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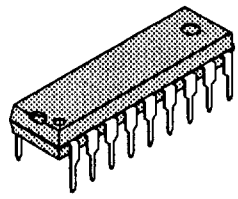
FUJITSU

DATA SHEET

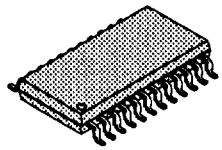
MB87007A and MB87008A
Dual Tone Multifrequency / Pulse Dialers

The Fujitsu MB87007A and MB87008A are dual tone multifrequency (DTMF)/pulse dialers for push button telephone sets that have both DTMF and PULSE modes. They have been manufactured with the Si-Gate CMOS process. Both devices can be switched from the PULSE mode to the DTMF mode by mode-selection entry or by input from a keyboard. The 26-digit redial memory permits the coexistence of the PULSE and DTMF modes, enabling mixing in both PULSE and DTMF modes by a single key entry.

- Selection of a PULSE mode operation at 10 pps or 20 pps, or a DTMF mode operation can be made with the switch pin (MODEIN)
- 26 digits of redial memory (up to 25 digits can be written into the memory)
- MB87007A is used for a Make Ratio of 39% and MB87008A is used for a Make Ratio of 33%
- LDT function (allows switching from PULSE mode to DTMF mode by key entry)
- Beep tone output for key entry inputs (independent of the PULSE or DTMF modes)
- Redial inhibit function prevents redial memory overflow
- Mixed redialing for both PULSE and DTMF modes
- Pause function with pause accumulation
- Flash function for ONHOOK mode selected by keyboard input
- Uses a crystal or ceramic oscillator (3.579545 MHz)
- Pause release function for release of two or more consecutive pauses
- Power supply voltages:
  Pulse mode 2.0 V to 6.0 V (T_A = −30° to +60°C)
- Package and Ordering Information:
  18-pin plastic DIP, order as MB87007AP or MB87008AP
  24-pin plastic SOP, order as MB87007APF or MB87008APF

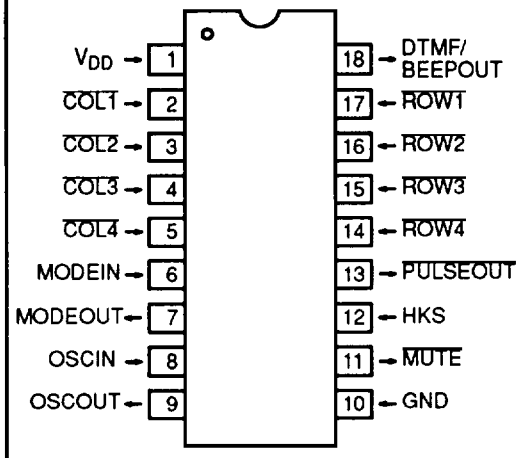


Plastic DIP
(DIP–18P–M02)



Plastic SOP
(FPT–24P–M02)

Pin Assignment



(DIP–18P–M02)

SOP Pin Assignment on Page 26

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Pin Name	Value	Unit
Power Supply Voltage	V_{DD}	V_{DD}	GND – 0.3 to 7.0	V
Input Voltage	V_I	All inputs	GND – 0.3 to V_{DD} + 0.3	V
Ouput Voltage	V_O	All outputs	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.

