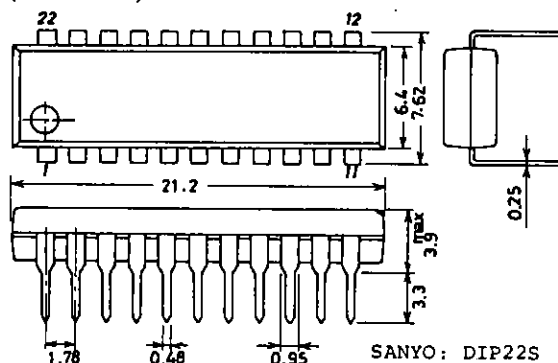CMOS LSI

No.3095A

**SANYO**

# LC7367J, 7367JM

## DTMF/PULSE Switchable Dialer

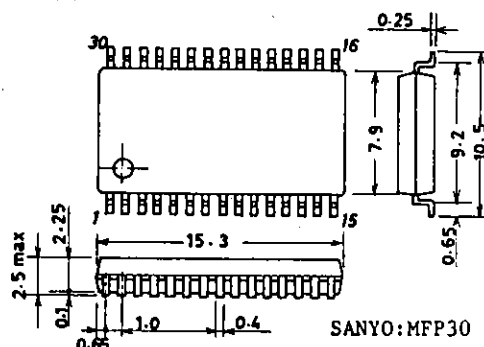The LC7367J,7367JM are DTMF/OUTPUT-PULSE dialer CMOS LSIs with redial function for use in pushbutton telephones.

### Features

(1) Low voltage CMOS process for direct operation from telephone line.

(2) Possible to use single contact or standard 2-of-7, 2-of-8 key pad.

(3) Possible to use color-burst crystal resonator for on-chip oscillator ($f_{OSC} = 3.58MHz$)

(4) Possible to use either mode select pin (P/T) or function key (4×4 matrix key) to select DTMF mode/OUTPUT-PULSE mode.

(5) Mode change with MC key is made in one direction only - from pulse mode to tone mode.

(6) Delivers 12 DTMF signals when in DTMF mode.

(7) On-chip 31-digit redial memory

(8) Possible to provide mix redial (31 digits-PAUSE-MC) of DTMF/OUTPUT-PULSE mode.

(9) Either auto pause select (4sec.×n) or manual release available for mode select standby time during redial operation.

(10) Output pulse make rate of OUTPUT-PULSE mode : Pin-selectable (33.2% or 40%)

(11) Output pulse rate of OUTPUT-PULSE mode : Pin-selectable (10pps or 20pps)

(12) On-chip circuit to prevent malfunction due to noise pulse caused by key entry.

(13) Key touch tone (pacifier tone) output capability
    OUTPUT-PULSE mode : 1243Hz/50ms

(14) Supply voltage / operating temperature
    DTMF mode : $V_{DD} = 2.0$ to $6.0V$ / $Ta = -30$ to $+70°C$
    OUTPUT-PULSE mode : $V_{DD} = 1.5$ to $6.0V$ / $Ta = -30$ to $+70°C$

(15) Operating current
    DTMF mode : $I_{DD} = 1.0mA$ max / $V_{DD} = 3.5V$
    OUTPUT-PULSE mode : $I_{DD} = 500μA$ max / $V_{DD} = 3.5V$

(16) Data retention current
    $I_{DR} \leq 0.5μA$ / $V_{DD} = 1.0V$

(17) Package
    LC7367J : Dual-in-line shrink 22-pin package
    LC7367JM : Miniflat 30-pin package
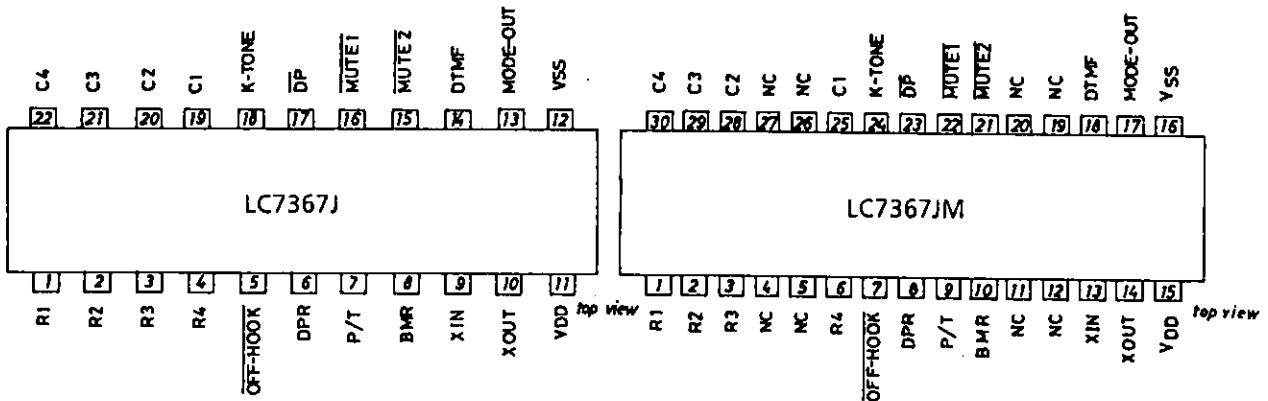
Package Dimensions 3059 [LC7367J]
(unit : mm)



