse number	10	1	2	3	4	5	6	7	8	9

Error Indication

■ If an invalid key is entered, "ERROR" will be diplayed. If Error display is shown for more than 10 seconds, the display will automatically return to CLOCK mode.

■ Press two keys simultaneously (< 20ms), this operation will be invalid and ignored.

Store Indication

■ If store display is shown for more than 20 seconds, the display will automatically return to CLOCK mode.

Lower Bank Indicator

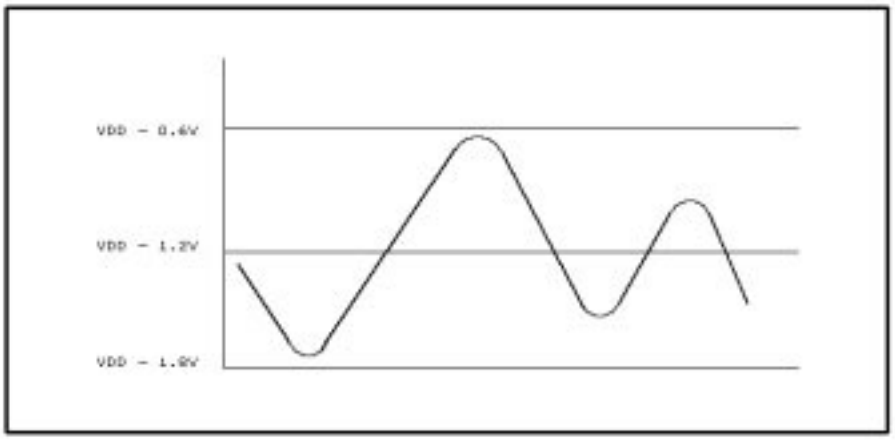
■ When lower memory bank is chosen, lower bank indicator will be turned on.
■ Lower bank indicator is assigned to LCD annunciator.

Reset Function

■ When power is on, or set RESET pin to high for at least 3 msec.
  1. All registers and temporary area will be cleared. The phone number area will be cleared, too.
  2. All pin selectable options (pause, flash etc.) will be initialized.
■ After reset, the clock display will blink.
■ Partial reset function is provided:
  If "0" is depressed and held down, if will force the RESET pin to go high, thus the phone number memory location will not be cleared.

DTMF Output

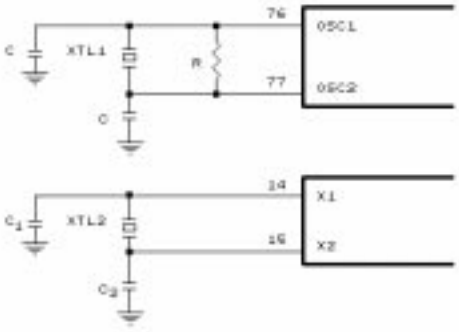
The DTMF output signal depends on the reference voltage of VDD - 1.2V.



Oscillator Circuit

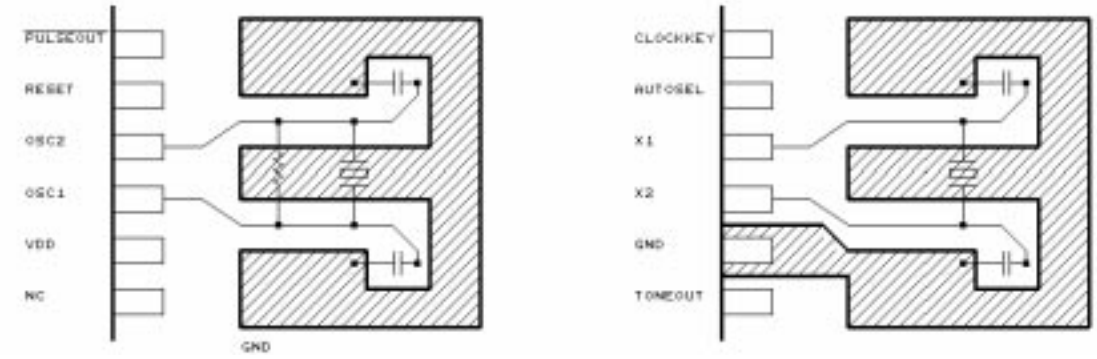
■ External Clock Operation Circuit

■ Crystal Clock Operation Circuit

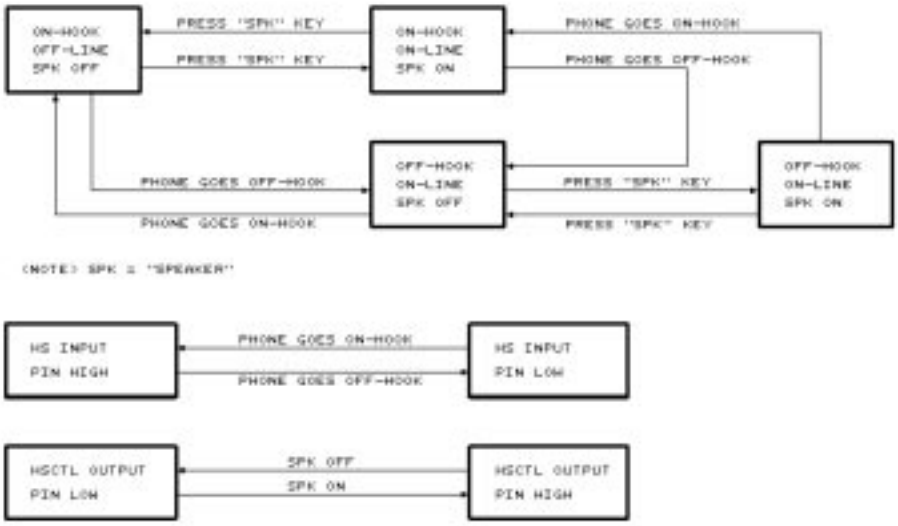


XTL1 => (3.5795MHz) Crystal Oscillator or Ceramic resonator Oscillator
XTL2 => (32.768KHz) Crystal Oscillator
R => 1M ohm approx.
C => 20pF is recommended
C1 => 20pF is recommended
C2 => 20pF is recommended

■ Layout of Oscillator Circuit



SPEAKER Mode State Diagram

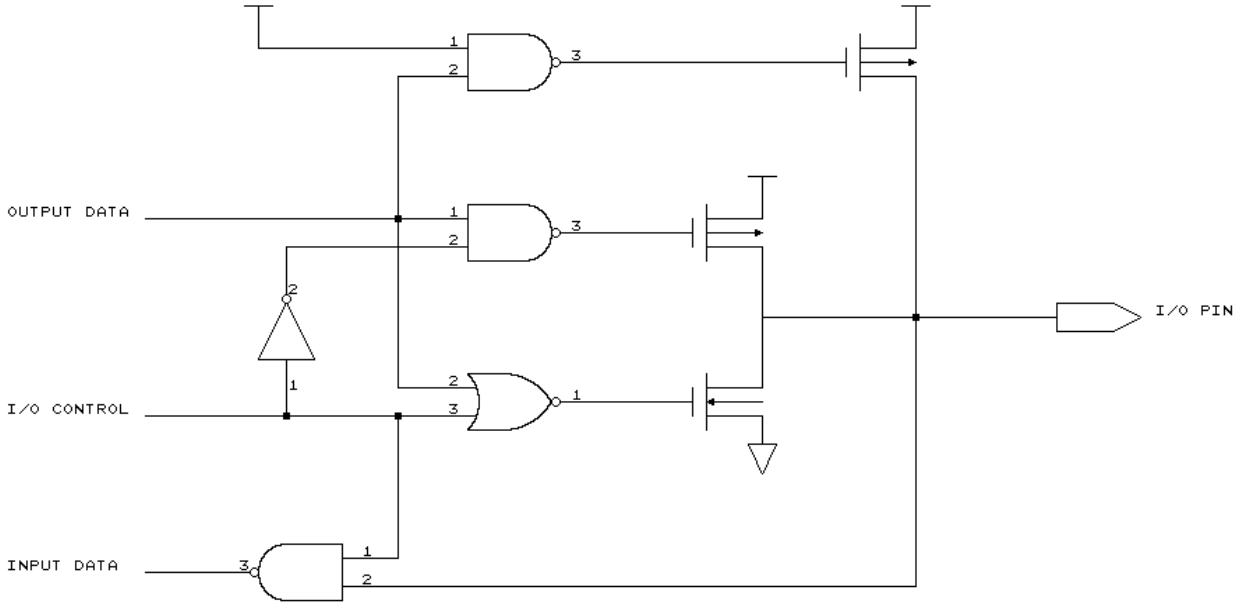


See HS and HSCTL Timing Diagram.

I/O Pin Type

I/O pin type	Designation	Description
Output pins (with pull up CMOS)	$\overline{\text{PULSEOUT}}$, HSCTL, HOLDLED $\overline{\text{MUTE}}$, $\overline{\text{XMUTE}}$, HOLDOUT, TONEOUT, $\overline{\text{ROW1}}$ ~ $\overline{\text{ROW6}}$	During on-hook and no operation state, these will output low except for TONEOUT
Input pins (with pull up CMOS)	HS, $\overline{\text{COL1}}$ ~ $\overline{\text{COL8}}$, $\overline{\text{RINGDET}}$ /HOLDIN, $\overline{\text{BATDET}}$	These pins are internally pulled high
Input pins (without pull up CMOS)	MODESEL, MBRSEL, PAUSESEL, FLASHSEL, MEMSEL, $\overline{\text{TONEDET}}$, RESENABL	These pins should not be floating. For example, MODESEL should be connected to VDD or GND

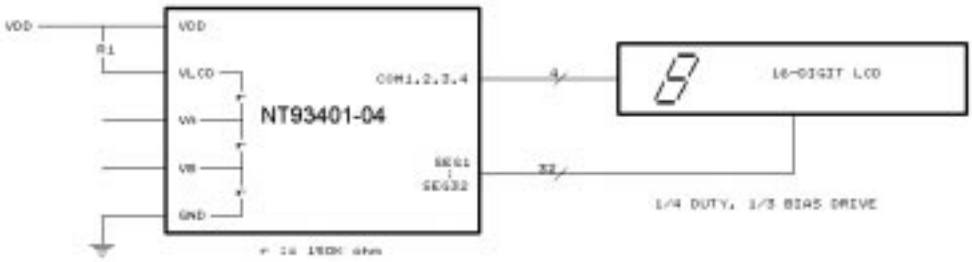
The NT93401-04 I/O pins can be configured as input pins or output pins. When they are configured as output pins, they are pulled high through MOS. If they are configured as input pins, the pull-up MOS could be enabled or disabled.



I/O control = high : input port
= low : output port

LCD Connection and Format

■ LCD connection
The LCD should be operated on 1/4 duty and 1/3 bias.
The examples of LCD connection are given as follows.

