June 1991

FUJITSU

DATA SHEET

MB87009

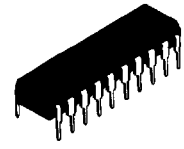
Dual Tone Multi-Frequency/Pulse Dialer

The Fujitsu MB 87009 is an IC for pushbutton telephone sets using Si gate CMOS process and can be used for both DTMF and PULSE modes.

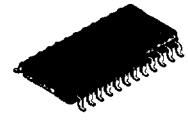
The MB 87009 can be switched from PULSE mode to DTMF mode by mode selection entry or by input from the keyboard.

The MB 87009 contains a 26-digit redial memory, permitting coexistence of PULSE and DTMF modes, enabling mixed redialing in both PULSE and DTMF modes by a single key entry.

- Pulsed 10 pps, 20 pps, or DTMF operation can be selected by the mode switch pin (MODEC).
- 26-digit redial memory is built in (up to 25 digits can actually be written in the memory).
- Selectable make ratio by MA/BR: 39% or 33%.
- LDT function is provided (key entry enables switching from PULSE mode to DTMF mode).
- Beep tone for input confirmation can be output (for all effective key entry independently of PULSE/DEMF mode.
- Redial inhibit function is included for redial memory overflow.
- Mixed redialing of both PULSE and DTMF modes is possible.
- PAUSE function is provided and pause accumulation is possible.
- FLASH function is provided (ONHOOK mode is entered by keyboard entry).
- Crystal or ceramic oscillator (3.579545 MHz) can be used.
- PAUSE release function is provided (two or more consecutive pauses can be released).
- Operating voltage (-30°C to 60°C)
  PULSE mode : 2.0 to 6.0 V
  DTMF mode : 2.5 to 6.0 V

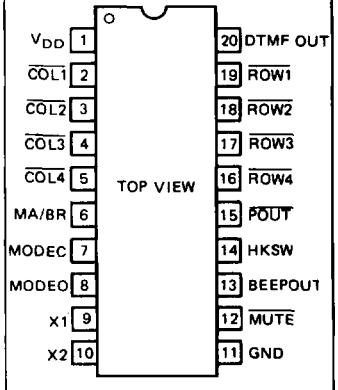


PLASTIC PACKAGE
DIP-20P-M01



PLASTIC PACKAGE
FPT-24P-M02

PIN ARRANGEMENT



ABSOLUTE RATINGS

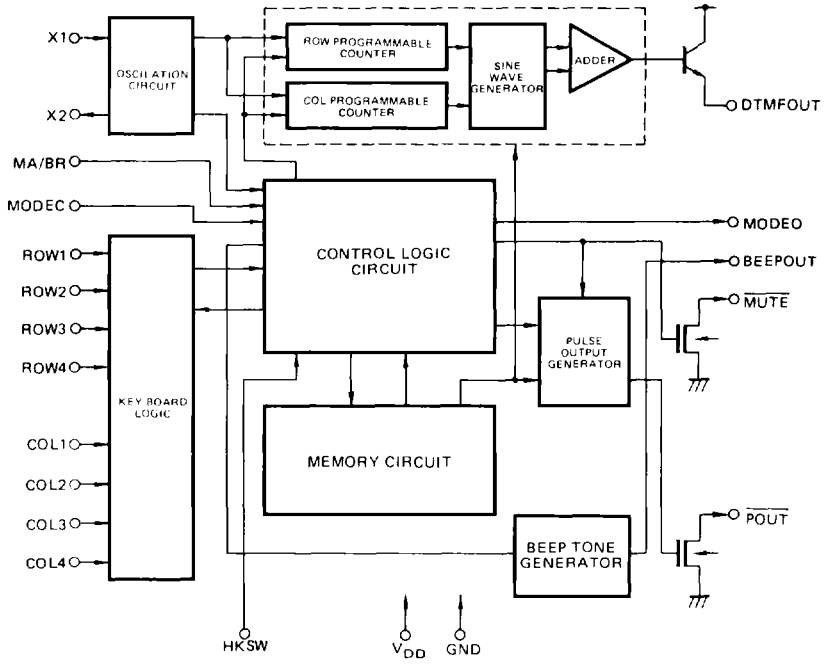
Rating	Symbol	Value	Unit
Power voltage	V_{DD}	GND-0.3 to 7.0	V
Input voltage	V_{IN}	GND-0.3 to V_{DD}+0.3	V
Output voltage	V_{OUT}	GND-0.3 to V_{DD}+0.3	V
Storage temperature	T_{STG}	-55 to 150	°C

NOTE: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

7

MB 87009 BLOCK DIAGRAM



EXPLANATION OF THE BLOCK DIAGRAM

Setting the HKSW pin from "H" to "L" changes the mode from ONHOOK to OFFHOOK, activating the 3.579545 MHz oscillator and entering a key entry accepting state.

MODEC pin entry in OFFHOOK mode enables selection of PULSE mode 10 pps or 20 pps or DTMF mode. In PULSE mode, DTMF mode can be set by pressing the LDT key.

The keyboard logic circuit discriminates key entry information on $\overline{ROW1}$ to $\overline{ROW4}$ and $\overline{COL1}$ to $\overline{COL4}$ pins, and transmits key information to the control logic circuit after a time interval for debouncing, for effective key entry.

The control logic circuit controls the memory circuit, beep tone generator, pulse output generator, and DTMF output

generator according to key entry information.

The memory circuit contains a 26-digit redial memory. One-touch redialing is possible after mode and key entry information is stored.

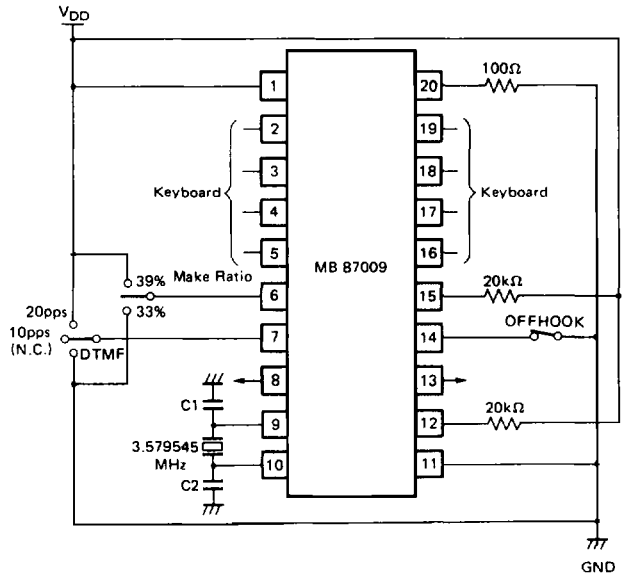
Independently of PULSE/DTMF mode, the beep tone generator operates to output beep tone to the BEEPOUT pin for all effective key entries.