SANYO: DIP22S
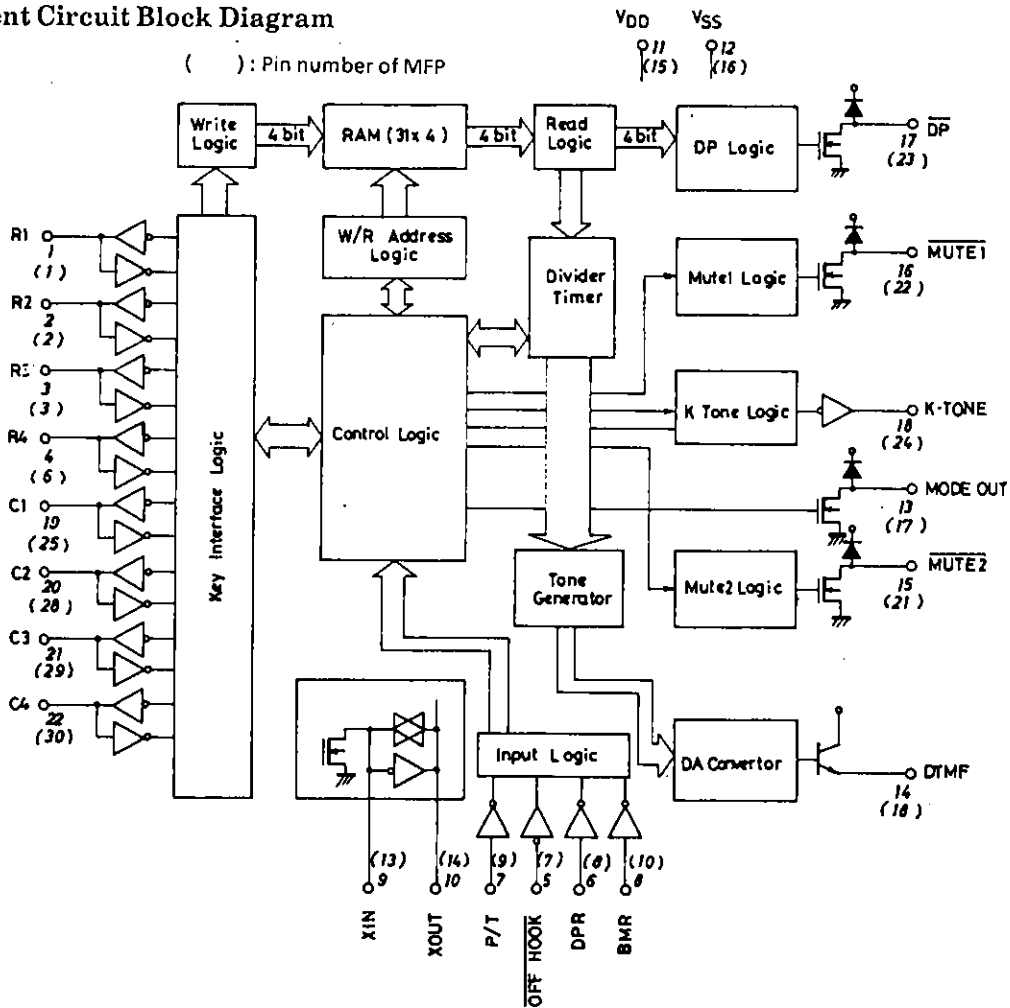
Package Dimensions 3073A [LC7367JM]
(unit : mm)



SANYO: MFP30

## Pin Assignment



LC7367J

Top pins (22→12): C4 [22], C3 [21], C2 [20], C1 [19], K-TONE [18], DP [17], MUTE1 [16], MUTE2 [15], DTMF [14], MODE-OUT [13], VSS [12]

Bottom pins (1→11): R1 [1], R2 [2], R3 [3], R4 [4], OFF-HOOK [5], DPR [6], P/T [7], BMR [8], XIN [9], XOUT [10], VDD [11] *top view*

LC7367JM

Top pins (30→16): C4 [30], C3 [29], C2 [28], NC [27], NC [26], C1 [25], K-TONE [24], DP [23], MUTE1 [22], MUTE2 [21], NC [20], NC [19], DTMF [18], MODE-OUT [17], VSS [16]

Bottom pins (1→15): R1 [1], R2 [2], R3 [3], NC [4], NC [5], R4 [6], OFF-HOOK [7], DPR [8], P/T [9], BMR [10], NC [11], NC [12], XIN [13], XOUT [14], VDD [15] *top view*

## Equivalent Circuit Block Diagram

( ) : Pin number of MFP

**Pin Description**     (     ) : Pin number of MFP

| Pin Name | Pin No. | I/O Configuration | Function |
|---|---|---|---|
| $V_{DD}$ | 11 (15) | | Power supply pin. |
| $V_{SS}$ | 12 (16) | | |
| $X_{IN}$ | 9 (13) | | Used to generate the reference frequency. Uses a crystal resonator of 3.579545MHz. With the feedback resistor and capacitors contained to form the OSC circuit, a crystal resonator is simply connected across the pins. |
| $X_{OUT}$ | 10 (14) | | When using a ceramic resonator, a capacitor of approximately 30pF must be connected to each pin. |
| R1 to R4 C1 to C4 | 1 to 4 22 to 19 ⎡ 1 to 3 ⎢ 6 ⎢ 25 ⎣ 28 to 30 ⎦ | | Row and column input pin. High-active input. Contains a P-channel transistor for keyboard scan and an N-channel transistor for pull-down. When in the ON-HOOK state, the P-channel transistor is turned OFF and the N-channel transistor is turned ON. |
| $\overline{\text{OFF-HOOK}}$ | 5 (7) | | HOOK SW input.     "H" level = ON-HOOK            "L" level = OFF-HOOK |
| DPR | 6 (8) | | Dial pulse rate select input.        "H" level = 20pps        "L" level = 10pps |
| P/T | 7 (9) | | Pulse/tone select input.        "H" level = Pulse mode        "L" level = DTMF mode |
| BMR | 8 (10) | | Make rate select input.        "H" level = 33.2%        "L" level = 40% |
| $\overline{\text{DP}}$ | 17 (23) | | Dial pulse output. |
| $\overline{\text{MUTE1}}$ | 16 (22) | | Mute output. Operates at the OUTPUT-PULSE mode. Capable of being wired-ORed with $\overline{\text{MUTE2}}$. |
| $\overline{\text{MUTE2}}$ | 15 (21) | | Mute output. Operates at the DTMF mode. Capable of being wired-ORed with $\overline{\text{MUTE1}}$. |
| MODE-OUT | 13 (17) | | DTMF/OUTPUT-PULSE mode output.        OUTPUT-PULSE mode = "L" level        DTMF mode = "H" impedance |
| K-TONE | 18 (24) | | When a key is pushed at the OUTPUT-PULSE mode, the K-TONE (pacifier tone) of 1243Hz/50ms is output. |
| DTMF | 14 (18) | | The DTMF signal is output. NPN transistor-used emitter follower output. |

## Key Assignment

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | F | R1 |
| 4 | 5 | 6 | P | R2 |
| 7 | 8 | 9 | RD | R3 |
| ✳ | 0 | ＃ | MC | R4 |
| C1 | C2 | C3 | C4 | |