Block Diagram

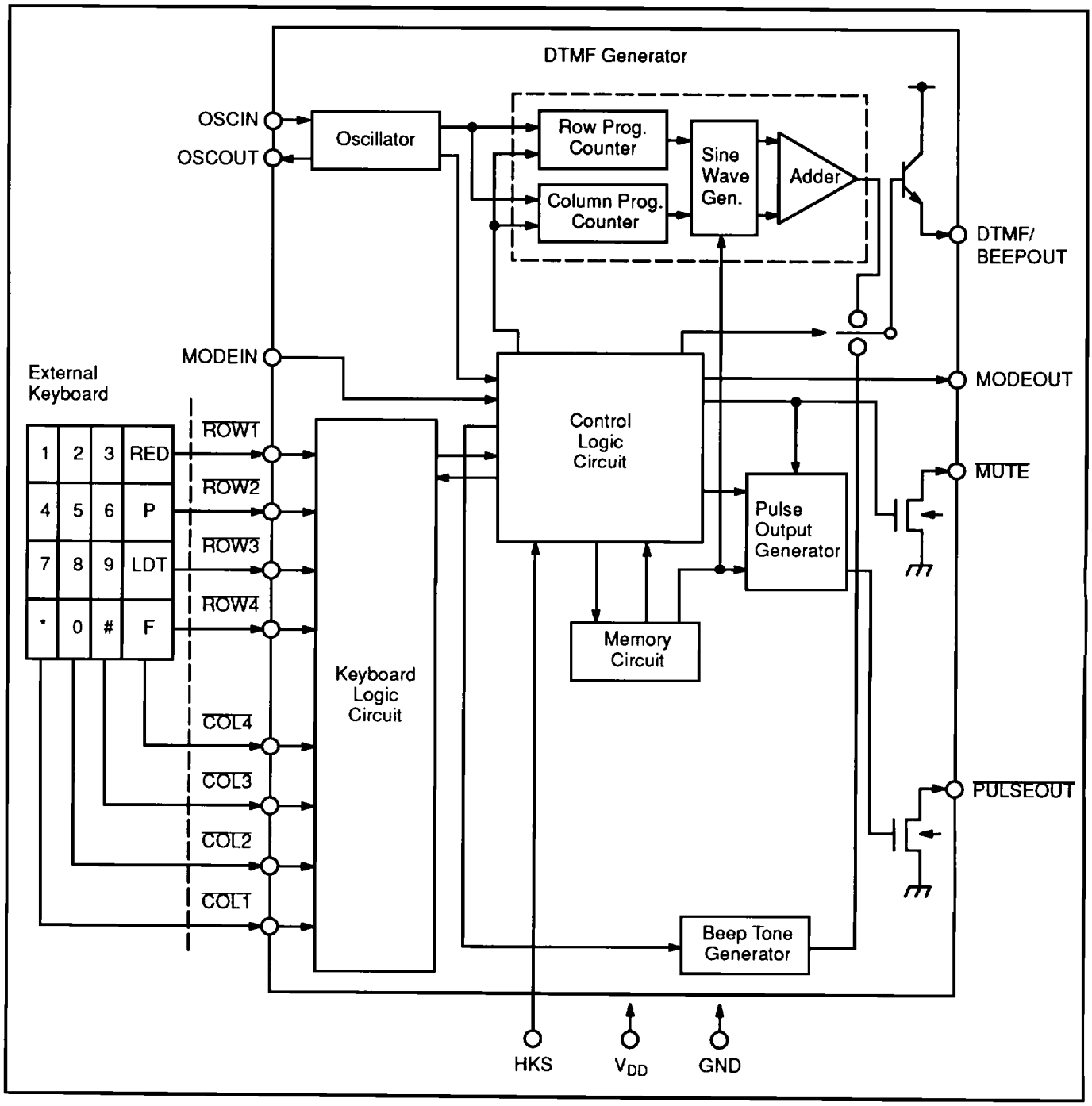


Figure 1. MB87007A and MB87008A Block Diagram

Pin Description

I/O	Pin No. DIP	Pin No. FPT	Symbol	Description
Power Supply	1	1	V_{DD}	Power supply voltages: Pulse mode 2.0 V to 6.0 V DTMF mode 2.5 V to 6.0 V Memory Retention mode 2.0 V min.
	10	12	GND	Ground
Input	2	2	$\overline{COL1}$	Key entries to the MB87007A or MB87008A are from 2 of 7 or 2 of 8 keyboards that use common GND. Both ICs are available with single contact from A-type keyboard and electronic input (Low Input). Key input chattering prevention time and release guard time is 23 ms typical for both PULSE and DTMF modes. Key entry is accepted in PULSE/DTMF mode only when a single key (one key on the keyboard) is pressed longer than the chattering prevention 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 chattering prevention 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 chattering prevention time. However, if even one key is pressed in $\overline{COL4}$, the single-tone keys are ineffective. When multiple single-tone keys are released one-by-one, and the last key is held closed longer than the chattering prevention time after all other keys are released, the keys become effective as a DUAL-TONE key. Hereafter, key entries descriptions assume that keys are held closed longer than the debouncing time. Pause between key entries in PULSE and DTMF modes must be 50 ms or more. However, up to 50 ms is necessary from key entry to output start for a single-tone output. Key switch contact resistance up to 5kΩ is allowable.
	3	3	$\overline{COL2}$	
	4	4	$\overline{COL3}$	
	5	5	$\overline{COL4}$	
	17	23	$\overline{ROW1}$	
	16	22	$\overline{ROW2}$	
	15	21	$\overline{ROW3}$	
	14	20	$\overline{ROW4}$	
	6	8	MODEIN	This pin is provided to select the PULSE mode, at 10 pps or 20 pps, and the DTMF mode.

Mode		Setting
PULSE	10 pps	Open (1 MΩ or more)
	20 pps	V_{DD}
DTMF		GND

When mode switching is requested by MODEIN during PULSE or TONE transmission, the request will not be accepted. The request is accepted by key entry when data entry transmission is completed.

In ONHOOK mode, MODEIN is set to a high impedance state (HZ).

Continued on next page

Pin Description (continued)

I/O	Pin No. DIP	Pin No. FPT	Symbol	Description
Input	12	15	HKS	Hook switch input pin. ONHOOK Mode: Open or V_{DD} OFFHOOK Mode: GND Output is inhibited in the ONHOOK mode and $\overline{\text{PULSEOUT}}$, DTMF/BEEPOUT, $\overline{\text{MUTE}}$, and MODEOUT are set at a high impedance state. All key entries are set to HZ and the on-chip operational amplifier and oscillator (OSCIN = L, OSCOUT = L) become power down states. This pin is pulled up by a high internal resistance. The input level is in the CMOS level.
	8	10	OSCIN	Oscillator input pin. This pin is pulled up by a high resistance in the ONHOOK mode.
Output	9	11	OSCOUT	Oscillator output pin. This pin is pulled down by a high resistance in the ONHOOK mode.
	7	9	MODEOUT	The output level is CMOS and it is set to a high impedance state in the ONHOOK mode. Low level is output in the PULSE mode. The high level is output in the DTMF mode and includes the LDT function. MODEOUT blinks on and off at a frequency of 2.5 Hz (typical), if there is no pause before or after mode switching in the redial function. Independent of PULSE/DTMF modes, the beep tone is output at the BEEPOUT when the FLASH key is pressed. The MODEOUT pin is output to a low level during the beep tone output. High impedance of 0.6 second (typical) is output following the beep tone output and the key acceptance state (OFFHOOK mode) is entered.
	11	13	$\overline{\text{MUTE}}$	N-channel open drain output. The following are $\overline{\text{MUTE}}$ pin HZ conditions in the PULSE/DTMF modes: 1. There is no key entry. 2. When the FLASH key is pressed, HZ at 0.6 (typical) second is output after the beep tone output. 3. During pause output state. (However, when a key is pressed, $\overline{\text{MUTE}}$ is low level while beep tone is being output). 4. During MODEOUT blinking. After key entries become effective in the PULSE or DTMF modes, the output level is low during the beep tone and pulse transmissions in accordance with effective key entries and DTMF output transmission.
	13	16	$\overline{\text{PULSEOUT}}$	N-channel open drain output. High impedance (HZ) is set in ONHOOK or DTMF modes. In PULSE mode, this pin is set low for pulse brakes, according to numerical key entries. When the FLASH key is pressed in either the PULSE or DTMF mode, a low level is output for 600 ms (typical) after the beep tone is sent (even during a PULSE/DTMF send). The key acceptance state (OFFHOOK state) then returns. The make ratio for PULSE output is 39% for MB87007A and 33% for MB87008A.

Continued on next page

Pin Description (continued)

I/O	Pin No. DIP	Pin No. FPT	Symbol	Description
	18	24	DTMF/ BEEPOUT	The DTMF/BEEPOUT pin is a bipolar type emitter follower that can drive a 100 Ω load between pin and GND. In the DTMF mode when, a single key (numeric, [*], [#]) is pressed, excluding $\overline{COL4}$, a dual tone is output. Pressing two or more keys in the same ROW or COL on the keyboard outputs the single tone in either $\overline{ROW}$ or $\overline{COL}$. Please see page 20 for further single tone information. If the FLASH key is pressed during DTMF sending, the beep tone is output at BEEPOUT and subsequent DTMF tones are not output. The ONHOOK mode is entered for 600 ms (typically) after which MODEIN and key entries are placed in the acceptance state (OFFHOOK mode) Beep tone (key entry confirmation tone) is output in PULSE mode. The 41 ms (typical) beep tone (1 kHz square wave) is output when the following effective keys are pressed: • Numerical key entry. • First LDT key entry (second or subsequent LDT key entries are ineffective). • Pause key entry ([*] [P] keys). However, if the first key after OFFHOOK is the PAUSE key, the key entry is ineffective and is not accepted. • Redial key entry ([#] [RED] keys). This entry is effective only when the redial key is the first key after OFFHOOK. • PAUSE release key entry ([*], [P] [RED] keys). This entry is accepted only during redialing and effective only when MODEOUT is blink ing or at a pause time during redialing. • FLASH key entry ([F] key). For FLASH key entry, the beep tone is output in PULSE and DTMF modes. When two or more keys are pressed simultaneously (that is double or multiple key entries), the key entries are ineffective and the beep tone is not output. If a DTMF mode tone request is received during a beep tone transmission, the beep tone is terminated (even though the duration is 41 ms or shorter) and the DTMF tone is output. DUAL TONE output time conditions are as follows: • 80 ms (typical) for redial output. • 80 ms (typical) when the key entry time is within 130 ms (typical) and more than the chattering prevention time. • DUAL TONE output is stopped if a key is pressed over 130 ms (typical) and released. • Signal tone is output from the end of chattering prevention time until the key is released. • When a beep or DTMF tone is not being output, this pin is placed in a high impedance state.