The pulse output generator detects the memory output when the PULSE mode is selected, and outputs to the $\overline{POUT}$ pin as many PULSE signals "L" as the number depending on effective memory data in PULSE mode.

The make rate is 39% when MA/BR is "H", and 33% when "L."

When the DTMF mode is selected, the DTMF output generator outputs DTMF tones from the DTMF OUT pin according to effective memory data output. Row and column program counters and DA converter generate row and column sine wave signals, which are added by the analog adder to generate DTMF tones.

REFERENCE CIRCUIT



7

PIN DESCRIPTION

<table>
<tr><th>Pin No.</th><th>Pin name</th><th>I/O</th><th>Description</th></tr>
<tr><td>1</td><td>V_{DD}</td><td rowspan="2">Power supply</td><td rowspan="2">– Voltages 2.0 to 6.0 V in PULSE mode
2.5 to 6.0 V in DTMF mode
2.0 V min. for maintaining memory</td></tr>
<tr><td>11</td><td>GND</td></tr>
<tr><td>2
3
4
5
19
18
17
16</td><td>$\overline{COL1}$
$\overline{COL2}$
$\overline{COL3}$
$\overline{COL4}$
$\overline{ROW1}$
$\overline{ROW2}$
$\overline{ROW3}$
$\overline{ROW4}$</td><td rowspan="2">Input pin</td><td>– Key entries to this IC are from the 2 of 7 or 2 of 8 keyboard using common GND. This IC is available with a single contact (FORM A) type keyboard and electronic input ("L" entry).

– Debouncing time is 34 ms typ. for both PULSE and DTMF.

– Key entry is accepted in PULSE mode only when a single key (one key on the keyboard) is pressed longer than the debouncing time. If two or more keys are pressed, they are not accepted unless they are released one by one and the last key is held closed longer than the debouncing time after all other keys are released.

– Key entry is accepted in DTMF mode only when either a single key (DUAL TONE key) is pressed or two or more keys in the same $\overline{COL}$ or $\overline{ROW}$ (single tone keys) are pressed longer than the debouncing time. However, if even one key is pressed in $\overline{COL4}$, single tone keys are ineffective. When multiple single tone keys are pressed, if they are released one by one and the last key is held closed longer than the debouncing time after all other keys are released, the key is effective as a DUAL TONE key. Hereafter, key entries are described with the premise that keys are held closed longer than the debouncing time.

– Pause between key entries in PULSE and DTMF mode is required to be 50 ms or more. However, for single tone outputs, up to 50 ms is necessary from key entry to output start.

– Key switch contact resistance up to 5 kΩ is allowable.</td></tr>
<tr><td>6</td><td>MA/BR</td><td>– Switch to select make rate as listed below:
<table><tr><th>MA/BR</th><th>Make Rate</th><th>Break Rate</th></tr><tr><td>"V_{DD}"</td><td>39</td><td>61</td></tr><tr><td>"GND"</td><td>33</td><td>67</td></tr></table>– Prohibited to switch it during PULSE/DTMF outputting.
– Input level is CMOS level.</td></tr>
</table>

PIN DESCRIPTION (Cont'd)

<table>
<tr><th>Pin No.</th><th>Pin name</th><th>I/O</th><th>Description</th></tr>
<tr><td>7</td><td>MODEC</td><td rowspan="3">Input pin</td><td>– Switch to select Pulse 10 pps, 20 pps, or DTMF operation.
The table below shows mode settings.
<table>
<tr><th colspan="2">Mode</th><th>Setting</th></tr>
<tr><td rowspan="2">PULSE mode</td><td>10 pps</td><td>Open (1 MΩ or more)</td></tr>
<tr><td>20 pps</td><td>V_{DD}</td></tr>
<tr><td colspan="2">DTMF mode</td><td>GND</td></tr>
</table>
– When mode switching is requested by MODEC during pulse or tone transmission, the request will not be accepted. The request is accepted by key entry after data transmission.
– In ONHOOK mode, a high impedance (HZ) is set.</td></tr>
<tr><td>14</td><td>HKSW</td><td>– Hook switch entry
<table>
<tr><td>ONHOOK mode</td><td>Open or V_{DD}</td></tr>
<tr><td>OFFHOOK mode</td><td>GND</td></tr>
</table>
– Output inhibit state is entered in ONHOOK mode and $\overline{POUT}$, DTMFOUT, BEEPOUT, MUTE, and MODEO are set to HZ. All key entries are set to HZ and the built-in operational amplifier and oscillator (X1 = "L", X2 = "L") enter power down states in ONHOOK mode.
– This pin is pulled up by a high resistance in the IC.
– The input level is CMOS level.</td></tr>
<tr><td>9</td><td>X1</td><td>– Resonator input pin.
– Pulled down to "L" by a high resistance in ONHOOK mode.
– Both crystal and ceramic resonators are available (3.579545 MHz).</td></tr>
<tr><td>10</td><td>X2</td><td rowspan="2">Output pin</td><td>– Resonator output pin.
– Pulled down to "L" by a high resistance in ONHOOK mode.
– Both crystal and ceramic resonators are availble (3.579545 MHz).</td></tr>
<tr><td>8</td><td>MODEO</td><td>– CMOS output pin which is set to HZ in ONHOOK mode.
– Outputs "L" level in PULSE mode, and "H" level in DTMF mode (including the LDT function).
– Blinks MODEO on and off at a frequency of 2.5 Hz typ. if there is no pause before and after mode switching in redialing function.</td></tr>
</table>

PIN DESCRIPTION (Cont'd)