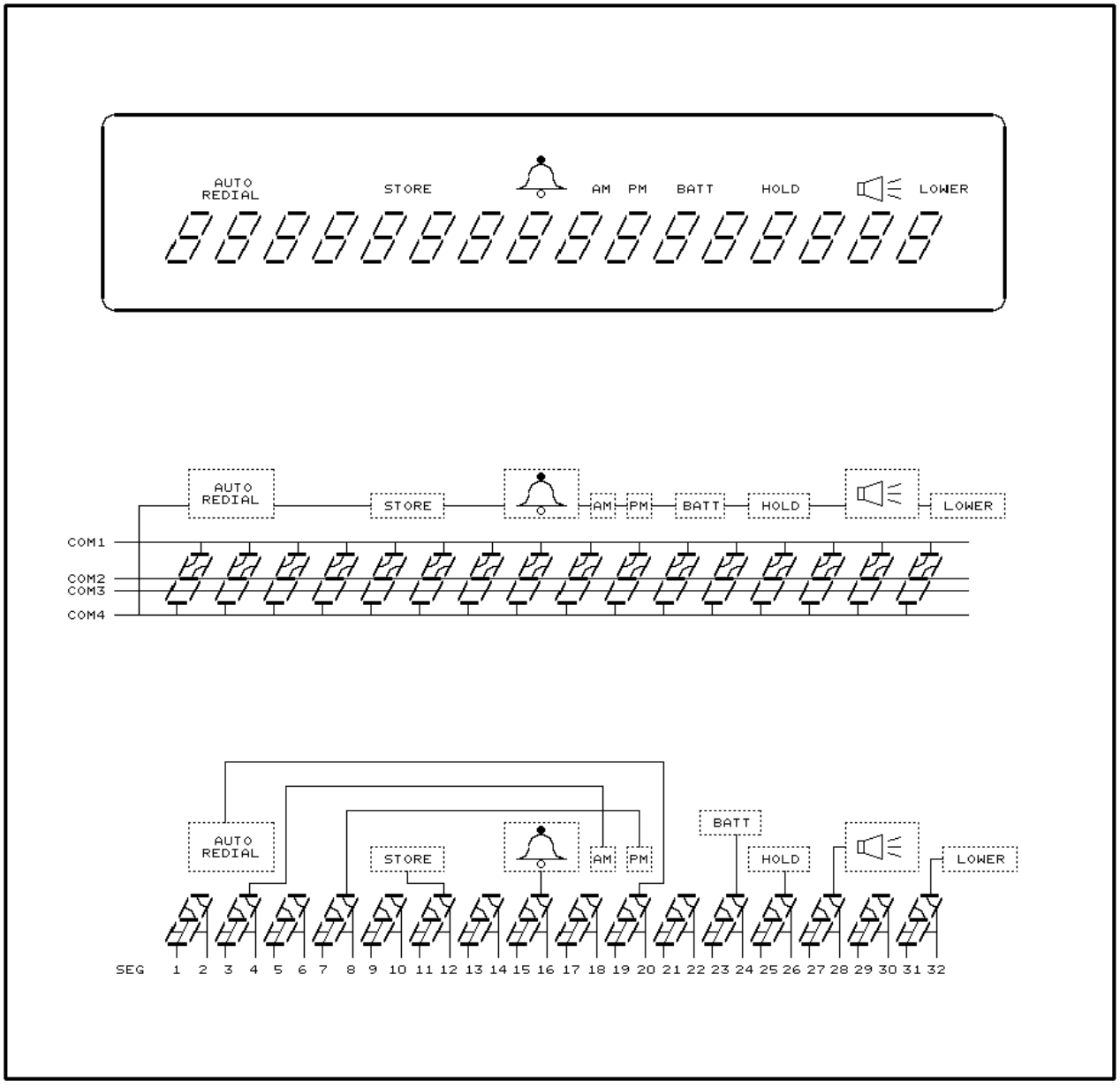


Since large LCD panels need large driving current, it is possible the internal dividing resistor circuit cannot provide the correct bias voltage. In this case, external resistors can solve this problem.

However, small external resistors result in more power dissipation.
Hence external resistors must be experimentally determined.
Also, R1 should be experimentally determined.

VLCD = driving voltage of LCD = $\frac{r + r + r}{R1 + r + r + r}$ x VDD

NT93401-04 LCD Format



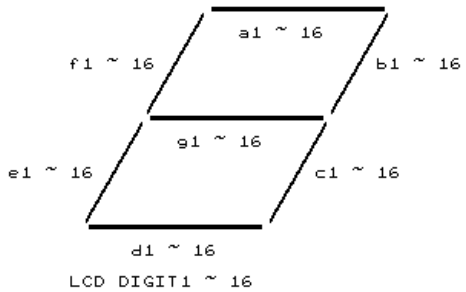
If the HOLD indicator is not provided on the LCD, HOLDLED pin can be used to drive LED as HOLD indicator.

LCD Display Dot Format

LCD	SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	SEG9	SEG10	SEG11	SEG12
COM1	f1	a1	f2	a2	f3	a3	f4	a4	f5	a5	f6	a6
COM2	g1	b1	g2	b2	g3	b3	g4	b4	g5	b5	g6	b6
COM3	e1	c1	e2	c2	e3	c3	e4	c4	e5	c5	e6	c6
COM4	d1	-	d2	AM	d3	-	d4	PM	d5	-	d6	STORE

LCD	SEG13	SEG14	SEG15	SEG16	SEG17	SEG18	SEG19	SEG20	SEG21	SEG22
COM1	f7	a7	f8	a8	f9	a9	f10	a10	f11	a11
COM2	g7	b7	g8	b8	g9	b9	g10	b10	g11	b11
COM3	e7	c7	e8	c8	e9	c9	e10	c10	e11	c11
COM4	d7	-	d8	ALARM	d9	-	d10	AUTO REDIAL	d11	-

LCD	SEG23	SEG24	SEG25	SEG26	SEG27	SEG28	SEG29	SEG30	SEG31	SEG32
COM1	f12	a12	f13	a13	f14	a14	f15	a15	f16	a16
COM2	g12	b12	g13	b13	g14	b14	g15	b15	g16	b16
COM3	e12	c12	e13	c13	e14	c14	e15	c15	e16	c16
COM4	d12	BATT	d13	HOLD	d14	SPK	d15	-	d16	LOWER BANK

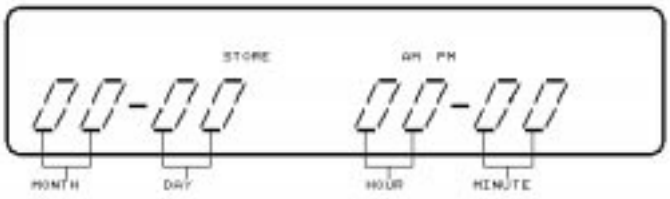


NT93401-04 User's Manual

TIME ADJUST

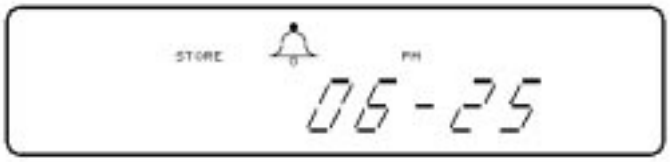
1. Press the "STORE" key and then "CLOCK" key.
2. The LCD will show "STORE" followed by Month/Day/AM-PM/Hour/Minute.
3. Enter the numbers in respective sequence from keyboard. (use "*" for AM, "#" for PM)
4. Press "STORE" key.

Note:
- Blinking segment indicates the ADJUSTING mode.
- 12 hour display.



ALARM TIME SETTING

1. Press the "STORE" key and then "ALARM" key.
2. The LCD will show "STORE".
3. The LCD will show the previous alarm time.
4. Enter new data of AM-PM/Hour/Minute in sequence.
5. Press "STORE" key.



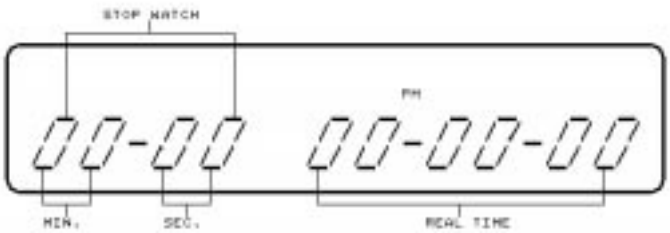
ALARM OPERATION

1. A bell symbol will show on LCD "🔔" to indicate the alarm function.
2. Beep sound will be heard during the alarm time.
3. Press "ALARM" key to stop the alarm.
   (Beep sound will last for 1 minute unless the "ALARM" key is pressed)

To cancel the alarm set: Press the "STORE" key, then press "ALARM" key twice and press "STORE" key once. The bell symbol will disappear and the alarm function is cancelled.

STOP-WATCH OPERATION

1. Press "STOP WATCH" key once.
2. The LCD will show 00-00 and then begins counting.
3. Press "STW" key once again to stop timer.
   Hang up the telephone by Handset or "SPEAKER" key may also stop the timer's counting.
4. Display shows timer approx. 10 seconds after stopping and returns to month and day automatically.



REDIALING

LAST NUMBER REDIAL

1. Engage the telephone line by handset or Hands-Free.
2. Press the "REDIAL" key once and the previous phone number called will show on the
   LCD then the Redial will begin.

AUTO REDIAL

1. Engage the telephone line.
2. Enter desired number from keyboard and press "REDIAL" key once.
   or
   Press the "REDIAL" key twice.
3. Hang up the phone and "AUTO REDIAL" will show on the LCD to indicate the function is in progress.
4. The unit will switch to HANDS-FREE mode automatically and a speaker symbol together with the redial number will show on LCD while redialing.
5. "AUTO REDIAL" will disappear from the LCD to indicate that the redialing is completed. If redialing is completed, but the "AUTO REDIAL" still shows on the LCD, in this case, the user can lift the handset or press the "SPEAKER" key to terminate auto redial.

SETTING AUTO REDIAL PARAMETERS

1. Press the "STORE" key and then the "REDIAL" key.
2. The LCD will shown "STORE", "S" and the parameters.
3. Enter the new parameters (from 01to 15 times and from 10 sec. to 60 sec.)
4. Press the "STORE" key.

MEMORY DIALING

"ONE-TOUCH" MEMORY DIALING

STORING PHONE NUMBERS INTO MEMORY:
1. Press the "STORE" key.
2. Press the "BANK" key, if necessary.
3. Enter desired location key.
4. The LCD will show "STORE" and Location number.
5. Enter the phone number to be stored.
6. Check the number on display, if correct, press "STORE" key once and it will be placed in memory.

DIALING WITH MEMORY LOCATION KEY:
1. Lift the Handset or press "SPEAKER" key to engage the line.
2. Press the "Memory Location" key.
   (The stored number will show on LCD and begin dialing automatically.)

"2-DIGIT CODE" MEMORY DIALING

STORING PHONE NUMBERS INTO MEMORY:
1. Press the "STORE" key.
2. Enter the "2-Digit Code" (from 00 to 29) from keyboard.
3. The LCD will show "STORE" and the "2-Digit Code". If the memory location is occupied, the stored phone number wil appear behind the code.
4. Enter the phone number to be stored.
5. Press the "STORE" key once again and the number is memorized.

DIALING WITH THE "2-DIGIT CODE":
1. Lift the handset or press "SPEAKER" key.
2. Press the "MEMORY" key and then the 2-Digit code. (The stored number will show on LCD and begin dialing automatically.)

PAUSE OPERATION

When dialing or storing long distance call numbers, or in other special cases, a pause should be inserted in dialing sequence. The unit provides programmable and stackable "Pause" functions which provide flexible applications.

SETTING PAUSE TIME

1. Press the "STORE" key and then the "PAUSE" key.
2. The LCD will show "STORE", "P" and the pause time in seconds.
3. Enter the new pause duration (from 1 sec to 5 sec) from keyboard.
4. Press the "STORE" key.