F : Flash

P : Pause

RD : Redial, pause release

MC : Pulse = tone select

When in OUTPUT-PULSE mode

✳ = P

＃ = RD

### Absolute Maximum Ratings at Ta = 25°C

| | | | | unit |
|---|---|---|---|---|
| Maximum Supply Voltage | $V_{DD}$ | | $-0.3$ to $+7$ | V |
| Maximum Input Voltage | $V_{IN}$ | | $-0.3$ to $V_{DD}+0.3$ | V |
| Maximum Output Voltage | $V_{OUT}$ | | $-0.3$ to $V_{DD}+0.3$ | V |
| Allowable Power Dissipation | Pd max | Ta = 70°C | 300 | mW |
| Minimum Load Resistance | $R_L$ min | Across DTMF and $V_{SS}$ pin | 100 | Ω |
| Operating Temperature | Topr | | $-30$ to $+70$ | °C |
| Storage Temperature | Tstg | | $-40$ to $+125$ | °C |

### Allowable Operating Conditions at Ta = $-30$ to $+70°C$, $V_{DD}$ = 1.5 to 6.0V

| | | | min | typ | max | unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DDP}$ | OUTPUT-PULSE mode | 1.5 | | 6.0 | V |
| | $V_{DDT}$ | DTMF mode | 2.0 | | 6.0 | V |
| 'H'-Level Input Voltage | $V_{IH}$ | All input pins | $0.7V_{DD}$ | | $V_{DD}$ | V |
| 'L'-Level Input Voltage | $V_{IL}$ | All input pins | $V_{SS}$ | | $0.3V_{DD}$ | V |
| Key Contact Resistance | $R_{KI}$ | | | | 3.0 | kΩ |
| Keyboard Capacitance | $C_{KI}$ | | | | 330 | pF |
| Resonator Specification | f | | | 3.579545MHz ± 0.7% | | |
| | $R_S$ | | | $<100Ω$ | | |

### Electrical Characteristics at Ta = 25°C, $V_{DD}$ = 1.5 to 6.0V

| | | | min | typ | max | unit |
|---|---|---|---|---|---|---|
| Operating Current | $I_{DDP}$ | OUTPUT-PULSE mode, output open, $V_{DD}$ = 3.5V | | 0.3 | 0.5 | mA |
| | $I_{DDT}$ | DTMF mode, output open, $V_{DD}$ = 3.5V | | 0.5 | 1.0 | mA |
| Quiescent Current | $I_{DD(ST)}$ | $\overline{OFF\text{-}HOOK}$ pin = $V_{DD}$, $V_{DD}$ = 1.5 to 6.0V, output open | | | 1 | μA |
| Data Retention Voltage | $V_{DR}$ | | | | 1 | V |
| Data Retention Current | $I_{DR}$ | $V_{DD}$ = 1V | | | 0.5 | μA |
| 'H'-Level Input Current | $I_{IH}$ | ($\overline{OFF\text{-}HOOK}$, DPR, P/T, BMR) pin, $V_{IH}$ = $V_{DD}$ | | | 1 | μA |
| 'L'-Level Input Current | $I_{IL}$ | (OFF-HOOK, DPR, P/T, BMR) pin, $V_{IL}$ = $V_{SS}$ | $-1$ | | | μA |
| Key Pin Current | $I_{IHK}$ | $V_{DD}$ = 1.5V, $V_{IH}$ = $V_{DD}$ | | | 20 | μA |
| | | $V_{DD}$ = 6.0V, $V_{IH}$ = $V_{DD}$ | | | 300 | μA |
| | $I_{OHK}$ | $V_{DD}$ = 1.5V, $V_{OH}$ = $0.8V_{DD}$ | | | $-50$ | μA |
| | | $V_{DD}$ = 6.0V, $V_{OH}$ = $0.8V_{DD}$ | | | $-700$ | μA |
| Output OFF-State Leakage Current | $I_{OFF}$ | V0 = $V_{DD}$, $V_{DD}$ = 6V, output OFF, ($\overline{DP}$, $\overline{MUTE1}$, $\overline{MUTE2}$, MODE-OUT) | | | 1 | μA |

Continued from preceding page.

| | | | | min | typ | max | unit |
|---|---|---|---|---|---|---|---|
| 'H'-Level Output Pin Voltage | $V_{OH}$ | K-TONE : $V_{DD} = 1.5V$, $I_{OH} = -125\mu A$ | | $V_{DD} - 0.5$ | | | V |
| | | K-TONE : $V_{DD} = 3.5V$ $I_{OH} = -500\mu A$ | | $V_{DD} - 1$ | | | V |
| 'L'-Level Output Pin Voltage | $V_{OL}$ | (K-TONE, $\overline{DP}$, $\overline{MUTE1}$, $\overline{MUTE2}$, MODE-OUT) pin | $V_{DD} = 1.5V$, $I_{OL} = 125\mu A$ | | | 0.4 | V |
| | | | $V_{DD} = 3.5V$, $I_{OL} = 500\mu A$ | | | 0.4 | V |

**AC Characteristics** at Ta = 25°C, $V_{DD}$ = 1.5 to 6.0V, $f_{OSC}$ = 3.579545MHz

| | | | min | typ | max | unit |
|---|---|---|---|---|---|---|
| Key Debounce Time | $T_{KD}$ | | 10.8 | | 11.6 | ms |
| K-TONE Frequency | $f_{KT}$ | | | 1243 | | Hz |
| K-TONE Output Time | $T_{KT}$ | | | 50.9 | | ms |
| Auto Pause Time | $T_{AP}$ | | | 3.99 | | s |
| Single Tone Output | $V_{OR}$ | ROW TONE output, $V_{DD} = 3.5V$, $R_L = 10k\Omega$ | 170 | 205 | 245 | mVrms |
| Tone Output Ratio | $d_{BCR}$ | $V_{DD} = 2$ to $6V$, $R_L = 10k\Omega$ | 1 | 2 | 3 | dB |
| Tone Output Distortion | $\%_{DIS}$ | $V_{DD} = 2.5$ to $6V$, $R_L = 10k\Omega$, $f = 300$ to $3400Hz$ | | | 7 | % |
| | | $V_{DD} = 2$ to $6V$, $R_L = 10k\Omega$, $f = 300$ to $3400Hz$ | | | 10 | % |
| Oscillation Start Time | $T_{START}$ | $V_{DD} = 1.7$ to $6V$ | | | 20 | ms |
| | | $V_{DD} = 3.5V$ | | | 8 | ms |
| DTMF Output Time | $T_{MFON}$ | | 97.6 | | | ms |
| DTMF Interdigit Pause | $T_{MFOFF}$ | | 100.6 | | | ms |
| Flash Time | $T_{FLASH}$ | | | 605 | | ms |