Pin No.	Pin name	I/O	Description
8	MODEO	Output pin	– Independently of PULSE/DTMF mode, the beep tone is output at the BEEPOUT when the FLASH key is pressed. HZ of 0.6 second typ. is output after the beep tone is output. After that, key acceptance state (OFFHOOK mode) is entered.
12	$\overline{\text{MUTE}}$		– NCH open drain output pin. – The following are MUTE pin HZ conditions in PULSE and DTMF modes. (1) When there is no key entry. (2) After the beep tone is output when the FLASH key is pressed (0.6 s typ.) (3) During pause state However, $\overline{\text{MUTE}}$ is "L" while the beep tone is output. (4) During MODEO blinking. – After key entries become effective in PULSE and DTMF modes, the pin level is "L" during output of the beep tone, pulses, or DTMF according to effective key entries.
13	BEEPOUT		– CMOS Three-State Output. High-Impedance when the beep tone is not output. – Independently of PULSE/DTMF mode, the beep for input confirmation is output for all effective key entry. – BEEPTONE is output in 41 ms typ. at 1 kHz in rectangler pulse.
15	$\overline{\text{POUT}}$		– NCH open drain output pin. – HZ in ONHOOK and DTMF modes. – In PULSE mode, this pin is "L" for pulse breaks according to numerical key entries. – In PULSE and DTMF modes, when the FLASH key is pressed, "L" level is output for 0.6 second typ. after the beep tone is sent even during PULSE/DTMF sending, and a key acceptance state (OFFHOOK mode) returns.
20	DTMF OUT		– Bipolar type NPN emitter-follower pin. It can drive a load of 100Ω (between pin and GND). – When an ordinary single key is entered in DTMF mode, DUAL TONE of numerical, [*], and [#] keys is output ($\overline{\text{COL4}}$ column is not allowed). Pressing two or more keys in the same $\overline{\text{ROW}}$ or $\overline{\text{COL}}$ on the keyboard outputs the single tone in the $\overline{\text{ROW}}$ or $\overline{\text{COL}}$. However, if a key in $\overline{\text{COL4}}$ is pressed, DUAL TONE or single tone in the $\overline{\text{ROW}}$ or $\overline{\text{COL}}$ is not output. – See Section 8.4 for single tone output frequencies.

7

PIN DESCRIPTION (Cont'd)

Pin No.	Pin name	I/O	Description
20	DTMF OUT	Output pin	– In the FLASH key is pressed during DTMF sending, the beep tone is output at BEEPOUT and subsequent DTMF tones are not output. After beep tone output, nearly ONHOOK mode of 0.6 second typ. is entered, and then, key acceptance state (OFFHOOK mode) is entered. – DUAL TONE output time conditions: 1) 80 ms TYP for redial output. 2) 80 ms TYP when the key entry time is within 130 ms typ. more than the debouncing time. 3) DUAL TONE output stops being generated at once if a key is pressed over 130 ms TYP and released. 4) Single tone is output from the end of debouncing time until the key is released. – HZ when the DTMF tone is not output.

7

OPERATION AND FUNCTION USE CONDITIONS

Ordinary dialing

Dialing is done by entering numerical keys (1 to 0 keys) in PULSE mode and numerical, [*], and [#] keys in DTMF mode regardless of the number of digits of key input in OFFHOOK, PULSE, or DTMF signals according to the key input are output.

The redial memory is 26 digits. A digit is counted for numerical, pause, and [LDT] keys in PULSE mode and for numerical, [*], [#], and [P] keys in DTMF mode.

One digit is counted as mode information for mode switching by MODEC for both PULSE and DTMF modes. The first key after OFFHOOK is counted as one digit as mode information for numerical keys in PULSE mode and numerical, [*], and [#] keys in DTMF mode, and is written into the redial memory.

Redial function

The redial memory is read to execute redialing only if the redial key is the first key pressed in OFFHOOK state.

The redial key, [*], and [RED] keys are used in PULSE mode and only the [RED] key in DTMF mode.

When 27 or more digits are written into the redial memory, PULSE or DTMF signals corresponding to the key entries are output, but the redialing operation is ineffective because of memory overflow. At this time, even if the first key pressed after the state changes from ONHOOK to OFFHOOK is the redial key, the redial key is not accepted and the beep tone is not output regardless of PULSE or DTMF mode.

If a numerical or [LDT] key is the first key entry in PULSE mode after OFFHOOK or a numerical, [*], [#], or single-tone key (excluding COL4) in DTMF mode, the memory is reset and data is written into the redial memory according to key entry information.

Mix redial function

If the mode is changed from PULSE to DTMF mode by pressing the [LDT] key, or MODEC is switched during key entries, mix redialing is executed.

If there is a pause before or after mode switching (including the LDT function) at redialing, PULSE/DTMF is sent and DTMF/PULSE signals are sent after the pause. However, for redialing in which there is no pause before or after mode switching (including the LDT function), the operation stops immediately after mode switching and a HALT state is entered. MODEO blinks to indicate that the mode switching has no auto pause, prompting pause release. The pause release key at this time is [*], [RED], and [P] keys in PULSE mode, and [RED] and [P] keys in DTMF mode. By key entry, the operation sending subsequent PULSE/DTMF signals is returned. Key entries other than the above are not accepted, except the [F] key.

Key entries are not accepted during redial output, except the [F] and pause release keys (only when MODEO is blinking or during a pause at redialing).

Mode switching
When mode switching is requested by MODEC during pulse or tone transmission, the request will not be accepted. The request becomes acceptable after data transmission.

One digit is used as mode information in both PULSE and DTMF modes when the mode is switched by MODEC. If the first key entry is a numerical in PULSE mode after OFFHOOK or a numerical, [*], [#] in DTMF mode, mode information is written into redial memory.

In PULSE mode, the [LDT] key is accepted only once. After that, DTMF mode is fixed regardless of MODEC pin switching.
In DTMF mode, the [LDT] key is not accepted. MODEC pin switching enables the desired mode to be selected.

LDT function
If the [LDT] key is pressed in PULSE mode, the mode changes to DTMF mode in which DTMF tones can be sent. "In PULSE mode, only first [LDT] key is accepted after key acceptance state (OFFHOOK mode) is entered. Once [LDT] key is accepted, the following [LDT] key entries are ignored.

When DTMF mode is entered by the [LDT] key, dual tones of keys, excepting $\overline{COL4}$ and single tones, can be output. (If even one $\overline{COL4}$ key is pressed, dual and single tones on the $\overline{ROW}$ or $\overline{COL}$ are not sent.) The mode after that is not switched. If mode switching by LDT from memory is done during redialing, key entries after redialing are executed in DTMF mode regardless of the MODEC state and the data is additionally written into the redial memory. However, for effective keys other than the redial key after ONHOOK changes to OFFHOOK memory is reset and written in the current mode.

PAUSE function
A pause state can be entered by pause key entry.

In PULSE mode, both [*] and [P] keys can be used as the pause key. In DTMF mode (including the LDT function), only the [P] key is used.

If the pause key is the first key pressed after ONHOOK changes to OFFHOOK, the key is not accepted.

One pause key entry can make a 4.0 second typ. pause state. N x 4.0 second typ. pauses can be made by multiple consecutive pause key entries.