TONE OPERATION

During PULSE DIALING mode, the DTMF signal can be produced if "TONE" key is depressed. This versatile function can be used to match different telephone systems, especially for long distance call numbers.

- The tone information can be stored into memory for redial and memory dialing functions.
- The LCD will show " 7 " for " * " and "77" for " # " during tone operation.
- The symbol of tone is " - ". Any number which follows this will be dialed in tone.

FLASH OPERATION

SETTING FLASH TIME

1. Press the "STORE" key and then the "FLASH" key.
2. The LCD will show "STORE", "F" and the flash time. Enter the new number from keyboard.
3. Press the "STORE" key.

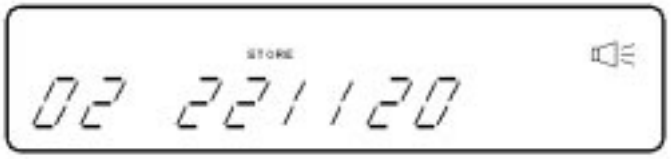
SEARCH DIAL OPERATION

Case I. All the memory locations are occupied

1. Press "SEARCH" key. If all the memory locations are occupied, the LCD will show the content of memory location M01.

2. Press "SEARCH" key again, the LCD will show the content of memory location M02. Assume M02 is the desired memory location which user wants to dial out.

3. Press the "SPK/DIAL" key, and turn on the SPEAKER mode.



4. Press the "SPK/DIAL" key again, and dial out the desired number (ie: 221120).

Case ii. Search the empty memory location.
1. Assume M01~M23 are being occupied but M24 is empty.
   Press "SEARCH" key and the LCD will show the empty location M24.

2. Enter the phone number to be stored, and press the "STORE" key to store it.

Case iii. Scan (Verify) the memory location from M01.
1. Press "SEARCH key and the LCD will show the empty location.
2. Press "SEARCH" key again, the contents of M01 will be displayed.
3. Press "SEARCH" key, the contents of M02 will will be displayed.
4. Press "SEARCH" key several times until the required memory location appears.
5. Use "SPK/DIAL" key to dial out the phone number.

Case iv. Scan (Verify) the memory location from M16.
1. Press the "STORE" and the "M16" key.
2. Press "SEARCH" key several times until the required memory location appears.

Case v. Clear the memory location
1. Press "SEARCH" key several times until the required memory location appears.
2. Press "FLASH" key to clear the memory location.
3. Press "STORE" key.

During each operation, the LCD will show the corr-esponding symbols. If wrong key or data is entered, the LCD will show "Error", and an error beep will be generated.

Absolute Maximum Ratings*

Power Supply Voltage. . . . . 5.5V (VDD)
Applied Voltage on Any Pin . . . . . 0.3V to VDD + 0.3V
Maximum Power Dissipation 100mW
Operating Temperature . . . . . .0°C to 70°C
Storage Temperature . . . . . -55°C to 150°C
Soldering Temp. & Time . . . . . < 260°C, 10sec

*Comments

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to this 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 or intended. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

DC Electrical Characteristics (VDD = 5.0V)

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit	Conditions
VDD	Power Supply Voltage	VDD	2.5		5.5	V	
I_{OP}	Current in OPERATION Mode	VDD		2.5		mA	
I_{SP}	Current in STOP Mode	VDD		30	40	mA	with LCD load (See Notes)

DC Electrical Characteristics (continued)

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit	Conditions
V_{IH}	Input High Voltage	RESET HS	0.9VDD		VDD+0.3	V	
		OSC1	VDD-0.3		VDD+0.3	V	
		except above pin	0.8VDD		VDD+0.3	V	
V_{IL}	Input Low Voltage	RESET HS	-0.3		0.1VDD	V	
		OSC1	-0.3		0.3	V	
		except above pin	-0.3		0.2VDD	V	
V_{OH}	Output High Voltage	all output pins	VDD-1.0			V	-Ioh = 0.5mA
V_{OL}	Output Low Voltage	all output pins			0.6	V	I_{OL} = 1.6mA
V_{RET}	RAM DATA Retention Voltage	VDD	1.5			V	STOPp mode
P_{TONE}	TONE output Volt. Ratio	TONE		2.5		dB	(col/row)
Voc	Single Column Output Amplitude	TONE		810		mVp-p	Rload = 10KΩê
Vor	Single Row Output Amplitude	TONE		630		mVp-p	Rload = 10KΩê
Dtone	TONE Output Distortion	TONE		3		%	
Rtone	TONE Output Resistance	TONE			1K	ohm	
Rpull	Pull-up Resistance	HS COL1- 6		200K		ohm	

Notes: STOP mode = Phone is on-hook and in a no operation state.

On this chip, only HS, $\overline{\text{BATDET}}$, $\overline{\text{RINGDET}}$ and $\overline{\text{COL1}}$ ~ $\overline{\text{COL8}}$ are pulled high. However, these pins are normally high or floating during STOP mode and no DC current path is generated. Hence, a very low standby current is possible.

Frequency Tolerance of the Output Tones for DTMF Signaling

Row/Column	Standard Frequency (Hz)	NT93401-04 (Hz)	Deviation (%)
ROW1	697	696.9	-0.01
ROW2	770	768.8	-0.15
ROW3	852	850.6	-0.15
ROW4	941	940.0	-0.10
COL1	1209	1209.3	+0.03
COL2	1336	1339.6	+0.27
COL3	1477	1481.6	+0.31
COL4	1633	1632.9	-0.01

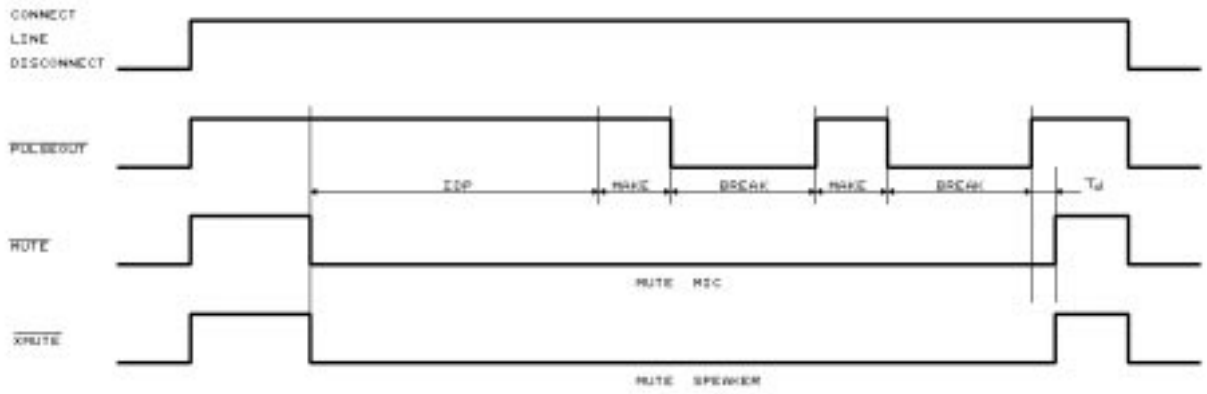
AC Characteristics

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit	Conditions
fosc	Oscillation Frequency	OSC1, 2		3.579545		KHz	
		X1, X2		32.768		KHz	
trstl	RESET high Level Width	RESET	3			msec	
trstf	RESET Falling Time	RESET			20	msec	
twch	Clock High Pulse Width	OSC1	120			msec	External Clock
twcl	Clock Low Pulse Width	OSC1	120			msec	External Clock

Timing Diagrams

NT93401-04 Pulse Dial & DTMF Timing

1. Pulse Dial Timing



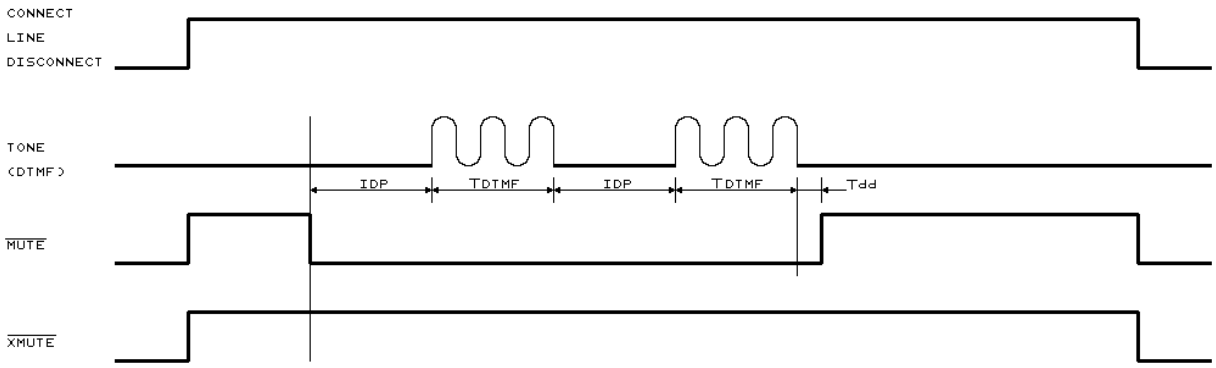
(1) 10 PPS (40/60)

Symbol	Min.	Typ.	Max.	Unit
IDP	-	800	-	msec
MAKE	-	40	-	msec
BREAK	-	60	-	msec
Td	-	30	-	µsec

(2) 10 PPS (33/67)

Symbol	Min.	Typ.	Max.	Unit
IDP	-	800	-	msec
MAKE	-	33	-	msec
BREAK	-	67	-	msec
Td	-	30	-	µsec