Functional Descriptions

Ordinary Dialing

In the OFFHOOK mode, PULSE and DTMF signals are output according to the key input, regardless of the number of key input figures.

PULSE mode:	Any number of digit entries by pressing keys 0 to 9.
DTMF mode:	Any number of digit entries by pressing keys 0 to 9, [*] and [#].

Up to 26 digits can be stored in the redial memory. In the PULSE mode, a redial digit is counted for any numeric entry, pause entry, and LDT entry. In the DTMF mode, a redial digit is counted for any numeric [*], [#], and [P] entries.
In both PULSE and DTMF modes, one digit is counted as mode information when MODEIN is used for mode switching. After OFFHOOK, the first numeric entry is counted as a mode digit. In the PULSE mode, a numeric key is counted as a mode digit. In the DTMF mode, any numeric key, [*] or [#] entry is counted as a mode digit. In each case, the mode-information digit is written into the redial memory.

Redialing Function

The redial memory is read out to execute a redialing operation when a redial key is the first key pressed in the OFFHOOK state. In the PULSE mode, the redial keys are [#] and [RED]. In the DTMF mode, only the [RED] key is accepted for redial.
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 entry is not accepted and the beep tone is not output in either mode of operation.
After OFFHOOK, if a numeric or LDT key is the first entry in PULSE mode or if the first entry in DTMF mode is a numeric [*], [#], or single-tone key entry (excluding $\overline{\text{COL4}}$), the redial memory is cleared and data is written into memory according to key entry information.

Mixed Redialing

When the mode is changing from the PULSE to DTMF mode (by pressing the LDT key), or if MODE is changed during key entries, mixed redialing is executed. If, at redialing, there is a pause before or after mode switching (including LDT), PULSE/DTMF is sent and PULSE/DTMF signals are transmitted after the pause. For a redialing in which there is no pause before or after mode switching (including LDT), all operations cease after mode switching and a HALT state is enabled. MODEOUT blinks to indicate that mode switching has no automatic pause, thus prompting pause release. For these conditions, the pause release keys in the PULSE mode are [*], [RED], and [P].

In the DTMF mode, the [RED] and [P] keys are used for pause release. PULSE and DTMF signals can now be sent by key entry. Except for the FLASH key, entries other than those above are not accepted. Key entries are not accepted during redial output, except for the [F] key, the pause release key is accepted only when MODEOUT is blinking or during a pause at redialing.

Mode Switching

Mode switching by MODEIN is not permitted during PULSE or TONE transmissions. After transmission is complete, MODEIN can be used for mode switching. When PULSE or DTMF modes are switched by MODEIN, one digit is stored into redial memory as mode information. After OFFHOOK, when the first key entry is numeric in the PULSE mode or numeric, [*], [#] in the DTMF mode, the mode-information digit is written into redial memory. In the PULSE mode, the LDT key is accepted only once, then the DTMF mode is selected regardless of MODEIN pin switching. In the DTMF mode, the LDT key is not accepted; MODEIN pin switching allows selection of the mode of operation.

Line Dialing Tone (LDT) Function

When the LDT key is pressed in the PULSE mode, the DTMF mode is selected, DTMF tones are output, and the beep tone for the LDT key is generated. When the LDT key is used to enter the DTMF mode, all keys (excluding $\overline{COL4}$ keys) provide dual-tone and single-tone outputs. (Note: If even one $\overline{COL4}$ key is pressed, both dual and single tones are inhibited.) The mode that follows is not switched. If mode switching by the LDT from memory is done during redialing, key entries after redialing are executed in DTMF mode, regardless of the MODEIN state, and the data is 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 pressing the pause key entry. In the PULSE mode, a pause is introduced by pressing the [*] or [P] keys. In the DTMF mode (including LDT), only the [P] key introduces a pause. If a pause key is the first key pressed after changing from ONHOOK to OFFHOOK, the entry is not accepted. One pause key entry introduces a pause state that is typically 4 seconds long. A contiguous pause (N × 4 seconds) can be executed by making consecutive key entries. The pause can be reduced by entering [P] or [RED] during a redialing pause time. In the PULSE mode, the [*] key can be used as a pause release key. Multiple pauses can be sent up to 500 times faster by entering a pause release key (that is, N × 4 s becomes N × 8 ms).

Flash Function

Keyboard entries enable the ONHOOK mode. Only the [F] key is used as a FLASH key in both PULSE and DTMF modes (including LDT). When the [F] key is pressed, the ONHOOK mode is entered for 600 ms (typically), after the beep tone is sent. During this time, the key entry pin is not accepted. MODEIN, $\overline{MUTE}$, MODEOUT, and DTMF/BEEPOUT pins are placed in the high-impedance state and the PULSEOUT pin is set low. After 600 ms typical, the return of OFFHOOK is automatic and key entries can again be accepted.

Test (High Speed) Mode

A test mode circuit is built into the IC. In the ONHOOK state, pins OSCIN and OSCOUT are pulled down by a high resistance. To activate the test mode, set OSCIN high and apply clock signal to OSCOUT. Internal circuits operate up to 128 times faster than normal operation.