Pause duration can be reduced by entering [P] and [RED] keys during redialing pause time. In PULSE mode, the [*] key can also be used as a pause release key.

When multiple consecutive pauses are written, the consecutive pauses are all sent fast by entering a pause release key. (N x 4.0 second typ. pause time becomes N x 8.0 ms pause time because the pauses are sent at a speed up to 500 times as fast.)

FLASH function
Keyboard entries enable ONHOOK mode. Only the [F] key is used as a FLASH key in both PULSE and DTMF modes (including the LDT function). When the [F] key is pressed, ONHOOK mode is entered for 0.6 second TYP after the beep tone is sent. The key entry pin, MODEC, $\overline{MUTE}$, DTMF-OUT, and BEEPOUT during the time become HZ and the $\overline{POUT}$ pin outputs level "L". OFFHOOK mode returns after 0.6 second typ., and key entries can be accepted.

TEST MODE (High speed mode) function
TEST MODE circuit is built into the chip. At ONHOOK, X1 and X2 are pulled down by high resistances. By making the X1 pin "H" and entering a clock from the X2 pin, TEST MODE is enabled to operate internal circuits up to 128 times as fast.

KEY OPERATION DIAGRAM

Redial key: [RED (P)] = [RED] or [#]

[RED (D)] = [RED]

Pause key: [P (P)] = [P] or [*]

[P (D)] = [P]

Pause release key: [PR (P)] = [RED], [P], or [*]

[RED (D)] = [RED] or [P]

(P) = Pause

Key Entries In PULSE Mode

When MODEC is set to 10 pps

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2]	1-2		
ON					
OFF	OPEN	[RED (P)]	1-2		
		[3]	3		
ON					
OFF	OPEN	[RED (P)]	1-2-3		
ON					
OFF	V_{DD}	[RED (P)]	1-2-3		
ON					
OFF	GND	[RED (D)]	1-2-3		
		[4]			4

7

When MODEC is set to 20 pps

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	V_{DD}	[1] [2]		1-2	
ON					
OFF	V_{DD}	RED (P)		1-2	
		[3]		3	
ON					
OFF	V_{DD}	RED (P)		1-2-3	
ON					
OFF	OPEN	RED (P)		1-2-3	
ON					
OFF	GND	RED (D)		1-2-3	
		[4]			4

7

Key Entries In DTMF Mode

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	GND	[1] [2]			1-2
ON					
OFF	GND	RED (D)			1-2
		[3]			3
ON					
OFF	GND	RED (D)			1-2-3
ON					
OFF	OPEN	RED (D)			1-2-3
ON					
OFF	V_{DD}	RED (P)			1-2-3
		[4]		4	

Key Entries When The LDT Key Is Used

When there is a pause before LDT

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [P (P)]	1-2-Ⓟ		
		[LDT] [3]			3
ON					
OFF	OPEN	[RED (P)]	1-2-Ⓟ		
					3
		[4]			4
ON					
OFF	V_{DD}	[RED (P)]	1-2-Ⓟ		
					3-4
ON					
OFF	GND	[RED (D)]	1-2-Ⓟ		
					3-4

When there is a pause after LDT

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [LDT]	1-2		
		[P (D)] [3]			Ⓟ-3
ON					
OFF	OPEN	[RED (P)]	1-2		
					Ⓟ-3
		[4]			4
ON					
OFF	V_{DD}	[RED (P)]	1-2		
					Ⓟ-3-4
ON					
OFF	GND	[RED (D)]	1-2		
					Ⓟ-3-4

7

When there is no pause before and after LDT

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2]	1-2		
		[LDT] [3]	MODEO blinks ↓		3
ON					
OFF	OPEN	[RED (P)]	1-2		
		[PR (D)]			3
		[4]	MODEO blinks ↓		4
ON					
OFF	V_{DD}	[RED (P)]	1-2		
		[PR (D)]	MODEO blinks ↓		3-4
ON					
OFF	GND	[RED (D)]	1-2		
		[PR (D)]			3-4

7

Key Entries When PULSE/DTMF Mode Is Switched (Mix Redial)

When there is a pause before mode switching

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [P (P)]	1-2-Ⓟ		
	V_{DD}	[3] [4] [P (P)]		3-4-Ⓟ	
	GND	[5] [*] [P (D)]			5-*-Ⓟ
	OPEN	[6] [7]	6-7		
ON					
OFF	OPEN	[RED (P)]	1-2-Ⓟ		
				3-4-Ⓟ	
			6-7		5-*-Ⓟ
ON					
OFF	V_{DD}	[RED (P)]	1-2-Ⓟ		
				3-4-Ⓟ	
			6-7		5-*-Ⓟ
ON					
OFF	GND	[RED (D)]	1-2-Ⓟ		
				3-4-Ⓟ	
			6-7		5-*-Ⓟ

When there is a pause after mode switching

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON OFF	OPEN V_{DD} GND OPEN	1 2 P (P) 3 4 P (D) 5 * P (P) 6 7	1-2 Ⓟ-6-7	Ⓟ-3-4	Ⓟ-5-*
ON OFF	OPEN	RED (P)	1-2 Ⓟ-6-7	Ⓟ-3-4	Ⓟ-5-*
ON OFF	V_{DD}	RED (P)	1-2 Ⓟ-6-7	Ⓟ-3-4	Ⓟ-5-*
ON OFF	GND	RED (D)	1-2 Ⓟ-6-7	Ⓟ-3-4	Ⓟ-5-*

7

When there is no pause before and after mode switching

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2]	1-2		
	V_{DD}	[3] [4]		3-4	
	GND	[5] [*]			5-*
	OPEN	[6] [7]	6-7		
ON			MODEO blinks ↓		
OFF	OPEN	RED (P)	1-2	MODEO blinks ↓	
		PR (P)		3-4	MODEO blinks ↓
		PR (D)			5-*
		PR (P)	6-7		
ON			MODEO blinks ↓		
OFF	V_{DD}	RED (P)	1-2	MODEO blinks ↓	
		PR (P)		3-4	MODEO blinks ↓
		PR (D)			5-*
		PR (P)	6-7		
ON			MODEO blinks ↓		
OFF	GND	RED (D)	1-2	MODEO blinks ↓	
		PR (P)		3-4	MODEO blinks ↓
		PR (D)			5-*
		PR (P)	6-7		