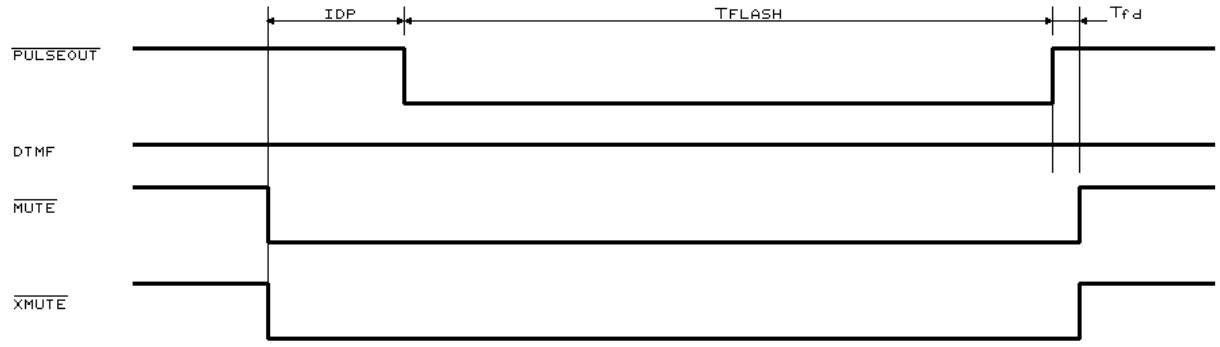
2. DTMF Timing



Symbol	Min.	Typ.	Max.	Unit
IDP	-	90	-	msec
T_{DTMF}	-	90	-	msec
Tdd	-	30	-	µsec

NT93401-04 Flash & Normal Dialing Timing

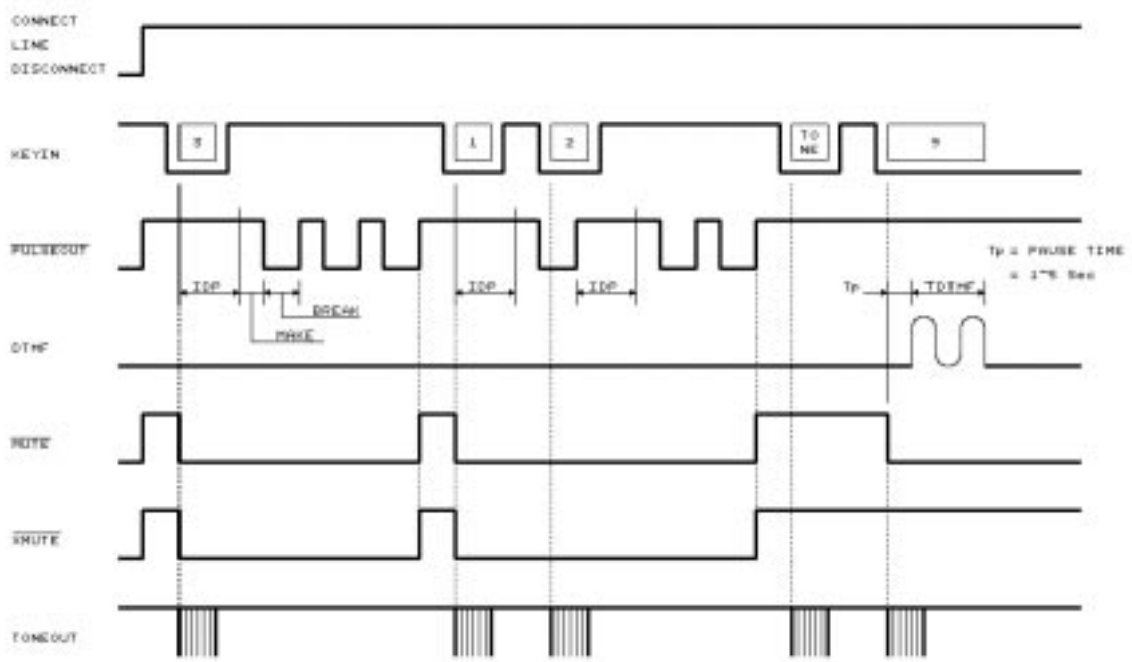
3. Flash Timing



Symbol	Min.	Typ.	Max.	Unit
IDP	-	20	-	msec
T_{FLASH}	-	*	-	msec
Tfd	-	30	-	µsec

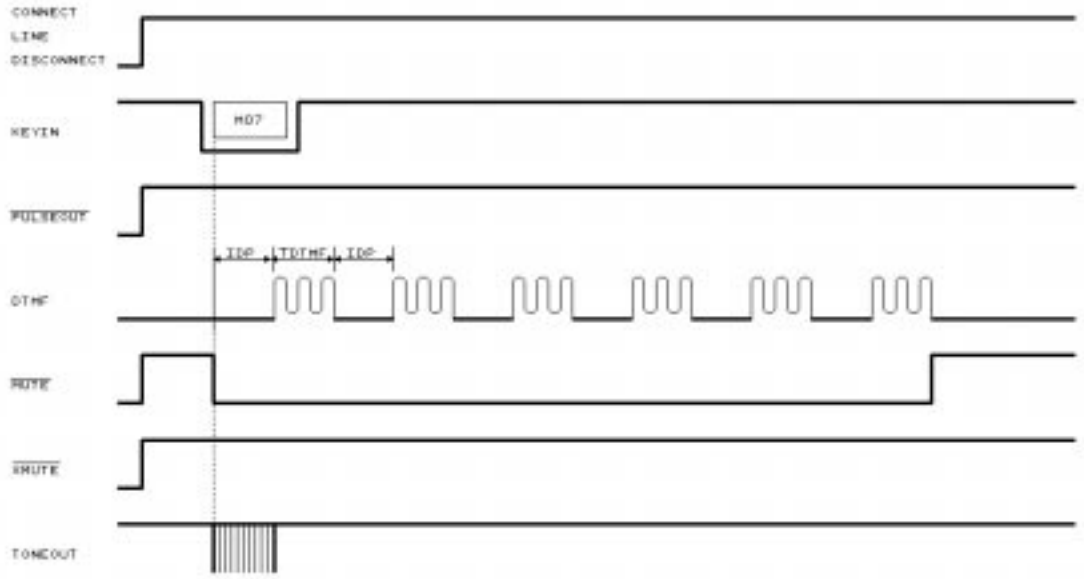
* 90, 100, 200, 300, 400, 500, 600, 700, 800, 900,

4. Normal Dialing

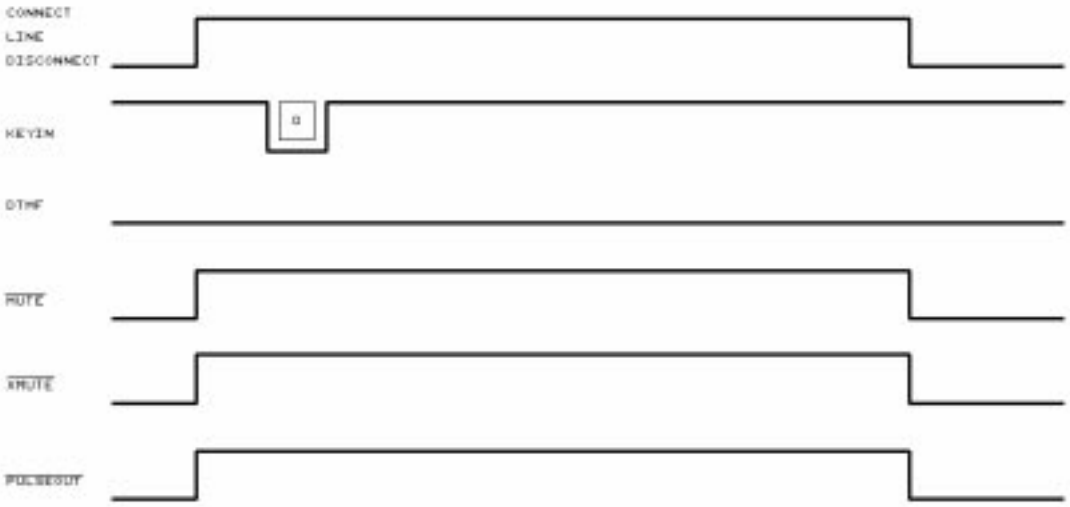


NT93401-04 One Touch Dialing & Restriction Timing

5. One Touch Dialing (TONE Mode)



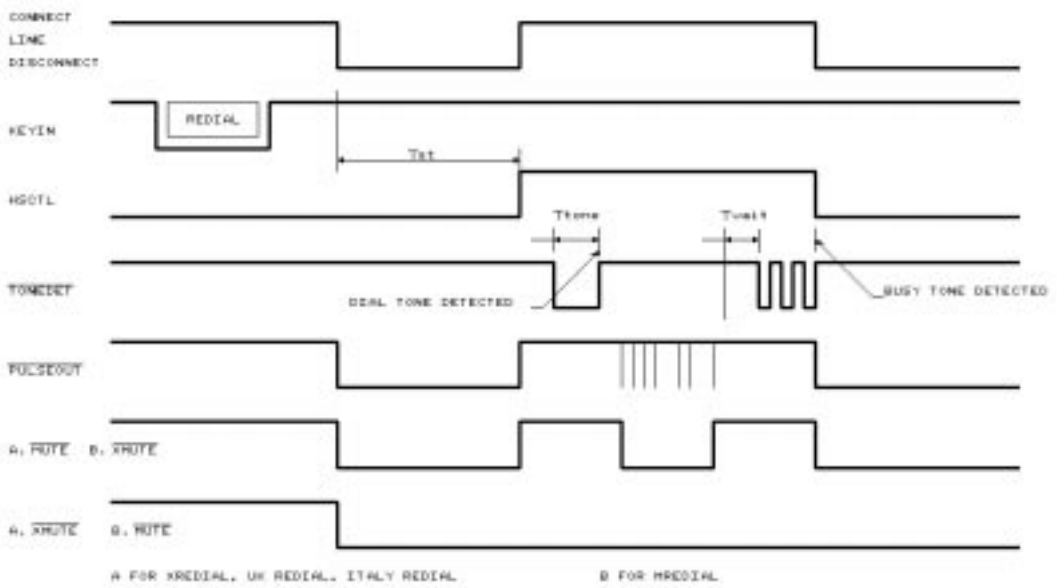
6. Restriction Timing (DTMF)
(Restriction number: "0")