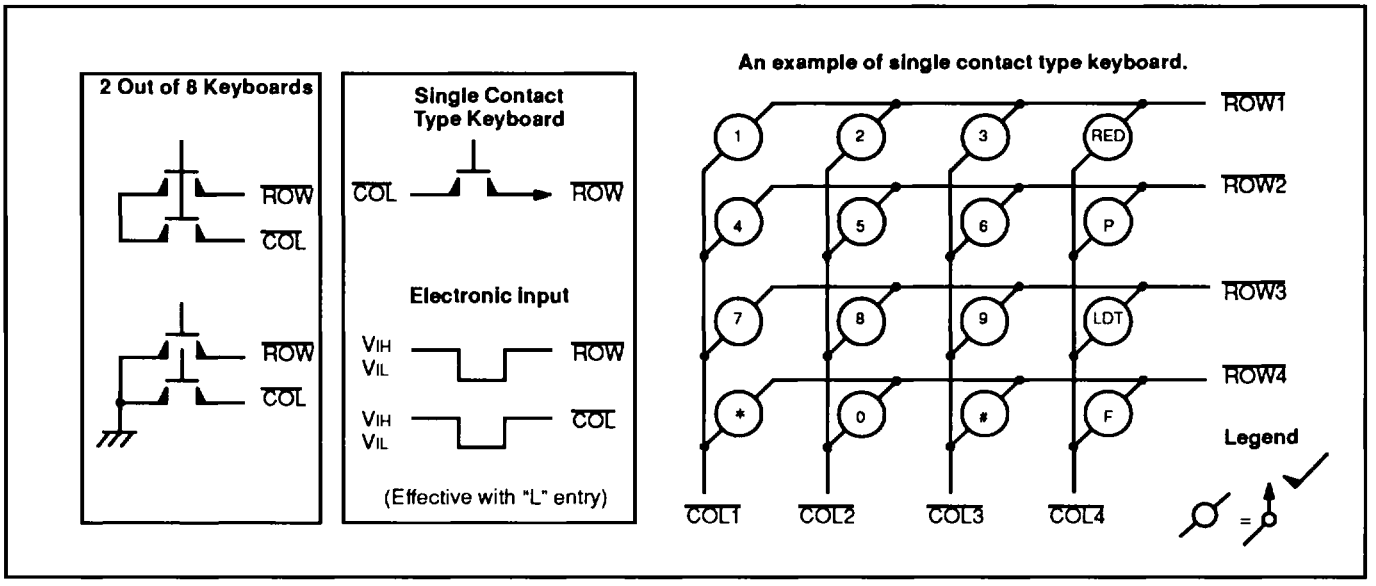
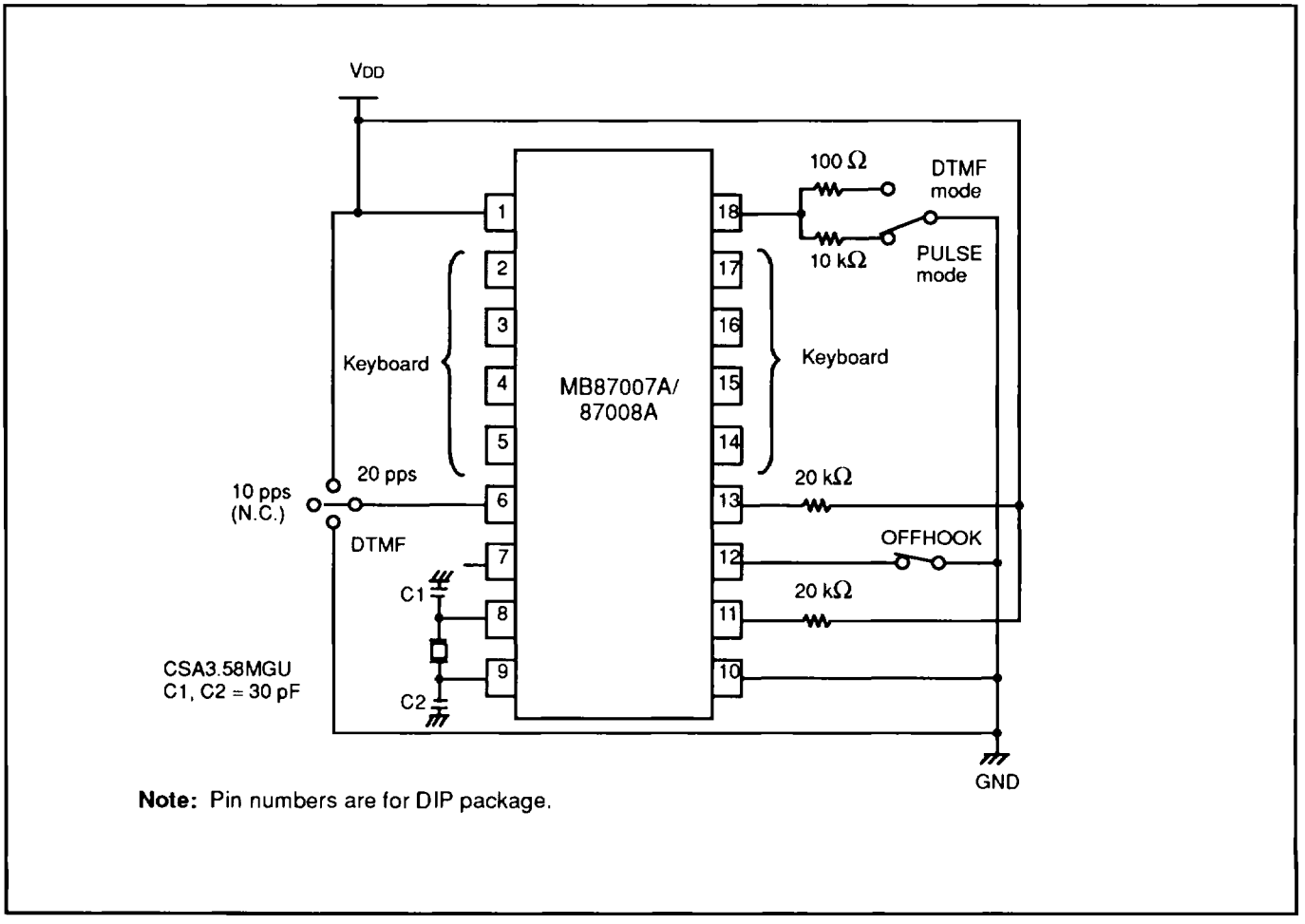


Figure 2. Keyboard Configuration



Note: Pin numbers are for DIP package.

Figure 3. Reference Circuit

Key Operation Diagram

Operation	Key
Redial key of PULSE mode	[RED (P)] = [RED] or [#]
Redial key of DTMF mode	[RED (D)] = [RED]
Pause Key of PULSE mode	[P (P)] = [P] or [*]
Pause key of DTMF mode	[P (D)] = [P]
Pause release key of PULSE mode	[PR (P)] = [RED], [P], or [*]
Pause release key of DTMF mode	[PR (D)] = [RED] or [P]
Pause output	Ⓟ = Pause

Key Entries in Pulse Mode

When MODEIN is set to 10 pps:

HOOK	MODEIN	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

When MODEIN is set to 20 pps:

HOOK	MODEIN	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

Key Entries in DTMF Mode

HOOK	MODEIN	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 (P)]			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	MODEIN	Key Entry	PULSE Output		DTMF Output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [P (P)] [LDT] [3]	1–2–Ⓟ		3
ON					
OFF	OPEN	[RED (P)] [4]	1–2–Ⓟ		3 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	MODEIN	Key Entry	PULSE Output		DTMF Output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [LDT] [P (D)] [3]	1–2		Ⓟ–3
ON					
OFF	OPEN	[RED (P)] [4]	1–2		Ⓟ–3 4
ON					
OFF	V_{DD}	[RED (P)]	1–2		Ⓟ–3–4
ON					
OFF	GND	[RED (D)]	1–2		Ⓟ–3–4

When there is no pause before and after LDT:

HOOK	MODEIN	Key Entry	PULSE Output		DTMF Output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2] [LDT] [3]	1–2		3
ON					
OFF	OPEN	[RED (P)] [PR (D)] [4]	1–2–MODEOUT blinks		3 4
ON					
OFF	V_{DD}	[RED (P)] [PR (D)]	1–2–MODEOUT blinks		3–4
ON					
OFF	GND	[RED (D)] [PR (D)]	1–2–MODEOUT blinks		3–4

Key Entries When Pulse and DTMF Modes are Switched (Mixed Redial)

When there is a pause before mode switching:

HOOK	MODEIN	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–Ⓟ 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–*–Ⓟ

When there is a pause after mode switching:

HOOK	MODEIN	Key Entry	PULSE Output		DTMF Output
			10 pps	20 pps	
ON					
OFF	OPEN	[1] [2]	1–2		
	V_{DD}	[P (P)] [3] [4]		P 3–4	
	GND	[P (D)] [5] [*]			P 5–*
	OPEN	[P (P)] [6] [7]	P 6–7		
ON					
OFF	OPEN	[RED (P)]	1–2 P 6–7	P 3–4	P 5–*
ON					
OFF	V_{DD}	[RED (P)]	1–2 P 6–7	P 3–4	P 5–*
ON					
OFF	GND	[RED (D)]	1–2 P 6–7	P 3–4	P 5–*

When there is no pause before and after mode switching:

HOOK	MODEIN	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					
OFF	OPEN	[RED (P)]	1–2–MODEOUT blinks		
		[PR (P)]		3–4–MODEOUT blinks	
		[PR (D)]			5–*–MODEOUT blinks
		[PR (P)]	6–7		
ON					
OFF	V_{DD}	[RED (P)]	1–2–MODEOUT blinks		
		[PR (P)]		3–4–MODEOUT blinks	
		[PR (D)]			5–*–MODEOUT blinks
		[PR (P)]	6–7		
ON					
OFF	GND	[RED (D)]	1–2–MODEOUT blinks		
		[PR (P)]		3–4–MODEOUT blinks	
		[PR (D)]			5–*–MODEOUT blinks
		[PR (P)]	6–7		

Redial Memory Inhibit Function

HOOK	MODEIN	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)]	No 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

Recommended Operating Conditions

Parameter	Symbol	Pin Name	Condition		Value Min	Value Typ	Value Max	Unit
Power Supply Voltage	V_{DD}	V_{DD}	PULSE mode and memory retention mode		2.0		6.0	V
			DTMF mode		2.5		6.0	V
Input Voltage	V_I	All Inputs			0		VDD	V
Output Load Resistance	R_O	DTMF/ BEEPOUT	Between Output pin and GND	DTMF mode	0.1		20	kΩ
				PULSE mode	0.1	10	100	kΩ
Ambient Temperature	T_A				–30		60	°C

Electrical Characteristics

V_{DD}: PULSE mode = 2.0 to 6.0 V
V_{DD}: DTMF mode = 2.5 to 6.0 V
T_A = –30 to +60°C

Parameter	Symbol	Pin name	Condition		Value Min	Value Typ	Value Max	Unit
Power Supply Current	I_{DD}	V_{DD}	All output pins are open in DTMF mode			2.5	5.0	mA
	I_{DP}		All output pins are open in PULSE mode			1.0	2.0	mA
	I_{DST}		All output pins, HKS pin open in Standby			1.5	10	µA
	I_{DD1}		V_{DD} = 2.5 V, T_A = 25 °C	All output pins open in DTMF		1.0	2.0	mA
	I_{DP1}			All output pins open in PULSE		0.3	0.6	mA
	T_{DST1}			All output pins HSK open in Standby		0.2	1.0	µA
Digital Input Voltage 1	V_{IH1}	$\overline{COL1}$ to $\overline{COL4}$			$\frac{4}{5}V_{DD}$		V_{DD}	V
	V_{IL1}	$\overline{ROW1}$ to $\overline{ROW4}$			0		$\frac{1}{5}V_{DD}$	V
Digital Input Voltage 2	V_{IH2}	HKS, MODEIN			$\frac{4}{5}V_{DD}$		V_{DD}	V
	V_{IL2}				0		$\frac{1}{5}V_{DD}$	V
Digital Input Current 1	I_{IH1}	$\overline{COL1}$ to $\overline{COL4}$ $\overline{ROW1}$ to $\overline{ROW4}$	$V_I = V_{DD}$		–0.01		$\frac{1}{5}V_{DD}$	mA
	I_{IL1}		V_I = GND		(–1/100) • V_{DD}		0.01	mA
Digital Input Leakage Current 1	I_{IZ1}		Key entry HZ GND ≤ V_I ≤ V_{DD}		–10		10	µA

Electrical Characteristics (continued)

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min.	Typ.	Max.	
Digital Input Current 2	I_{IH2}	MODEIN	$V_I = V_{DD}$	–0.01	—	1/75 V_{DD}	mA
	I_{IL2}		V_I = GND	(–1/75) • V_{DD}	—	0.01	mA
Digital Input Leakage Current 2	I_{IZ2}		MODEINHZ GND ≤ V_I ≤ V_{DD}	–10	—	10	µA
Digital Input Current 3	I_{IH3}	HKS	$V_I = V_{DD}$	–10	—	10	µA
Pull-up Resistor	R_{PLU}			100	200	400	kΩ
Digital Output Voltage	V_{OH}	MODEOUT	I_{OH} = –0.2 mA	V_{DD}–0.5	—	V_{DD}	V
	V_{OL}	MODEOUT, PULSEOUT, MUTE	I_{OL} = 0.5 mA	0	—	0.5	V
BEEP TONE High Output Voltage	V_{BTOH}	DTMF/ BEEPOUT	PULSE mode 10 kΩ is placed between output pin and GND	V_{DD}–1.0	—	V_{DD}	V
Digital Output Off Leakage Current	I_{OL}	MUTE, PULSEOUT, MODEOUT	GND ≤ V_O ≤ V_{DD}	–10	—	10	µA
External Resistance when digital input is open	R_{DIO}	COL1 to COL4, ROW1 to ROW4, HKS, MODEIN	Resistance connected to external circuit when input is open. The other end of the resistance must be between 0 V and V_{DD}.	1	—	—	MΩ
Pull-down Resistance	R_{PLD}	OSC_{IN}, OSC_{OUT}	ONHOOK mode	75	150	300	kΩ
Oscillator Frequency	OSC_{IN}			—	3.579545	—	MHz
DTMF Output Voltage 100 Ω is placed between output pin and GND In DTMF mode	A_{OUT}	DTMF/ BEEPOUT	No signal is output	—	0	—	V
			Offset voltage when signals are output	—	0.63V_{DD} –0.75	—	V
			DTMF TONE output voltage	—	1.44	—	Vp-p
			ROW single tone output voltage	—	0.64	—	Vp-p
			COLUMN single tone output voltage	—	0.80	—	Vp-p
			COLUMN/ROW tone ratio	—	2.0	—	dB
Redial Memory Digit	NRKEY	COL1 to COL4 ROW1 to ROW4		—	—	26	digits

Electrical Characteristics (continued)