● Dial Pulse Output

f osc=3.579545MHz

| Pin DPR | Pin BMR | Dial Pulse Rate | Interdigit Pause | Make Ratio |
|---|---|---|---|---|
| $V_{SS}$ | $V_{DD}$ | 9.94 PPS | 838.1 ms | 33.2 % |
| $V_{DD}$ | $V_{DD}$ | 19.89 PPS | 519.6 ms | 33.2 % |
| $V_{SS}$ | $V_{SS}$ | 9.94 PPS | 844.8 ms | 40 % |
| $V_{DD}$ | $V_{SS}$ | 19.89 PPS | 523.0 ms | 40 % |

● DTMF Output

f osc=3.579545MHz

| Input | Output Frequency (Hz) | | Deviation (%) |
|---|---|---|---|
| | Standard | LC7367J,7367JM | |
| R1 | 697 | 699.1 | +0.30 |
| R2 | 770 | 766.2 | -0.49 |
| R3 | 852 | 847.4 | -0.54 |
| R4 | 941 | 948.0 | +0.74 |
| C1 | 1209 | 1215.9 | +0.57 |
| C2 | 1336 | 1331.7 | -0.32 |
| C3 | 1477 | 1471.9 | -0.35 |

● Redial Operation

f osc=3.579545MHz

| Parameter | Time | |
|---|---|---|
| | 1st Digit | 2nd Digit onward |
| DTMF Output | 97.6 ms | 100.6 ms |
| Interdigit Pause | 100.6 ms | 100.6 ms |
| Period | 198.2 ms | 201.2 ms |

**Timing Charts**

**(1) OUTPUT-PULSE mode**

OFF HOOK

KEY 　2　3　P　1　RD

11ms　Make　4 sec　Make　11ms　4 sec

DP　IDP　IDP　IDP　IDP　IDP

IDP　Brake　½DP

MUTE1

MUTE2

K-TONE　50ms
1243Hz

OSC

$$800 - \left(1 - \frac{10}{DP}\right) \times 600 + \frac{\text{Make ratio}}{DP} \times 10 + DP \quad (\text{ms})$$

$$DP = \frac{1000}{OPR} \quad (\text{ms})$$

**(2) Tone mode**

OFF HOOK

KEY 　2　3　P　1　RD

11ms　3ms　3ms　97ms　100ms　4 sec
3ms　11ms　4 sec　97ms

DTMF　2　3　1　2　3　1
100ms　100ms

MUTE1

MUTE2　11ms　100ms　100ms

OSC

**(3) Pulse → tone mix (P/T = 'H')**

OFF HOOK

KEY 　2　1　MC　3　2　RD　RD
11ms

DP

MUTE1

DTMF　3　2　3　2

MUTE2　2ms　2ms

MODE OUT

K-TONE　50ms
1243Hz

## (4) Pulse → tone (P/T = 'H')



2nd MC key-in is invalid.