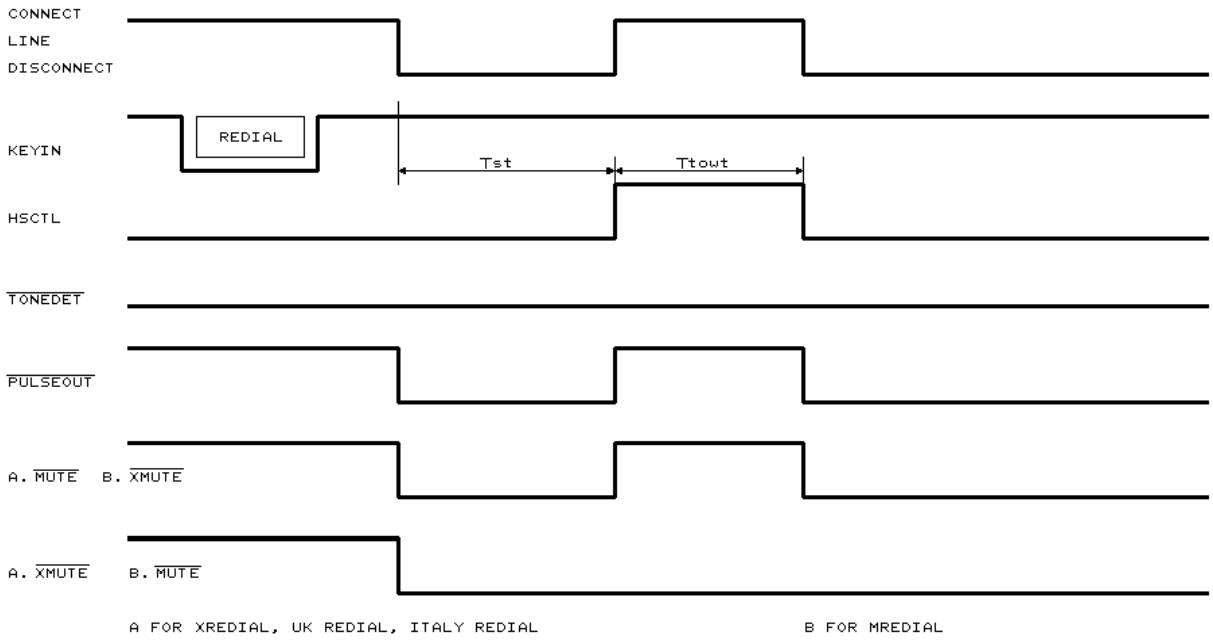
NT93401-04 Auto Redialing Timing

7. Auto Redialing

(1) PULSE DIAL Mode



(2) Dial Tone undetected

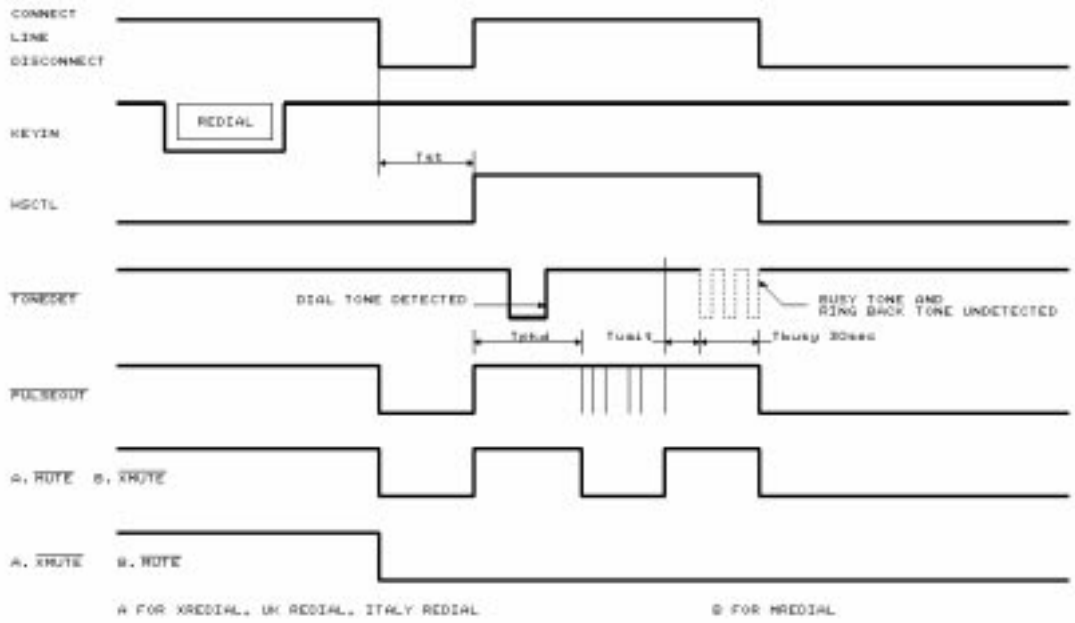


Symbol	Min.	Typ.	Max.	Unit
Ttone	-	0.147 or 0.735	-	sec
Ttowt	-	6	-	sec
Tst	-	*	-	sec

Ttone = 0.147 sec for Italy system
= 0.735 sec for others

* 10, 20, 30, 40, 50,60

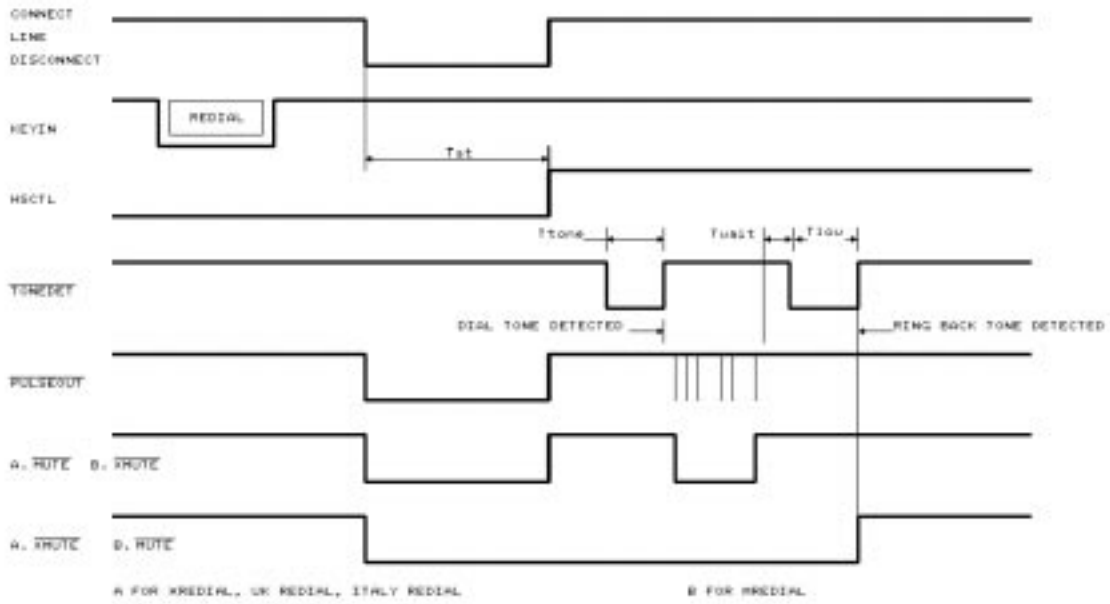
(3) Busy Tone Detected



Symbol	Min.	Typ.	Max.	Unit
Tpkd	-	0.58 or 2	-	sec
Twait	-	2	-	sec
Tbusy	-	30	-	sec

Twait = 2 sec for phone number, with first digit "0".
Twait = 0.58 sec for phone number, the first digit is not "0".
10 sec silence = Busy tone detected

(4) Ring Back Tone Detected



■ Dial Tone, Busy Tone, Ring Back Tone

Country	Italy Redial	UK Redial	World Xredial, Mredial
Dial Tone	0.6 sec on 1.0 sec off or 0.2 sec on 0.2 sec off	Continuous	Contiunous
Busy Tone	0.2 sec on 0.2 sec off or 0.1 sec on 0.1 sec off	0.4 sec on 0.4 sec off or 0.5 sec on 0.5 sec off	0.1 sec on 0.1 sec off 0.15 sec on 0.15 sec off 0.25 sec on 0.25 sec off 0.5 sec on 0.5 sec off
Ring Back Tone	1.0 sec on 4.0 sec off	0.4 sec on 0.2 sec off or 0.4 sec on 2.0 sec off	2.0 sec on 4.0 sec off 1.0 sec on 2.0 sec off 1.0 sec on 4.0 sec off 1.0 sec on 3.0 sec off 1.65 sec on 3.35 sec off 1.0 sec on 5.0 sec off

■ Dial tone detected range

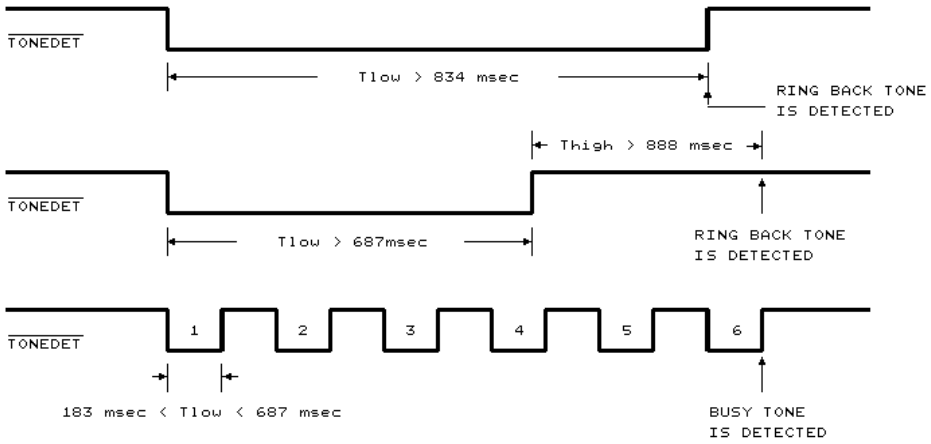
Country	Detected Range
Italy	Tone > 147 ms
UK and World	Tone > 735 ms

■ Busy tone detected range

Busy Tone on, off Duration		Detected Range
0.1 sec on	0.1 sec off	82 ms ~ 120 ms
0.15 sec on	0.15 sec off	136 ms ~ 165 ms
0.25 sec on	0.25 sec off	183 ms ~ 687 ms
0.4 sec on	0.4 sec off	183 ms ~ 687 ms
0.5 sec on	0.5 sec off	183 ms ~ 687 ms

■ Ring Back Tone Detected Range

Country	Detected Range
UK	On, off duration ± 40 ms
Italy and World	Tone > 83 ms or Tone > 687 ms + Thgh > 888 ms



■ Busy and ring back tone detected

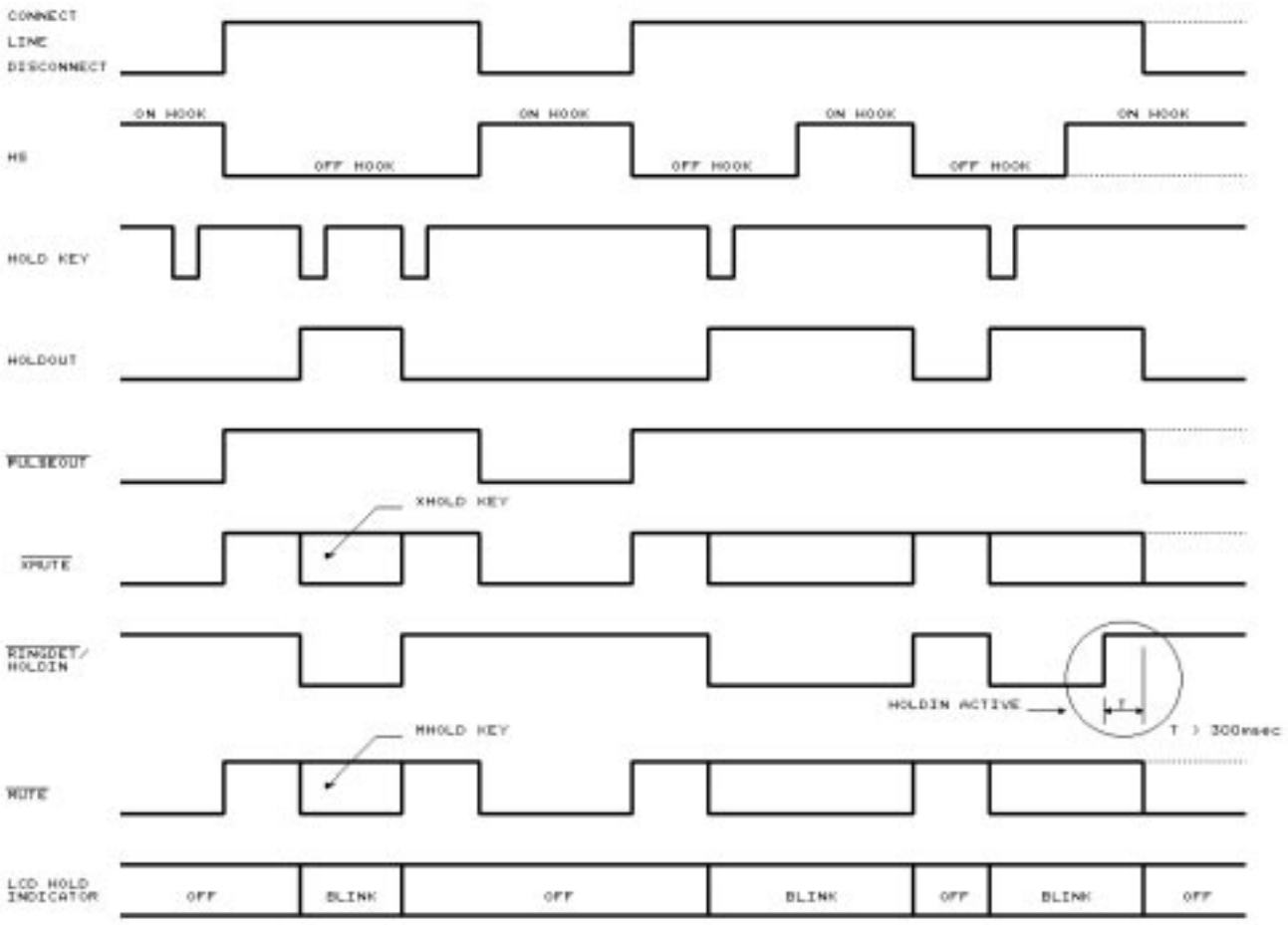
"AUTO REDIAL" will disappear from the LCD to indicate that the redialing is completed. When redialing is completed, but ring back tone is not detected by NT93401-04, the "AUTO REDIAL" still shows on the LCD. In this case, user can lift the handset or press the "SPEAKER" key to terminate auto redial.