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min.	Typ.	Max.	
Make Ratio	WMAKE	$\overline{\text{PULSEOUT}}$	MB87007A	—	39	—	%
			MB87008A	—	33	—	%
Oscillation Start Time	t_{OSS}	OSC_{IN}, OSC_{OUT}		0	8	16	ms
Oscillation Start Time	t_{OSSP}			0	8	16	ms
Key Entry HZ Hold Time	t_{HZKH}	$\overline{\text{COL1}}$ to $\overline{\text{COL4}}$ $\overline{\text{ROW1}}$ to $\overline{\text{ROW4}}$		0	—	5	ms
MODEIN HZ Hold Time	t_{HZMIH}	MODEIN		0	—	5	ms
MODEOUT HZ Hold Time	t_{HZMOH}	MODEOUT		0	—	5	ms
Key Entry HZ Start Time	t_{HZKS}	$\overline{\text{COL1}}$ to $\overline{\text{COL4}}$ $\overline{\text{ROW1}}$ to $\overline{\text{ROW4}}$		0	—	5	ms
MODEIN HZ Start Time	t_{HZMIS}	MODEIN		0	—	5	ms
MODEOUT HZ Start Time	t_{HZMOS}	MODEOUT		0	—	5	ms
Pause Time	t_{PAS}	$\overline{\text{PULSEOUT}}$, DTMF/ BEEPOUT		3.85	4.0	4.15	s
MODEOUT Switch Start Time 1	t_{MOC1}	MODEOUT		—	12	—	ms
MODEOUT Switch Start Time 2	t_{MOC2}			2	5	8	ms
MODEOUT HZ Start Time by F Key Entry	t_{MOFS}			—	72	—	ms
MODEOUT HZ Hold by F Key Entry	t_{MOFH}			0.59	0.6	0.61	s
MODEOUT Blinking Period	t_{MOSI}			0.39	0.4	0.41	s
MODEOUT Change Start Time by Pause Release Key Entry	t_{MOPS}			—	28	—	ms

Electrical Characteristics (continued)

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min.	Typ.	Max.	
DTMFOUT Output Start Time when Mode is Switched	t_{MST}	DTMF/ BEEPOUT		2	10	15	ms
DTMF Output Start Time by Pause Release Key Entry	t_{PDT}			—	39	—	ms
PULSEOUT Output Hold Time by F Key Entry	t_{PUFH}	$\overline{\text{PULSEOUT}}$		0.59	0.6	0.61	s
PULSEOUT Output Start Time by F Key Entry	t_{PUFS}			—	72	—	ms
Key Entry Width 1	t_{WK1}	$\overline{\text{COL1}}$ to $\overline{\text{COL4}}$ $\overline{\text{ROW1}}$ to $\overline{\text{ROW4}}$		50	—	—	ms
Key Entry Width 2	t_{WK2}			50	—	—	ms
Key Input Pause Time	t_{PK}			50	—	—	ms
Key Entry Debouncing Time	t_{CH}			21	23	25	ms
Key Entry Release Guard Time	t_{RE}			21	23	25	ms
BEEP TONE Output Start Time	t_{BES}	DTMF/ BEEPOUT		—	31	—	ms
BEEP TONE Output Width	t_{WBE}			39	41	43	ms
$\overline{\text{MUTE}}$ LOW Output Start Time	t_{MUS}	$\overline{\text{MUTE}}$		—	31	—	ms
$\overline{\text{MUTE}}$ LOW Output Hold Time 1	t_{MUSP1}		10 pps	26	30	34	ms
			20 pps	13	15	17	ms
			DUAL TONE Output	100	110	120	ms
Pulse Predigital Pause Time	t_{PDP}	$\overline{\text{PULSEOUT}}$	MB87007A 10 pps mode	950	980	1016	ms
			MB87007A 20 pps mode	480	510.5	556	ms
			MB87008A 10 pps mode	950	974	1016	ms
			MB87008A 20 pps mode	480	507.5	556	ms

Electrical Characteristics (continued)

Parameter	Symbol	Pin Name	Condition		Value Min.	Value Typ.	Value Max.	Unit
Pulse Make Width	t_{WMA}	PULSEOUT	MB87007A	10 pps mode	38	39	40	ms
				20 pps mode	19	19.5	20	
			MB87008A	10 pps mode	32	33	34	ms
				20 pps mode	16	16.5	17	
Pulse Break Width	t_{WBR}		MB87007A	10 pps mode	60	61	62	ms
				20 pps mode	30	30.5	31	
			MB87008A	10 pps mode	66	67	68	ms
				20 pps mode	33	33.5	34	
Pulse Interdigital Pause Time	t_{IDP}		MB87007A	10 pps mode	900	939	960	ms
				20 pps mode	450	469.5	480	
			MB87008A	10 pps mode	900	933	960	ms
				20 pps mode	450	466.5	480	
$\overline{\text{MUTE}}$ LOW Output Hold Time 2	t_{MUSP2}	$\overline{\text{MUTE}}$	Single Tone Output		0	—	8	ms
DUAL TONE Output Time	t_{WDT}	DTMF/ BEEPOUT			78	80	82	ms
DTMF Interpause Time	t_{DTP}				78	80	82	ms
Single Tone Output Start Time	t_{SIS}				—	31	—	ms
Single Tone Output Stop Time	t_{SISP}				0	—	8	ms
DUAL TONE Output Start Time	t_{DTS}				—	39	—	ms
DUAL TONE Output Stop Time	t_{DTSP}				0	—	5	ms
$\overline{\text{MUTE}}$ Hold Time 1 by PAUSE Key Entry	t_{PSM1}	$\overline{\text{MUTE}}$			0	10	20	ms
MUTE Hold Time 2 by PAUSE Key Entry	t_{PSM2}				75	90	105	ms
MODEOUT Blinking Start Time	t_{MOST}	MODEOUT			0	5	10	ms

DTMF Output Signal

Item	Symbol	Standard DTMF (Hz)	DTMF Output Signal[1] (Hz)	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