## (5) Timing of flash



Same state as after off-hook
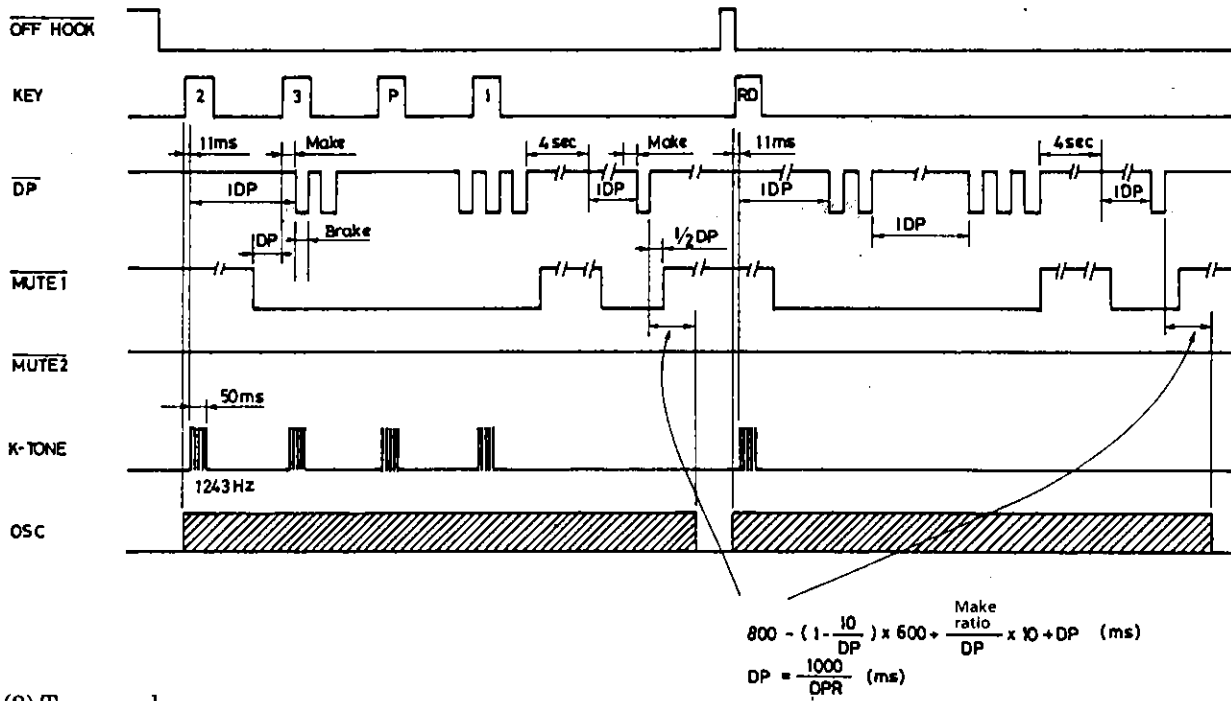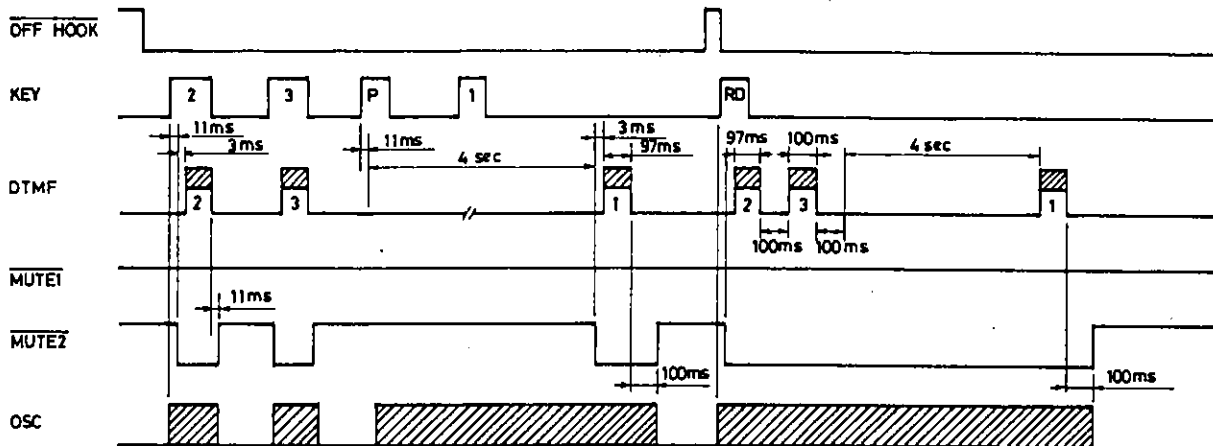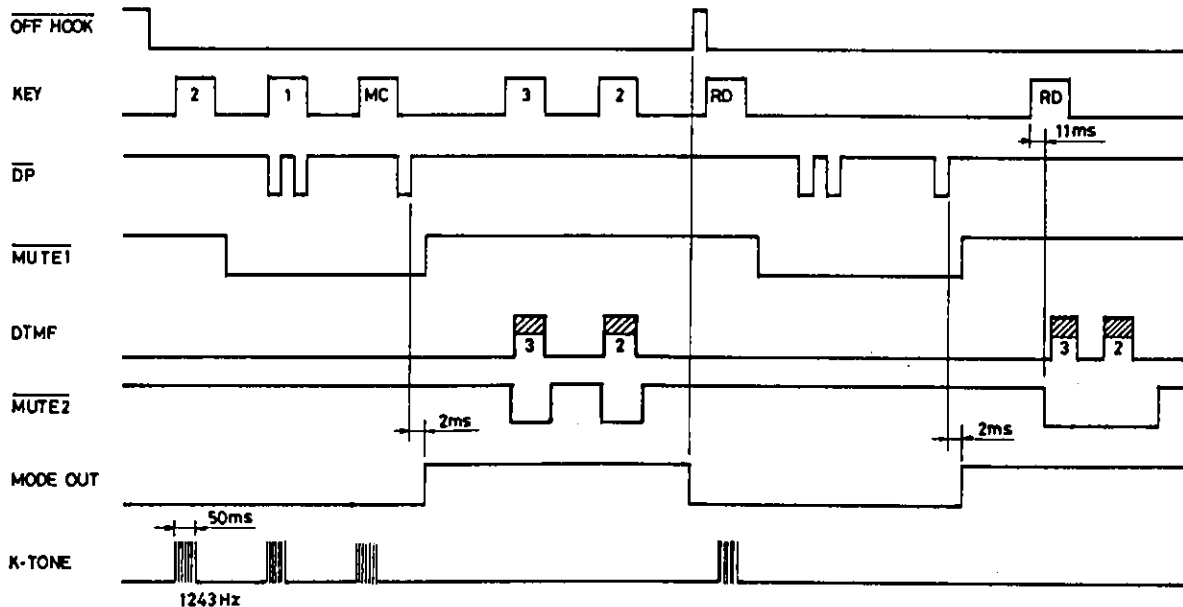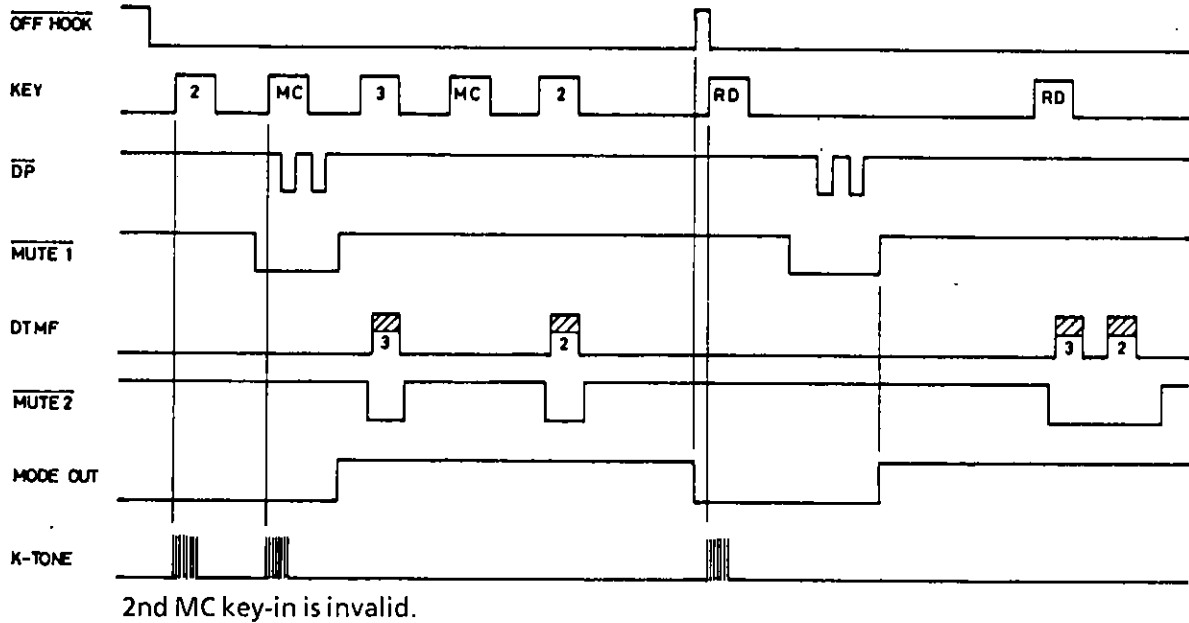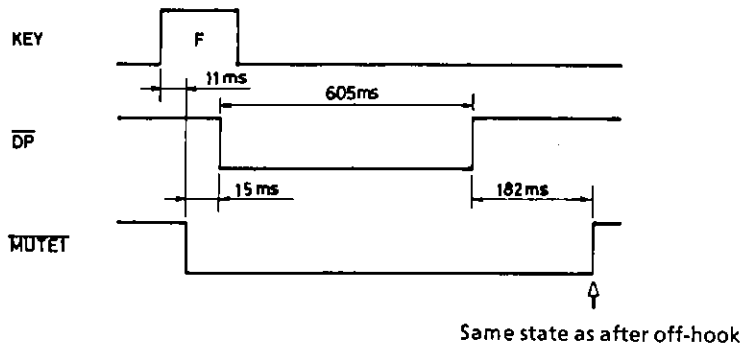
## (6) Mix dial and redial (key entry available after redial) by P/T input (slide SW, etc.)
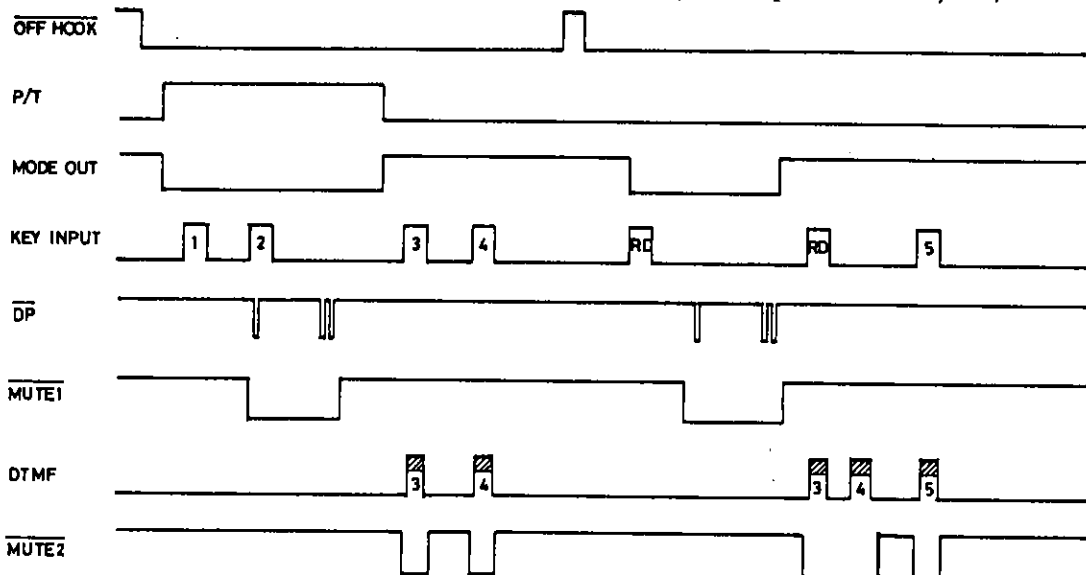