7

Redial Memory Inhibit Function

Hook	MODEC	Key entry	PULSE output		DTMF output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [1] ... [1] [1] (25)	1-1 ... 1-1 (25)		
ON					
OFF	OPEN	[RED (P)]	1-1 ... 1-1 (25)		
ON					
OFF	OPEN	[1] [1] ... [1] [1] (26)	1-1 ... 1-1 (26)		
ON					
OFF	OPEN	[RED (P)]	Not output		
		[2]	2		
ON					
OFF	OPEN	[RED (P)]	2		
ON					
OFF	V_{DD}	[RED (P)]	2		
ON					
OFF	GND	[RED (D)]	2		
		[3]			3
ON					
OFF	OPEN	[LDT] [1] [1] ... [1] [1] (25)			1-1 ... 1-1 (25)
ON					
OFF	OPEN	[RED (P)]			1-1 ... 1-1 (25)
ON					
OFF	OPEN	[1] [1] [LDT] [1] [1] ... [1] [1] (23)	1-1		1-1 ... 1-1 (23)
ON					
OFF	OPEN	[RED (P)]	No output		No output

7

RECOMMENDED OPERATING CONDITIONS

Rating	Symbol	Condition	Value			Unit
			Min.	Typ	Max	
Power voltage	V_{DD}	In PULSE mode and when memory is maintained	2.0	–	6.0	V
		In DTMF mode	2.5	–	6.0	V
Input voltage	V_{IN}		0	–	V_{DD}	V
Output load condition	RO	Between output pin and GND	0.1	–	20	kΩ
Ambient temperature	T_A		-30	–	60	°C

7

Electrical Characteristics

$\left\{\begin{array}{l} 2.0 \text{ to } 6.0 \text{ V in PULSE mode} \\ V_{DD}\ \ 2.5 \text{ to } 6.0 \text{ V in DTMF mode} \\ T_A = -30 \text{ to } 60^\circ\text{C} \end{array}\right\}$

Parameter	Condition		Pin name	Symbol	Value			Unit
					Min	Typ	Max	
Supply Current	All output pins are OPEN in DTMF mode.		V_{DD}	I_{DD}	–	2.5	5.0	mA
	All output pins are OPEN in PULSE mode.			I_{DDP}	–	1.0	2.0	mA
	All output pins and HKSW pins are OPEN in standby state.			I_{DDSB}	–	1.5	10	μA
	V_{DD} = 2.5V, T_A = 25°C	Output pins are OPEN in DTMF mode.		I_{DDL}	–	1.0	2.0	mA
		Output pins are OPEN in PULSE mode.		I_{DDPL}	–	0.3	0.6	mA
		Output pins and HKSW pin are OPEN in stand-by state.		I_{DDSBL}	–	0.2	1.0	μA
Digital Input Voltage 1			$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	V_{IH1}	4/5 X V_{DD}	–	V_{DD}	V
				V_{IL1}	0	–	V_{DD} /5	V

Electrical Characteristics (Cont'd)

Parameter	Condition	Pin name	Symbol	Value			Unit
				Min	Typ	Max	
Digital Input Voltage 2		HKSW, MODEC, MA/BR	V_{IH2}	4/5 X V_{DD}	–	V_{DD}	V
			V_{IL2}	0	–	V_{DD} /5	V
Digital Input Current 1	When $V_{IN} = V_{DD}$	$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	I_{IH1}	-0.01	–	V_{DD} /5	mA
	When V_{IN} = GND		I_{IL1}	$-V_{DD}$ /100	–	0.01	mA
Digital Input Leakage 1	When key entry is HZ GND ≦ V_{IN} ≦ V_{DD}		I_{ILK1}	-10	–	10	μA
Digital Input Current 2	When $V_{IN} = V_{DD}$	MODEC	I_{IH2}	-0.01	–	V_{DD} /75	mA
	When V_{IN} = GND		I_{IL2}	$-V_{DD}$ /75	–	0.01	mA
Digital Input Leakage 2	When MODEC is HZ GND ≦ VIN ≦ V_{DD}		I_{ILK2}	-10	–	10	μA
Digital Input Current 3	When $V_{IN} = V_{DD}$	HKSW, MA/BR	I_{IH3}	-10	–	10	μA
Pull-up Resistance		HKSW	R_{PLU}	100	200	400	kΩ
Digital Input Leakage 3	When V_{IN} = GND	MA/BR	I_{ILK3}	-10	–	10	μA
Digital Output Voltage	When I_{OH} = -0.2 mA	MODEO, BEEP OUT	V_{OH}	V_{DD} -0.5	–	V_{DD}	V
	When I_{OL} = 0.5 mA	$\overline{MODEO}$, $\overline{POUT}$, $\overline{MUTE}$, BEEP OUT	V_{OL}	0	–	0.5	V
Digital Output Off Leakage Current	GND ≦ V_{OUT} ≦ V_{DD}	$\overline{MUTE}$, $\overline{POUT}$, MODEO, BEEP OUT	I_{OFFLK}	-10	–	10	μA
External resistance when digital input is open	Resistance connected to external circuit when input is open. The other end of the resistance must be between 0 V and V_{DD}.	$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$, HKSW, MODEC	R_{DEXT}	1	–	–	MΩ

7

Electrical Characteristics (Cont'd)

Parameter	Condition	Pin name	Symbol	Value Min	Value Typ	Value Max	Unit
Pull-down Resistance	In ONHOOK mode	X1, X2	R_{PLD}	75	150	300	kΩ
Oscillator Frequency			f_{IN}	–	3.579545	–	MHz
DTMF output – When 100Ω is connected between output pin and GND	When no signal is output.	DTMF OUT	V_{AOUT}	–	0	–	V
	Offset voltage when signals are output.			–	0.63xV_{DD} -0.75	–	V
	DTMF TONE output voltage			–	1.44	–	Vp-p
	ROW signal tone output voltage			–	0.64	–	Vp-p
	COLUMN single tone output voltage			–	0.80	–	Vp-p
	COLUMN/ROW TONE ratio			–	2.0	–	dB
Number of Redial Memory Digits		$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	N_{KEY}	–	–	26	digits
Make Ratio	MA/BR = V_{DD}	$\overline{POUT}$		–	39	–	%
	MA/BR = GND			–	33	–	%
Oscillation Start Time		X1, X2	t_{START}	0	8	16	ms
Oscillation Stop Time			t_{STOP}	0	8	16	ms
Key Entry HZ Hold Time		$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	t_{HZK}	0	–	5	ms
MODEC HZ Hold Time		MODEC	t_{HZMC}	0	–	5	ms
MODEO HZ Hold Time		MODEO	t_{HZMO}	0	–	5	ms
Key Entry HZ Start Time		$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	t_{ZKS}	0	–	5	ms
MODEC HZ Start Time		MODEC	t_{ZMCS}	0	–	5	ms