Note: [1]Oscillation frequency 3.579545 MHz

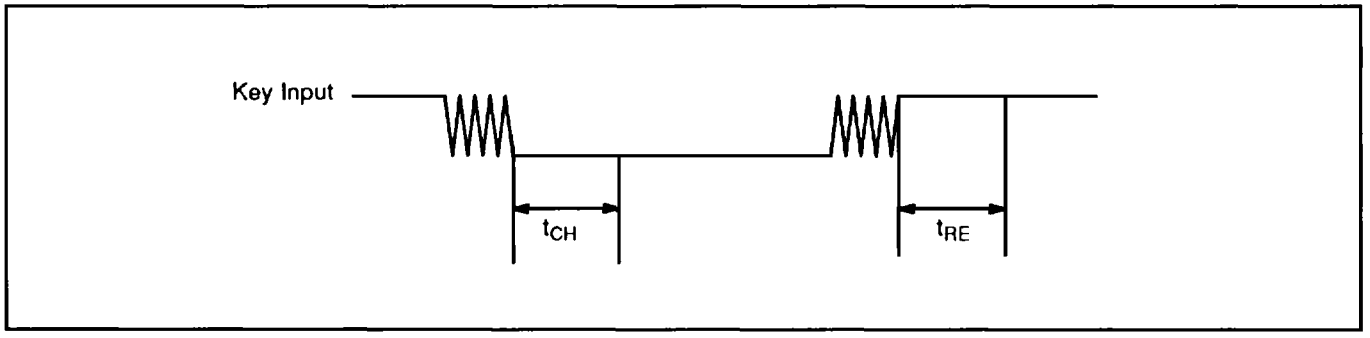


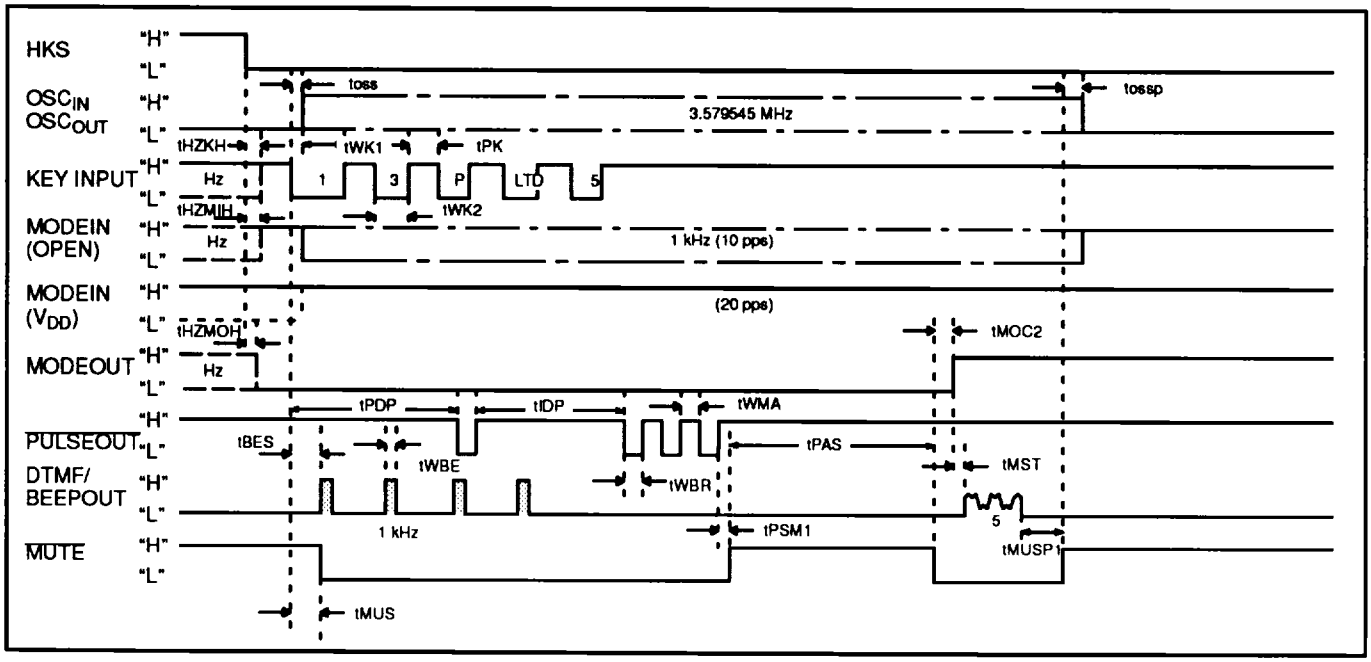
Figure 4. Key Input Timing

Key input Chattering Prevention Time, t_{CH}
Key entry is accepted when low level is longer than 23 ms typical.

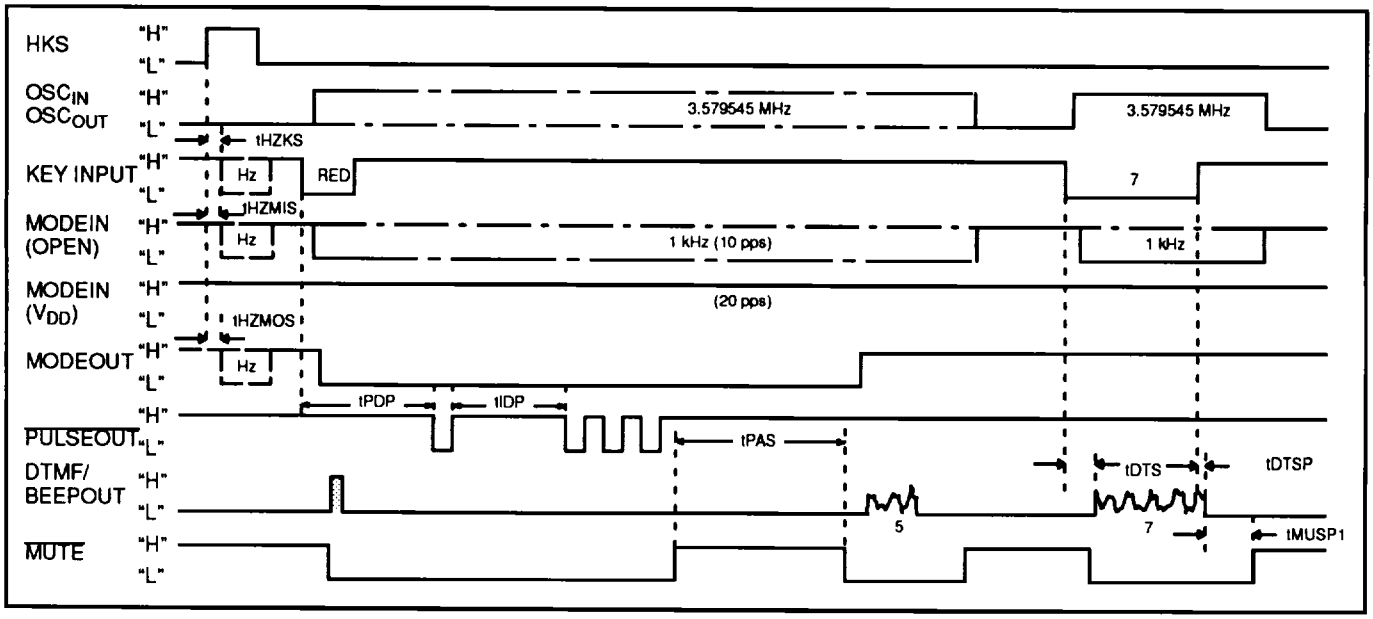
Key input Release Guard Time, t_{RE}
Key release is recognized when low level is longer than 23 ms typical.

Timing Chart 1 – A

(When there is a pause before LDT Key in PULSE mode)