User can interrupt the detection when "AUTO REDIAL" still shows on the LCD.

1. Lift handset = "Ring back tone is detected".
2. Press "SPEAKER" key = "Ring back tone is detected".
3. Press "REDIAL" key = "Busy tone is detected".

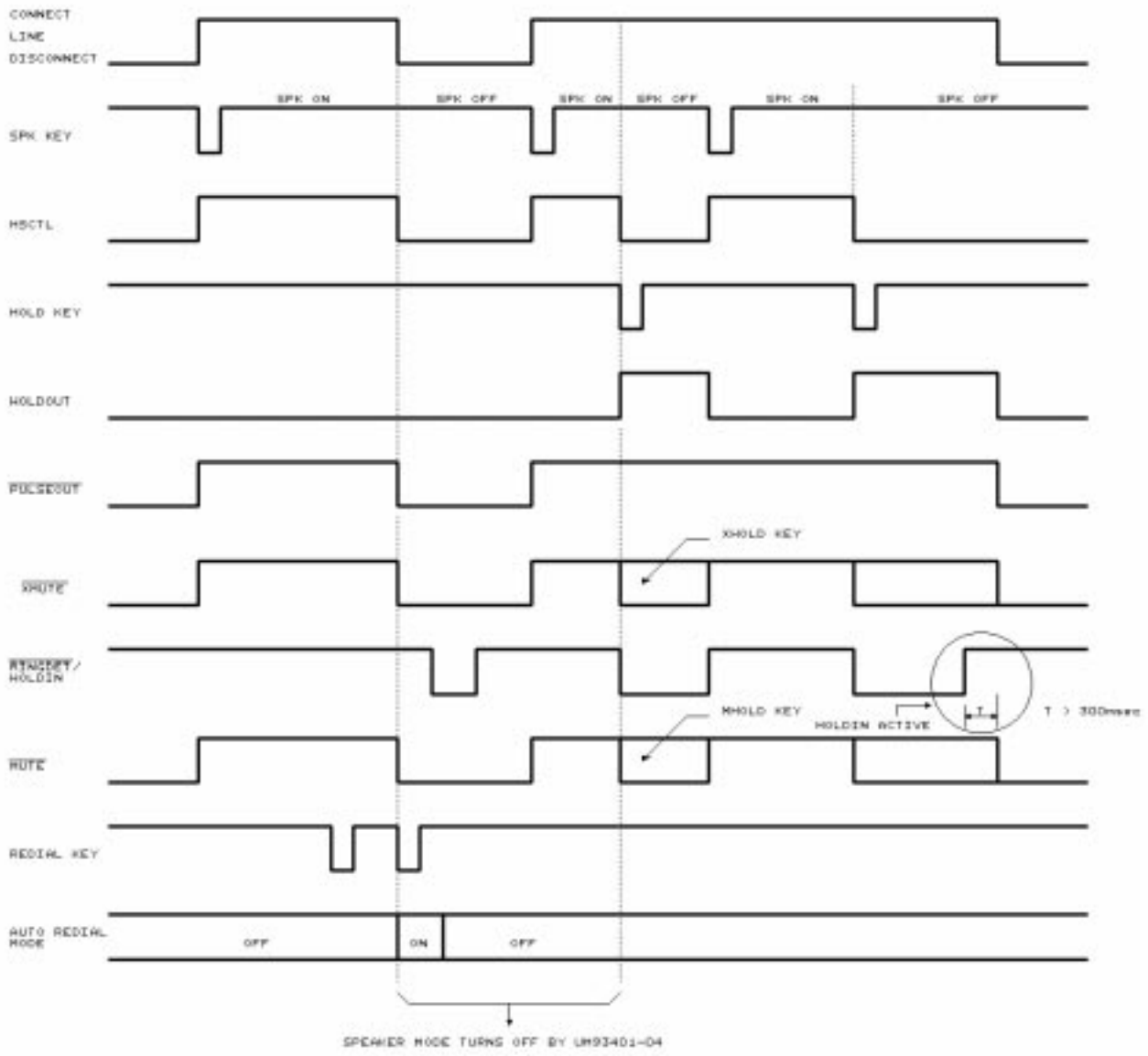
If redialing is completed and "AUTO REDIAL" disappears, pressing "SPEAKER" key will turn off speaker mode and disconnect the line.

NT93401-04 Hold Function Timing 1

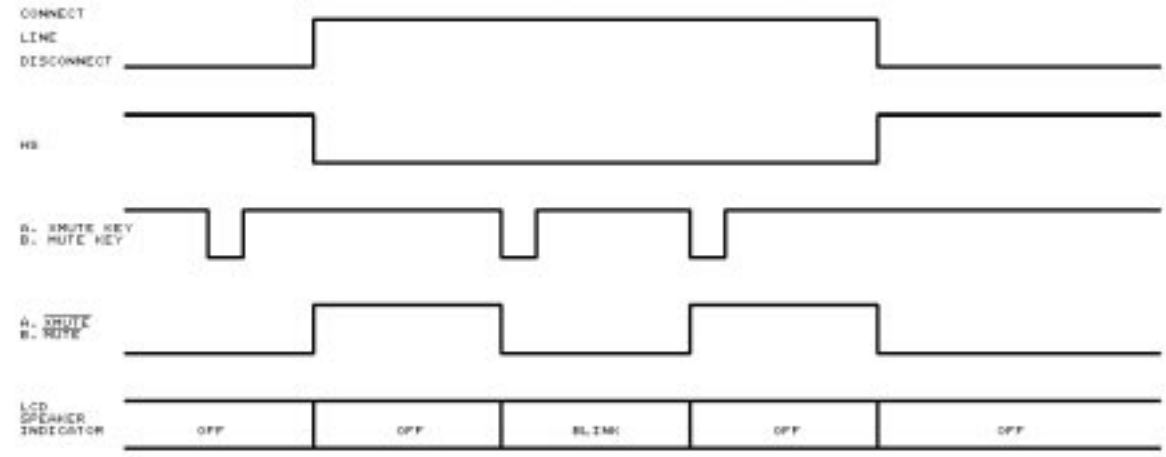


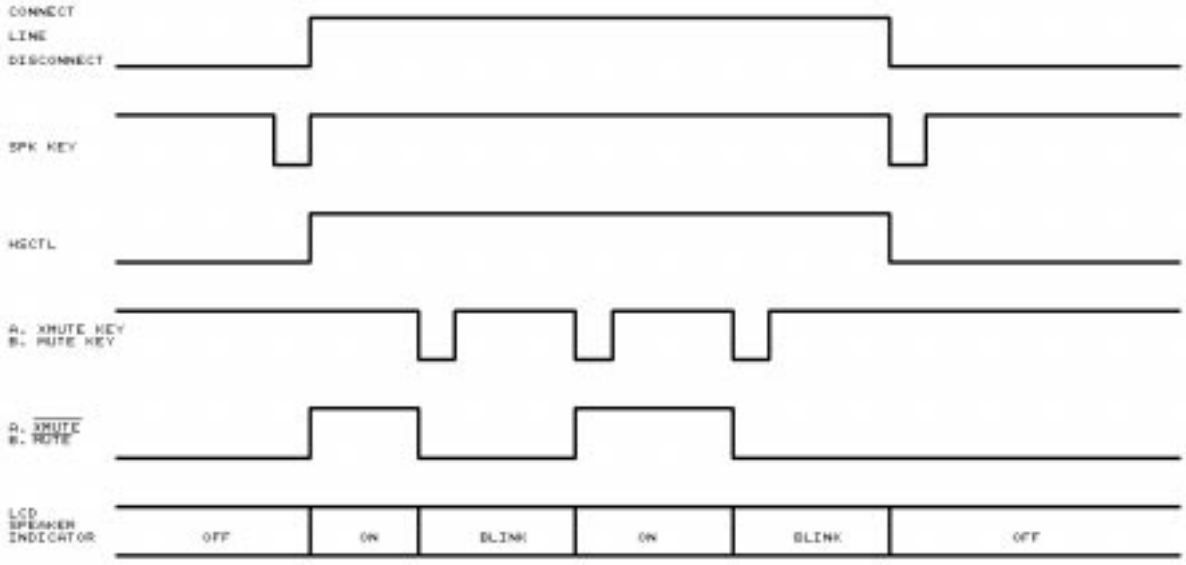
Dash line occurs if handset is in off-hook state during HOLDIN active.