7

Electrical Characteristics (Cont'd)

Parameter	Condition	Pin name	Symbol	Value			Unit
				Min	Typ	Max	
MODEO HZ Start Time		MODEO	t_{ZMOS}	0	–	5	ms
MODEO Switch Start Time 1			t_{MOSW1}	–	12	–	ms
MODEO Switch Start Time 2			t_{MOSW2}	–	5	–	ms
MODEO HZ Start Time by F Key Entry			t_{ZMOSF}	–	83	–	ms
MODEO HZ Hold Time by F Key Entry			t_{HZMOSF}	–	0.6	–	s
MODEO Blinking Period			t_{MOBLNK}	–	0.4	–	s
MODEO Switch Start Time by Pause Release Key			t_{MOSWPL}	–	39	–	ms
Pause Time		$\overline{POUT}$, DTMFOUT	t_{PAUSE}	–	4.0	–	s
DTMF Output Start Time by Pause Release Key		DTMFOUT	t_{OUTPL}	–	50	–	ms
$\overline{POUT}$ Output Hold Time by F Key Entry		$\overline{POUT}$	t_{HPH}	–	0.6	–	ms
$\overline{POUT}$ Output Start Time by F Key Entry			t_{POUTS}	–	83	–	ms
DTMFOUT Output Start Time when the Mode is Switched		DTMFOUT	t_{OUTSWS}	–	10	–	ms
Key Entry Width 1		$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	t_{WK1}	50	–	–	ms
Key Entry Width 2			t_{WK2}	50	–	–	ms
Pause Between Key Entries			t_{PK}	50	–	–	ms

7

ElectricalCharacteristics (Cont'd)

Parameter	Condition		Pin name	Symbol	Value Min	Value Typ	Value Max	Unit
Key Entry Debouncing Time			$\overline{COL1}$ to $\overline{COL4}$, $\overline{ROW1}$ to $\overline{ROW4}$	t_{ACHAT}	–	34	–	ms
BEEPTONE Output Start Time			BEEPOUT	t_{BEEPS}	–	42	–	ms
BEEPTONE Output Width				t_{WBEEP}	–	41	–	ms
$\overline{MUTE}$ LOW Output Start Time			$\overline{MUTE}$	t_{MS}	–	42	–	ms
$\overline{MUTE}$ LOW Output Hold Time 1	For 10 pps			t_{HML1}	26	30	34	ms
	For 20 pps				13	15	17	
	When DUAL TONE is output				100	110	120	
Pulse Pre-digital Pause	MA/BR = "VDD"	For 10 pps	$\overline{POUT}$	t_{PPDP}	950	990	1016	
		For 20 pps			480	520.5	566	
	MA/BR = "GND"	For 10 pps			950	984	1016	
		For 20 pps			480	517.5	556	
Pulse Make Width	MA/BR = "VDD"	For 10 pps		t_{WM}	–	39	–	ms
		For 20 pps			–	19.5	–	
	MA/BR = "GND"	For 10 pps			–	33	–	ms
		For 20 pps			–	16.5	–	
Pulse Break Width	MA/BR = "VDD"	For 10 pps		t_{WBRK}	–	61	–	ms
		For 20 pps			–	30.5	–	
	MA/BR = "GND"	For 10 pps			–	67	–	ms
		For 20 pps			–	33.5	–	
Pulse Inter-digital Pause	MA/BR = "VDD"	For 10 pps		t_{WIDP}	900	469.5	960	ms
		For 20 pps			450	469.5	480	
	MA/BR = "GND"	For 10 pps			900	933	960	ms
		For 20 pps			450	466.5	480	

7

Electrical Characteristics (Cont'd)

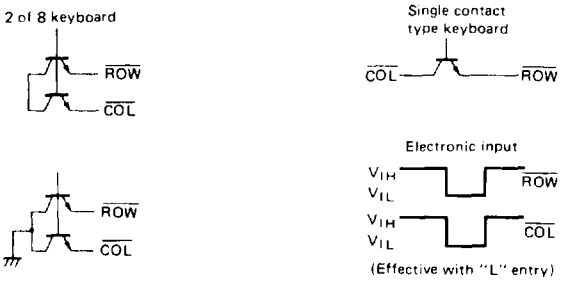
Parameter	Condition	Pin name	Symbol	Value			Unit
				Min	Typ	Max	
$\overline{\text{MUTE}}$ LOW Output Hold Time 2	When single tone is output	$\overline{\text{MUTE}}$	t_{HML2}	0	–	45	ms
DUALTONE Output Time		DTMFOUT	t_{WDT}	78	80	82	ms
DTMF Inter-pause			t_{INPS}	78	80	82	ms
Single Tone Output Start Time			t_{SINGS}	–	42	–	ms
Single Tone Output Stop Time			t_{SINGE}	0	–	5	ms
DUALTONE Output Start Time			t_{DUALS}	–	50	–	ms
DUALTONE Output Stop Time			t_{DUALE}	0	–	5	ms
$\overline{\text{MUTE}}$ Hold Time 1 by Pause Key		$\overline{\text{MUTE}}$	t_{PSM1}	0	10	20	ms
$\overline{\text{MUTE}}$ Hold Time 2 by Pause Key			t_{PSM2}	75	90	105	ms
MODEO Blinking Start Time		MODEO	t_{MOBS}	0	5	10	ms

7

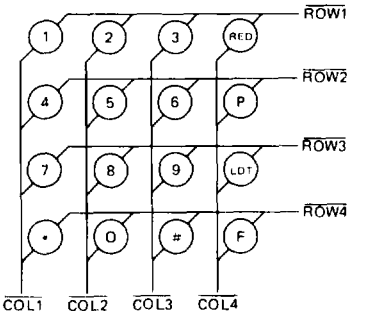
DTMF OUTPUT SIGNALS

Item	Symbol	Standard DTMF (Hz)	DTMF output signals (Hz) (Oscillator frequency 3.579545 MHz)	Error to standard DTmF (%)
ROW1	FR1	697	696.95	-0.01
ROW2	FR2	770	770.13	+0.02
ROW3	FR3	852	852.27	+0.03
ROW4	FR4	941	940.99	-0.01
COL1	FC1	1209	1209.31	+0.03
COL2	FC2	1336	1335.65	-0.03
COL3	FC3	1477	1476.71	-0.02