- Even when the tone mode (P/T SW : "Tone") is entered at the OFF-HOOK state, the OUTPUT-PULSE mode can be entered (P/T SW : "Pulse").
- The output mode provided when redialing is the one provided when dialed previously (regardless of the P/T SW position when the RD key is pushed).

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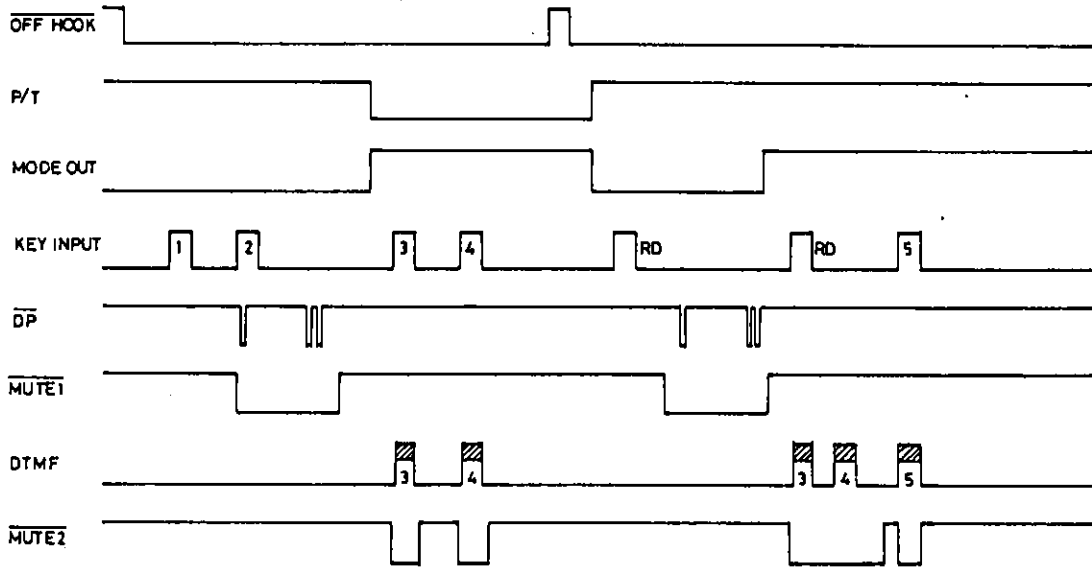


● The mode after completion of redialing is set again by the P/T SW position provided when redialing is completed.

Since the DP, MUTE1, MUTE2, MODE-OUT outputs are of the Nch open drain type, the output transistor OFF-state ("H" impedance) provides "H" level.