NT93401-04 Hold Function Timing 2



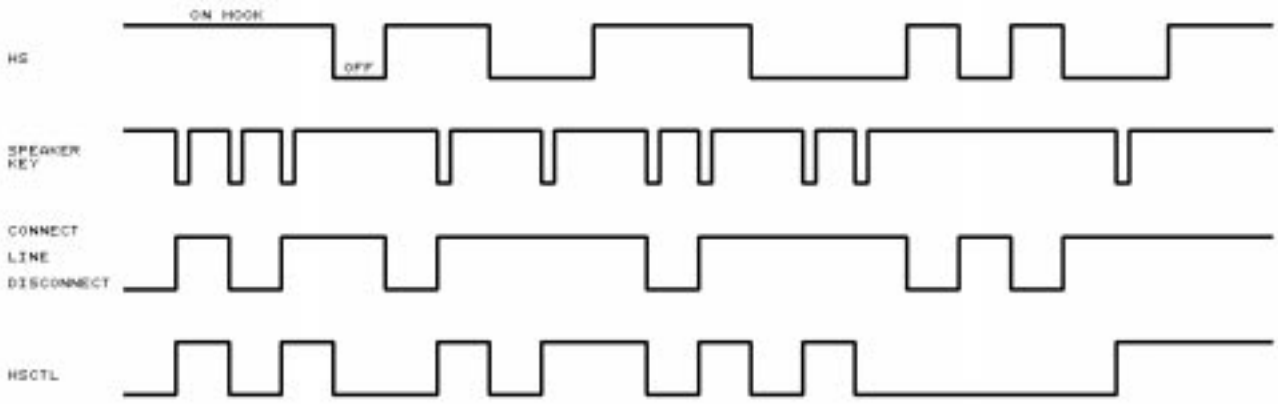
NT93401-04 Mute Function Timing



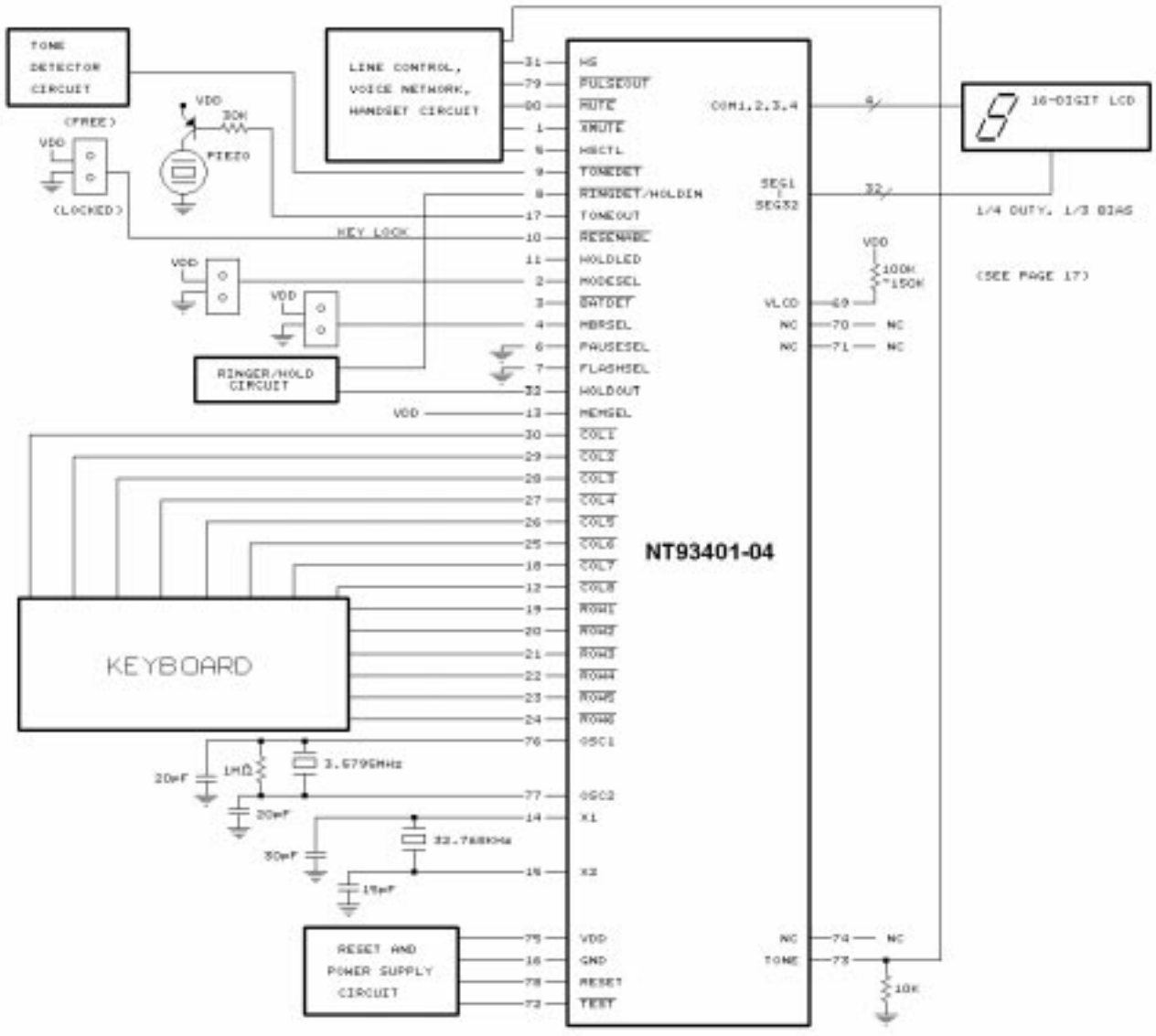


A for XMUTE B for MUTE

NT93401-04 HS and HSCTL Timing

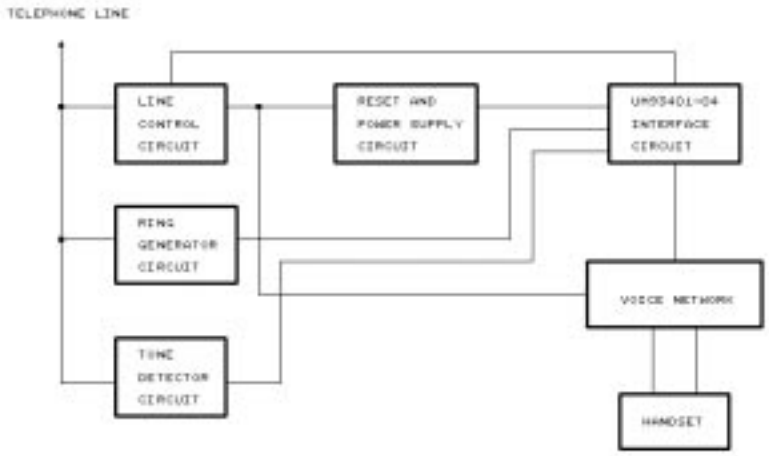


■ NT93401-04 Interface



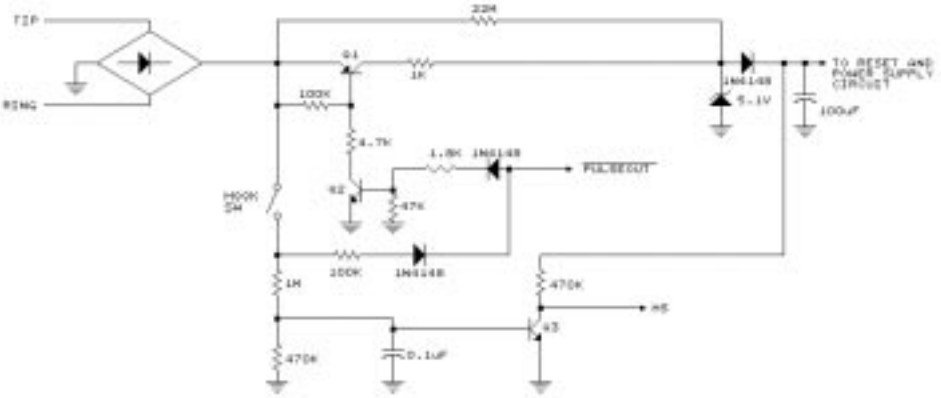
Application Circuits (for reference only)

■ Feature Phone Application Block Diagram

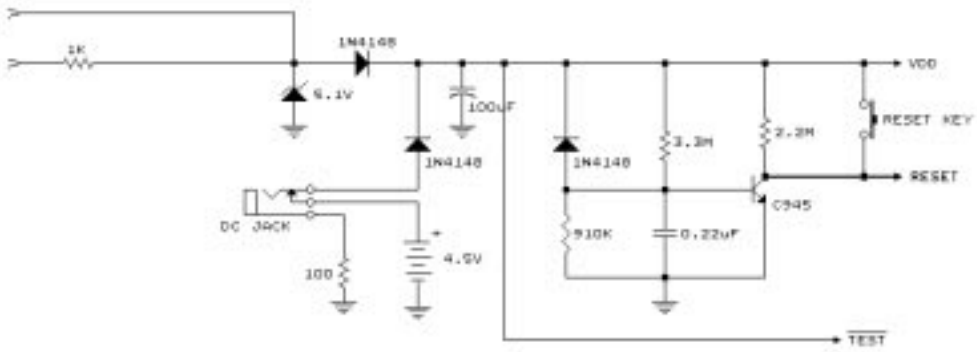


NT93401-04 Interface circuit includes: key-in tone and alarm tone circuit, optional select, keypad interface, LCD interface, and oscillator circuit.