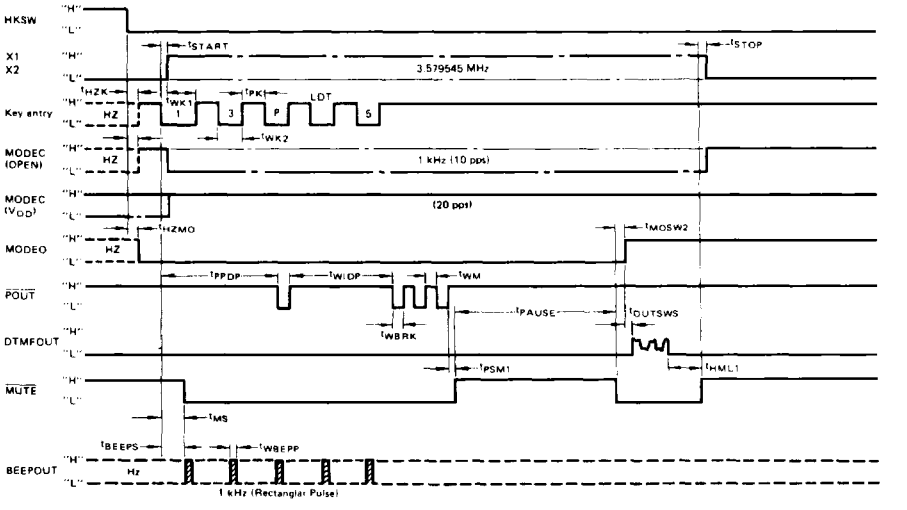
KEYBOARD CONFIGURATION



An example of a single contact type keyboard is shown below.



Timing chart 1-A (When there is a pause before LDT in PULSE mode)



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

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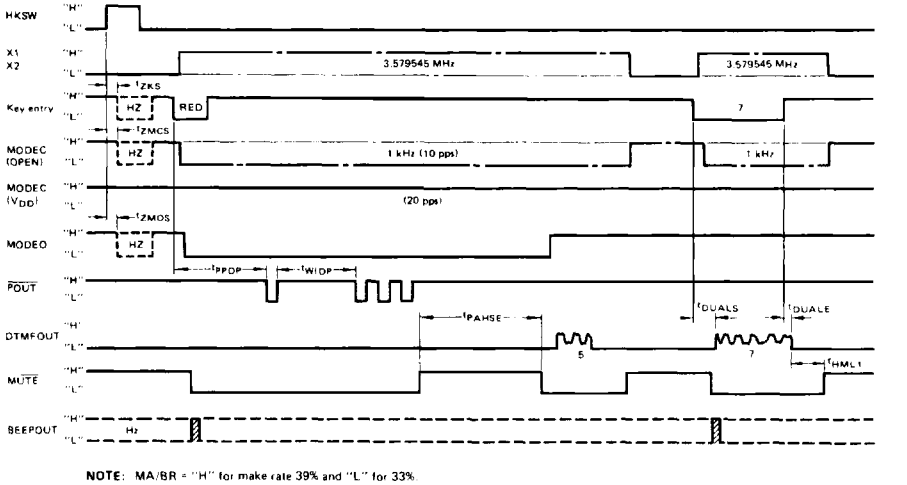
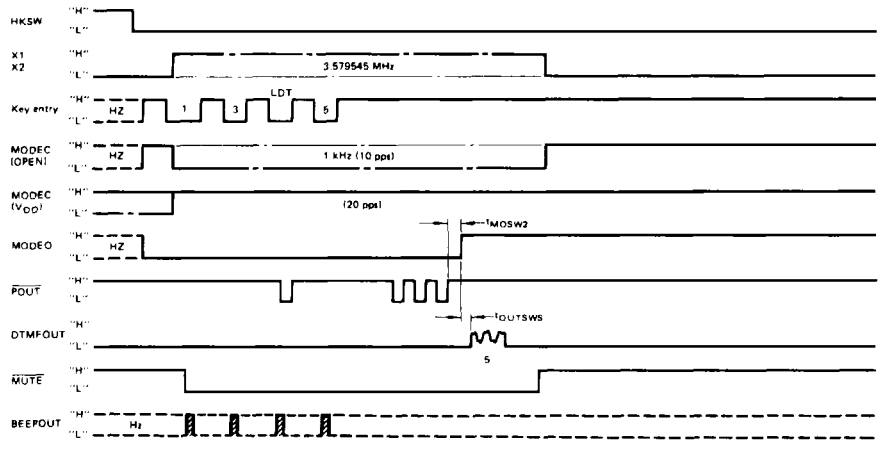
Timing chart 1-B (When there is a pause before LDT in PULSE mode)
Key entries in Timing chart 1-A are written as memory data.



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

Timing chart 2-A (When there is no pause before or after LDT in PULSE mode)



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

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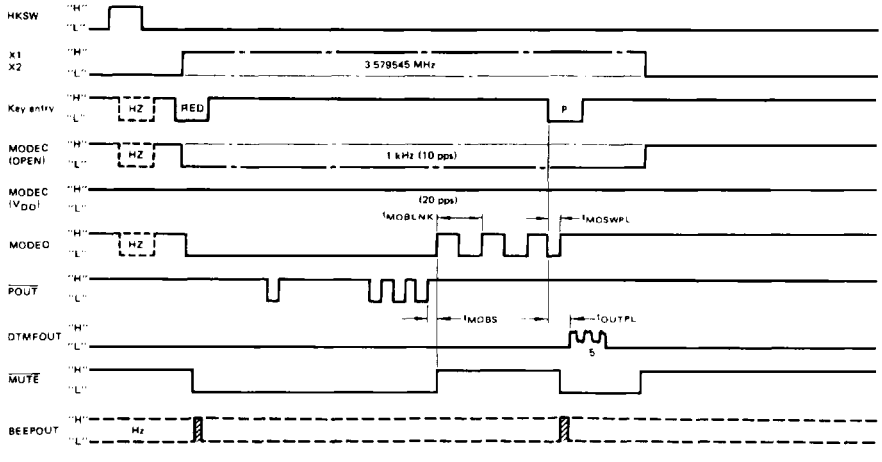
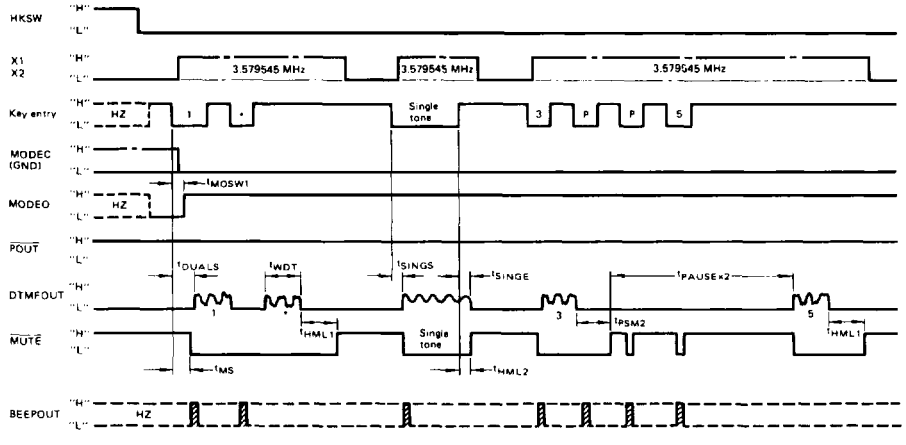
Timing chart 2-B (When there is no pause before or after LDT in PULSE mode)
Key entries in Timing chart 2-A are written as memory data.