Likewise, since the DTMF output is of the emitter follower type, the output transistor OFF-state ("H" impedance) provides "L" level.
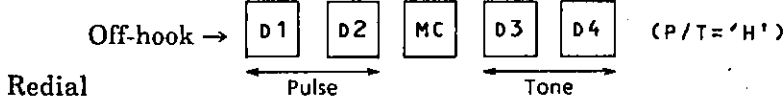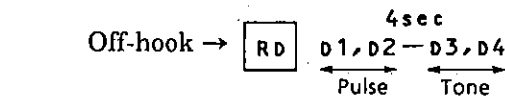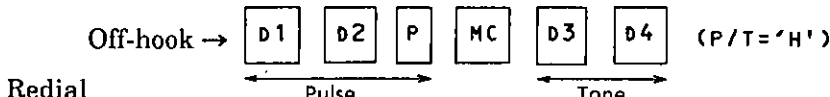
## Key Operation

(1) Normal dial

　　Off-hook → [D1] [D2] ‥‥ [Dn]

　　Redial

　　Off-hook → [RD]

(2) PBX dial

　　Off-hook → [D0] [P] [D1] [D2] ‥‥ [Dn]

　　Redial

　　Off-hook → [RD]
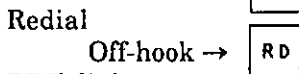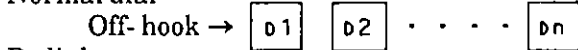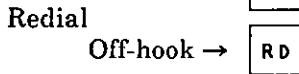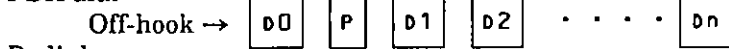
(3) Pulse/tone mix

　① In case where there is no pause during mode select

　　Off-hook → [D1] [D2] [MC] [D3] [D4]　　(P/T='H')
　　　　　　　　　←Pulse→　←Tone→

　Redial

　　Off-hook → [RD] D1,D2 [RD] D3,D4
　　　　　　　　　←Pulse→　←Tone→

　② In case where there are pauses during mode select

　　Off-hook → [D1] [D2] [P] [MC] [D3] [D4]　　(P/T='H')
　　　　　　　　　←—Pulse—→　←—Tone—→

　Redial
　　　　　　　　　　　4sec
　　Off-hook → [RD] D1,D2 — D3,D4
　　　　　　　　　←Pulse→ ←Tone→

(Note)　ⓐ When in OUTPUT-PULSE mode [P] = [×]　[RD] = [#]

　　　　ⓑ Pause : 4sec. / 1 push of [P], 8sec. / 2 pushes of [P],

　　　　　　　4×nsec. / n pushes of [P]

　　　　ⓒ For pause release, push [RD]. All pauses can be also released by pushing [RD] once.

## Function Specifications
The LC7367J, 7367JM are capable of pulse dial, DTMF dial and also both types of dialing mixed, as well as redial of these.

1) Dial Output Specifications
- The output pulse make ratio of OUT-PULSE mode can be set at 33.2 or 40% using the BMR pin.
- The output pulse rate of OUT-PULSE mode can be set at 20 or 10pps using the DPR pin.
- 12 types of DTMF dial signals (1 to 0,✳ , #) are generated in DTMF mode.
- DTMF signals are output continuously when the keys are pressed.
- A minimum output for DTMF of approximately 100ms, and also about 100ms for minimum IDP are guaranteed.

2) Summary of Operation
- Key input data is written consecutively in the 31 digit buffer memory (also used as RD memory; hereinafter referred to as RD memory).
- The dial data in the RD memory is read out according to the set dial rate, and is output at the $\overline{DP}$ and DTMF pins.
- Dial output of more than 31 digits is enabled by rewriting the key data from the top (address 0) of the RD memory.
- Because of this, the correct dial does not remain in the RD memory for 32 digits or more, so redial for 32 digits or more is prohibited.
- Dial data (1 to 0,✳ , #), mode change data (MC) and pause data (P) are written in the RD memory as 1 digit each.
- Dial output mode switching can be performed using the MC key on the key matrix or the P/T input pin.
- The dial output can be stopped for 4 seconds with the pause key (P).
- One-touch redial can be done using the redial key (RD).

3) Key and P/T Pin Descriptions
 ① Keys 1 to 0
 These are dial data keys. Data is written in the RD memory.
 ② ✳, # Keys
 | In DTMF mode : | ✳ and # dial data key |
 | In OUT-PULSE mode : | ✳ = pause key (P) |
 | | # = redial key (RD) |

 The ✳ and # keys for DTMF mode and ✳ key in the OUT-PULSE mode are for writing data in the RD memory.
 ③ F Key (flash key)
 · The same operation as for 0.6-second hooking is performed when $\overline{DP}$ output is turned on for 0.6 second.
 · Redial can be performed after flash operation.
 ④ RD Key (redial key)
 1. Redial operation
 When the RD key is pressed after hooking ($\overline{OFF\text{-}HOOK}$ pin) or F key operation, the number that immediately precedes will be redialed.
 Redial is prohibited if the number has 32 digits or more.
 2. Pause release
 The Pause key provides 4-second pause and releases pause attendant on the mode change (MC key, P/T pin).
 Even if there is a succession of 2 digits or more of pause data in the RD memory, it will all be released.
 ⑤ P Key (pause key)
 · Stops dial output for 4 seconds.
 · Data is written in the RD memory.

Continued from preceding page.

⑥ MC Key (mode change key)
  · Switches dial mode from OUT-PULSE mode to DTMF mode.
  · The mode cannot be switched from DTMF mode to OUT-PULSE mode.
⑦ P/T Pin
  · Input to indicate dial mode
        H = OUT-PULSE mode
        L = DTMF (tone) mode
  · The mode can be switched between DTMF and pulse mode differ from in case of MC key.
  · Mix dialing by P/T pin switching during dialing is possible.  MD data is written in the RD memory at this time.
  · At OUT-PULSE mode, if the MC key is pressed during dialing, data is written in the RD memory as MC data.
  · At OUT-PULSE mode, pressing the first digit (after OFF-HOOK) MC key switches the dial mode, but data is not written in the RD memory.