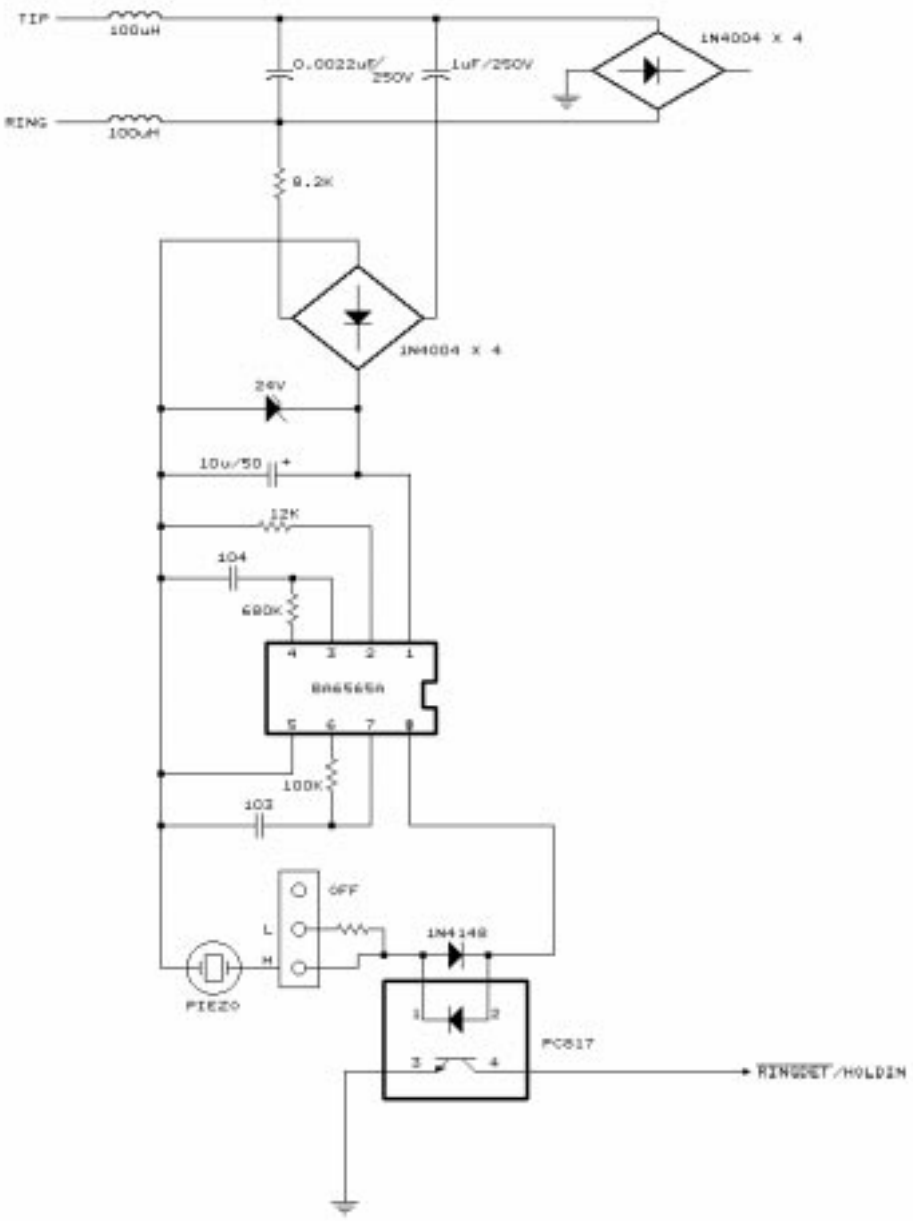
■ Line Control Circuit



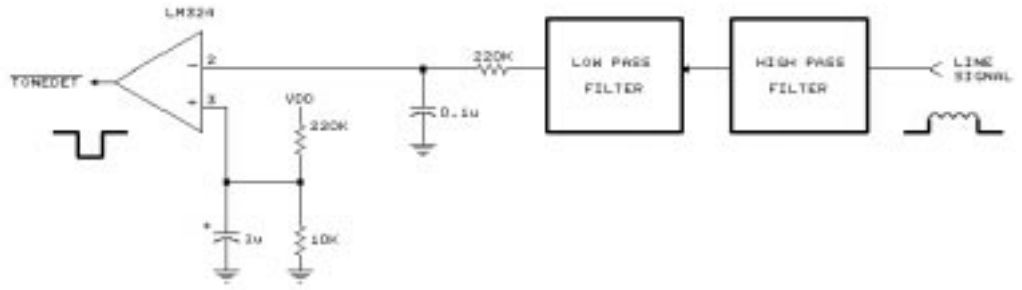
■ Reset and Power Supply Circuit



■ Ring Generator Circuit



■ Tone Detector Circuit

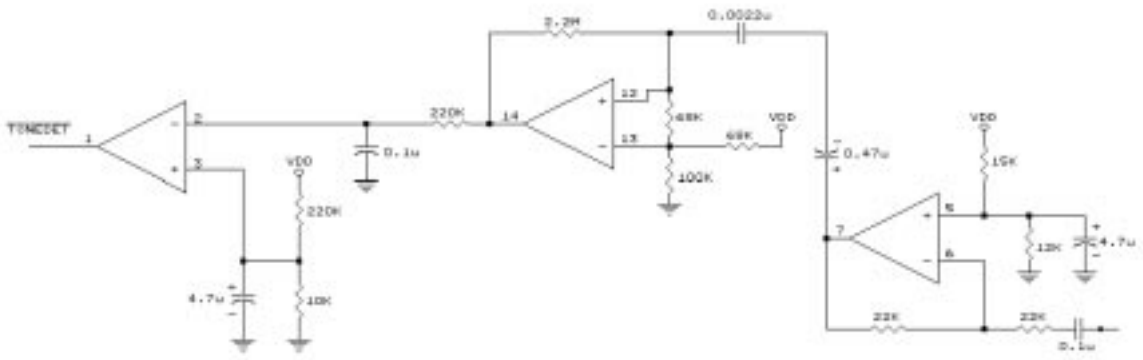


The following signals are detected by tone detector.

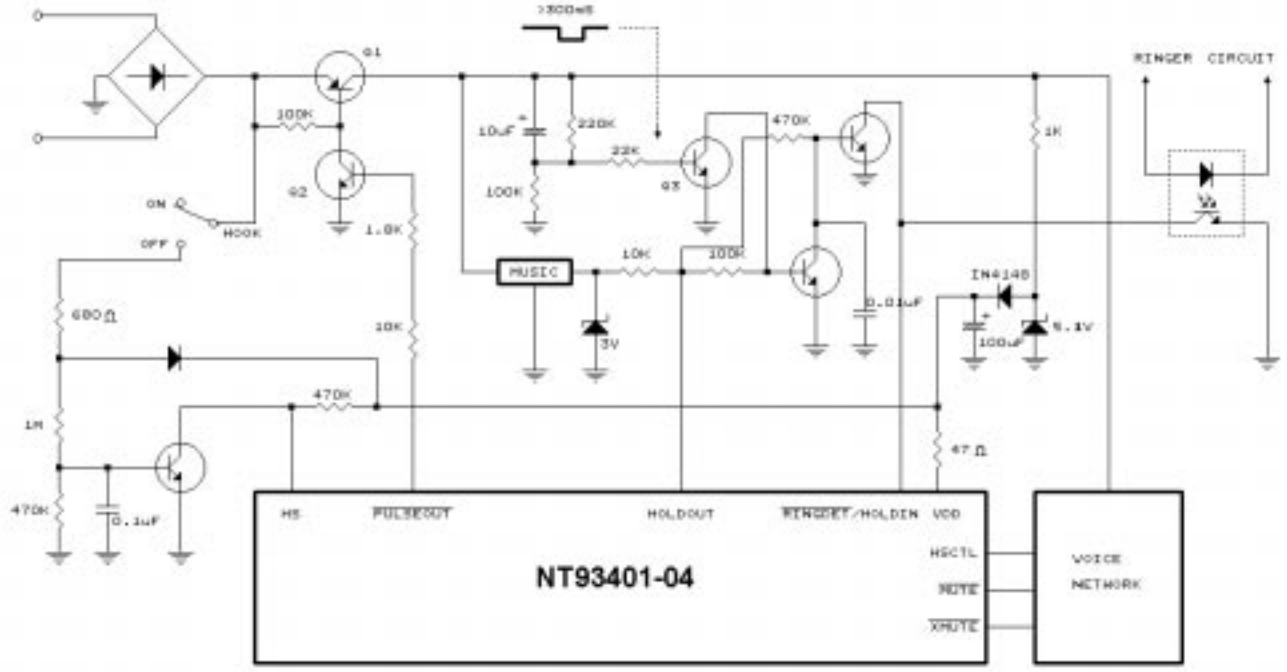
1. Dial tone: 350Hz + 440Hz
2. Busy tone: 480Hz + 620Hz
3. Reorder tone: 480Hz + 620Hz
4. Audible ring back tone: 440Hz + 480Hz

Hence, the low pass and high pass filters pass these signals and rejects the other signals. The output of filter is compared with a DC value and generates $\overline{\text{TONEDET}}$ signal.

Example:

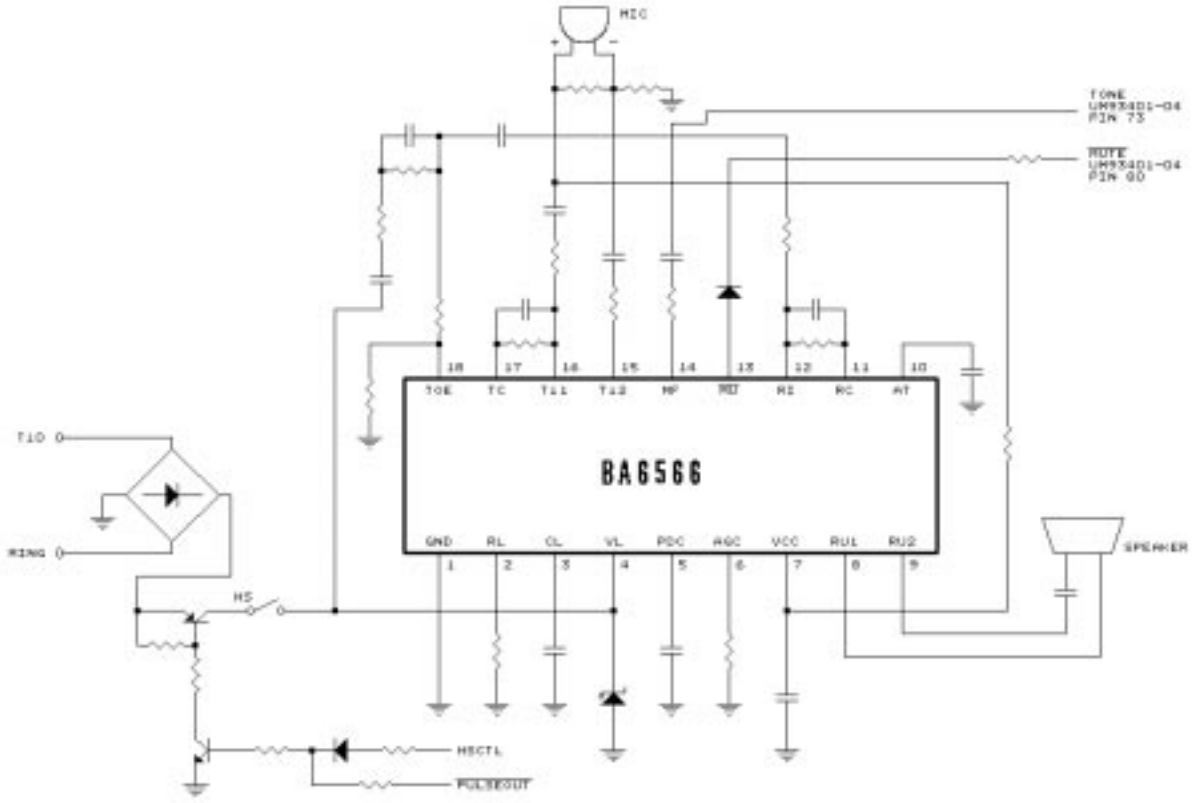


NT93401-04 Hold Application Circuit



1. Pin $\overline{\text{RINGDET}}$ RINGDET/HOLDIN is pulled high internally by NT93401-04.
2. A small 47 ohm resistor is better added between line voltage and chip VDD. If this small resistor is not provided, the maximum VDD is 5.0V and 5.1V zener diode should be changed to 4.7V.

Handset Circuit



This Circuit describes the interface between NT93401-04 and another handset I.C (BA6566).

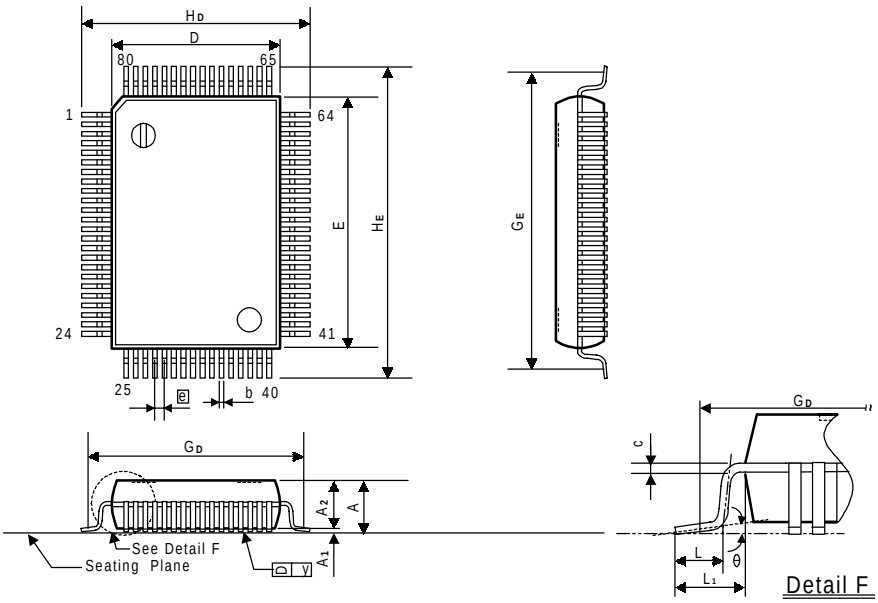
Ordering Information

Part No.	Package
NT93401F-04	80L QFP

Package Information

QFP 80L Outline Dimensions

unit: inches/mm



Symbol	Dimensions in inches	Dimensions in mm
A	0.130 Max.	3.30 Max.
A_1	0.004 Min.	0.10 Min.
A_2	0.112±0.005	2.85±0.13
b	0.014 +0.004 -0.002	0.35 +0.10 -0.05
c	0.006 +0.004 -0.002	0.15 +0.10 -0.05
D	0.551±0.005	14.00±0.13
E	0.787±0.005	20.00±0.13
e	0.031±0.006	0.80±0.15
G_D	0.693 NOM.	17.60 NOM.
G_E	0.929 NOM.	23.60 NOM.
H_D	0.740±0.012	18.80±0.31
H_E	0.976±0.012	24.79±0.31
L	0.047±0.008	1.19±0.20
L_1	0.095±0.008	2.41±0.20
y	0.006 Max.	0.15 Max.
θ	0° ~ 12°	0° ~ 12°

Notes:

1. Dimensions D & E do not include resin fins.
2. Dimensions G_D & G_E are for PC Board surface mount pad pitch design reference only.