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

Timing chart 3-A (in DTMF mode)



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

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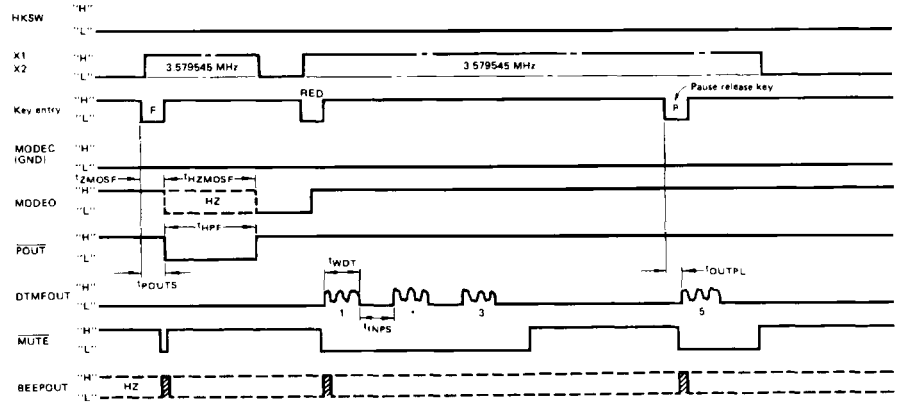
Timing chart 3-B (in DTMF mode)

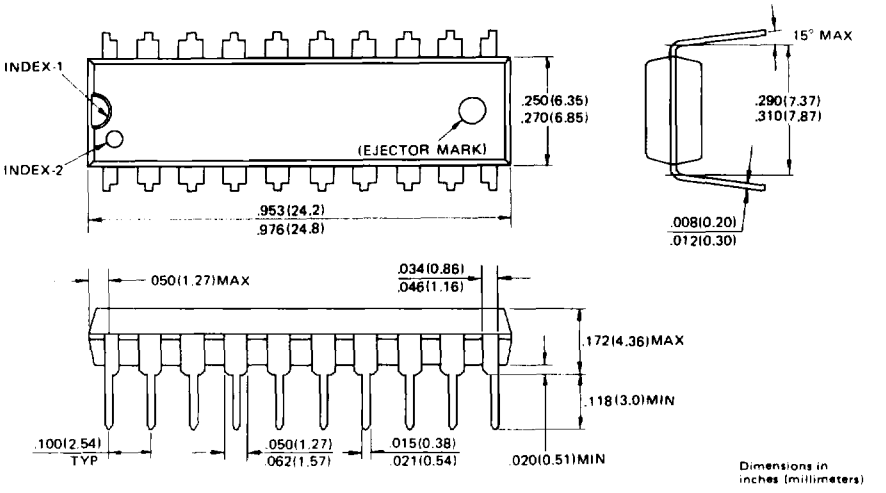
Key entries in Timing chart 3-A are written as memory data.



NOTE: MA/BR = "H" for make rate 39% and "L" for 33%.

PACKAGE DIMENSIONS (Suffix: P)

20-LEAD PLASTIC DUAL IN-LINE PACKAGE
(CASE No.: DIP-20P-M01)



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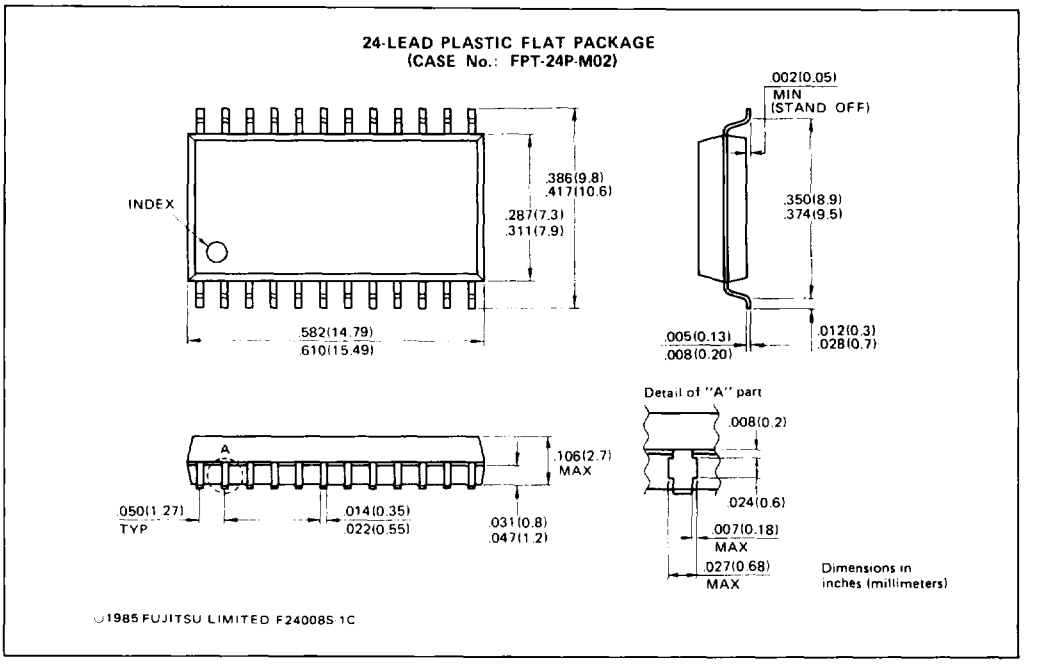
PACKAGE DIMENSIONS (Suffix: PF)



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