**Key Assignment**

|    | C1 | C2 | C3 | C4 |
|----|----|----|----|----|
| R1 | 1  | 2  | 3  | F  |
| R2 | 4  | 5  | 6  | P  |
| R3 | 7  | 8  | 9  | RD |
| R4 | ✳  | 0  | #  | MC |

**Key Debounce Time**
  • A key debounce circuit is built in key input to prevent misoperation caused by switch chattering.
      Input is valid when on continuously for 11ms or more,
      and is invalid when off continuously for 11ms or more.
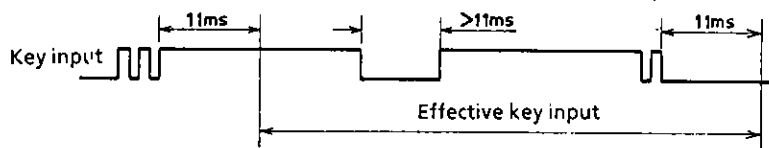


4) MC Data Writing in RD Memory
  • After the MC data is stored once in the MC data flag, it is written in the RD memory when another data key (1 to 0, ✳, #, P) is pressed.
  • The MC data flag is reset with hooking and the P key.
  • The contents of the MC data flag are canceled and are not written in the RD memory when the P/T pin is switched as P→T→P.

5) Notes on Dial Specifications
  ① Pause operation during mode switching
     When there is no P data before or after MC data
     1. Normal dial
        Mode change is done and DTMF data key is started  during dial pulse output:
          → After dial pulse ends, pause begins, and the DTMF signal is output with release using the RD key.
        DTMF data keyed in after dial pulse output :
          → DTMF signal is output with key-in.
     2. Redial for the above
        After dial pulse ends, pause begins, and the DTMF signal is output with release using the RD key.

Continued from preceding page.

② Key input during redial
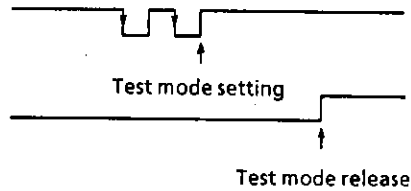This is ignored except for the F key and the RD key during pause operation.

6) Test Mode
A high speed test mode is provided in order to reduce the LSI test time.
• Test mode setting and release methods

BMR pin input

Test mode setting

OFF-HOOK pin input
+ built-in power-on reset pulse

Test mode release

• Test mode summary
The internal divider circuit (72 divisions) is bypassed.
Key scan frequency  .....  72 times
Dial pulse rate  ..........  72 times
4-second pause  .........  1/72

## Sample Application Circuit

(Pin numbers are for DIP package.)
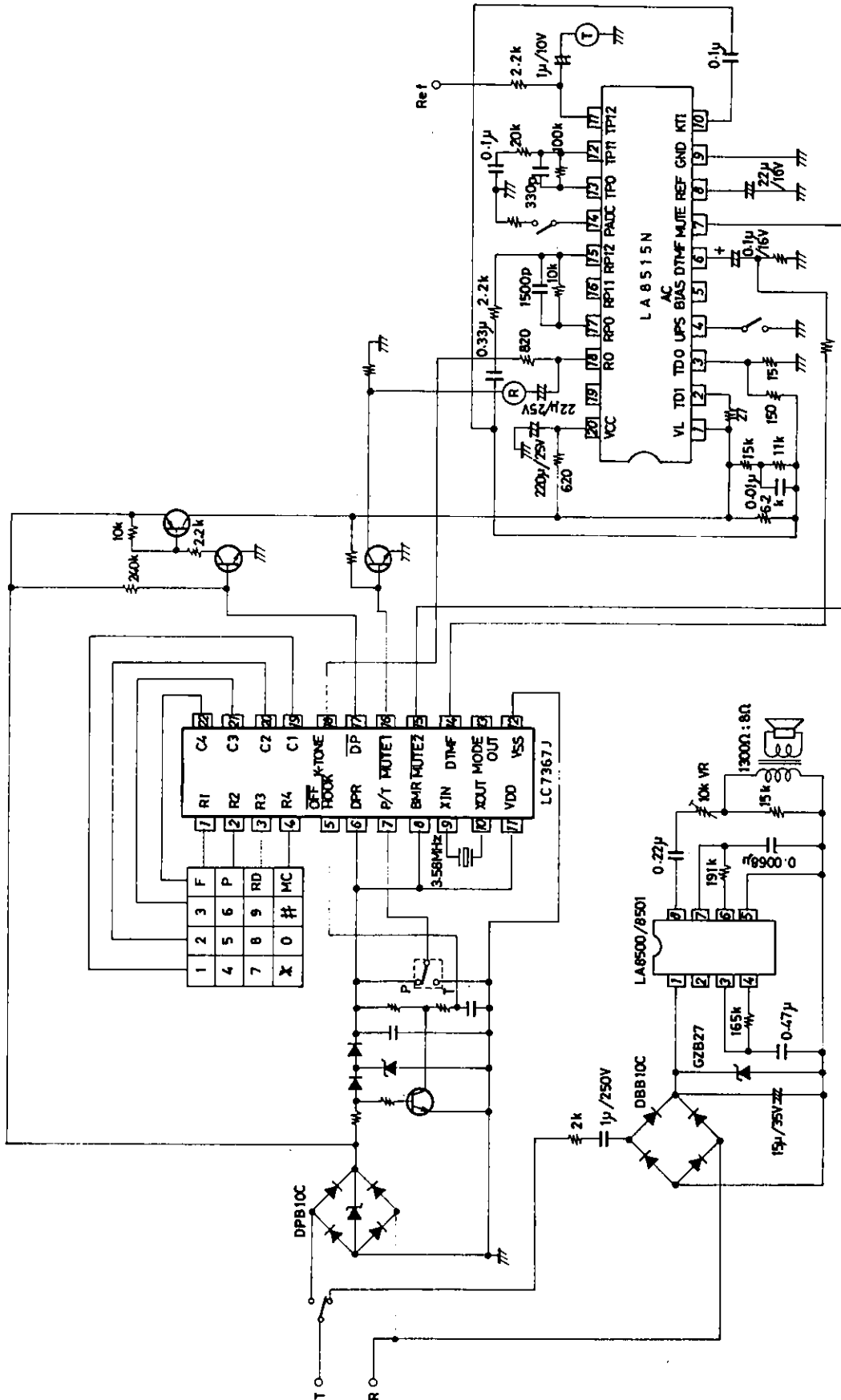


Unit (resistance: Ω, capacitance: F)