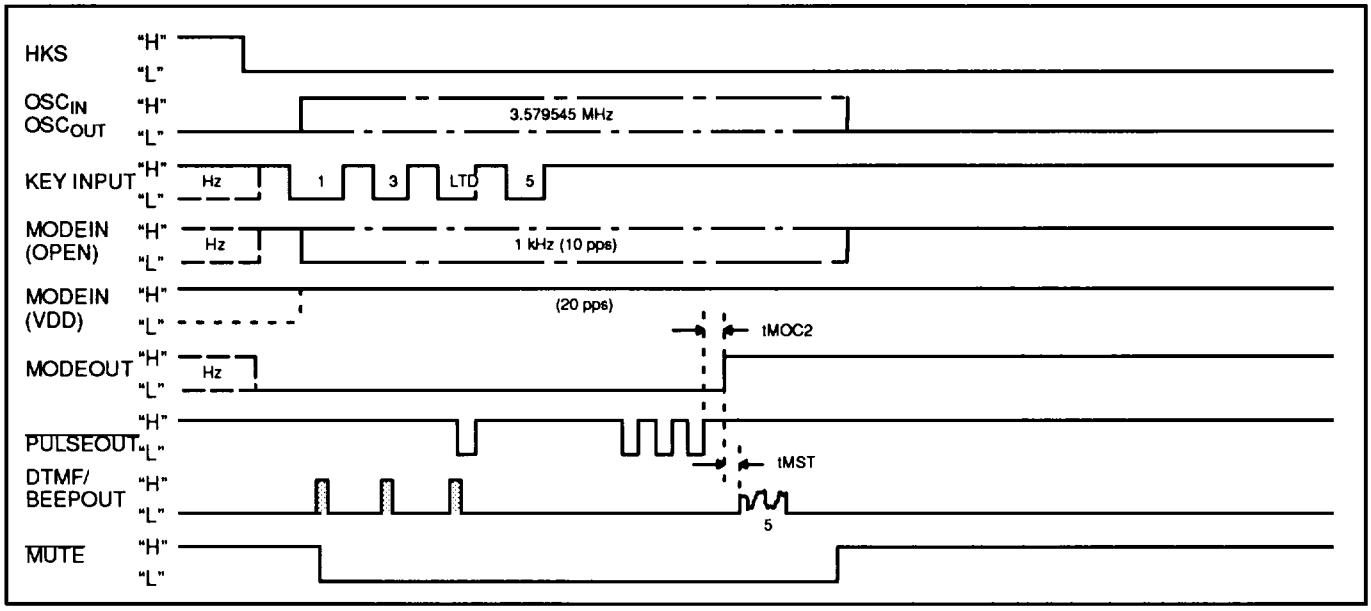


Timing Chart 1 – B

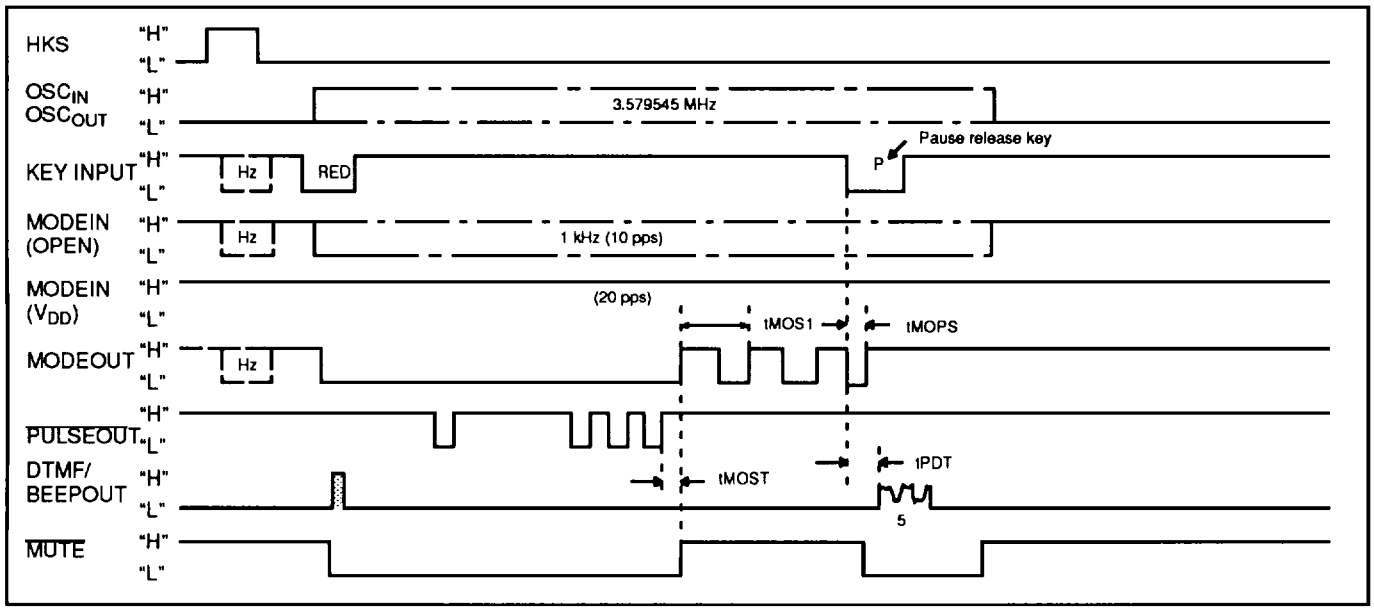


Timing Chart 2 – A

(When there is no pause before or after LDT Key in PULSE mode)

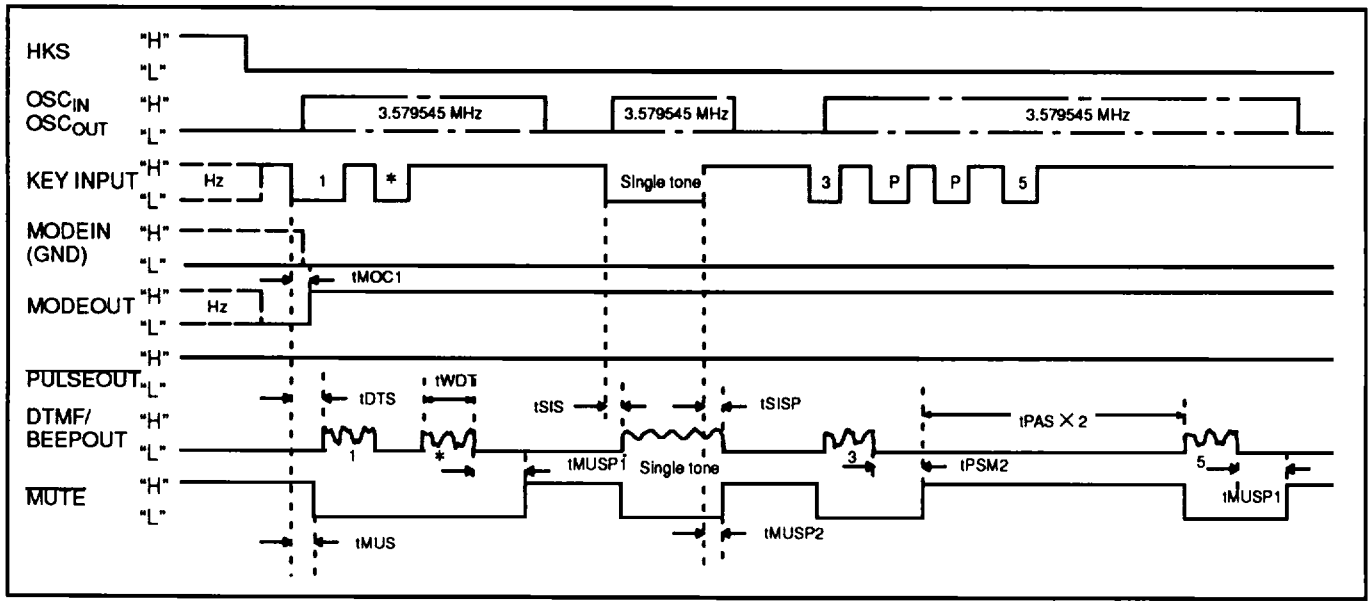


Timing Chart 2 – B

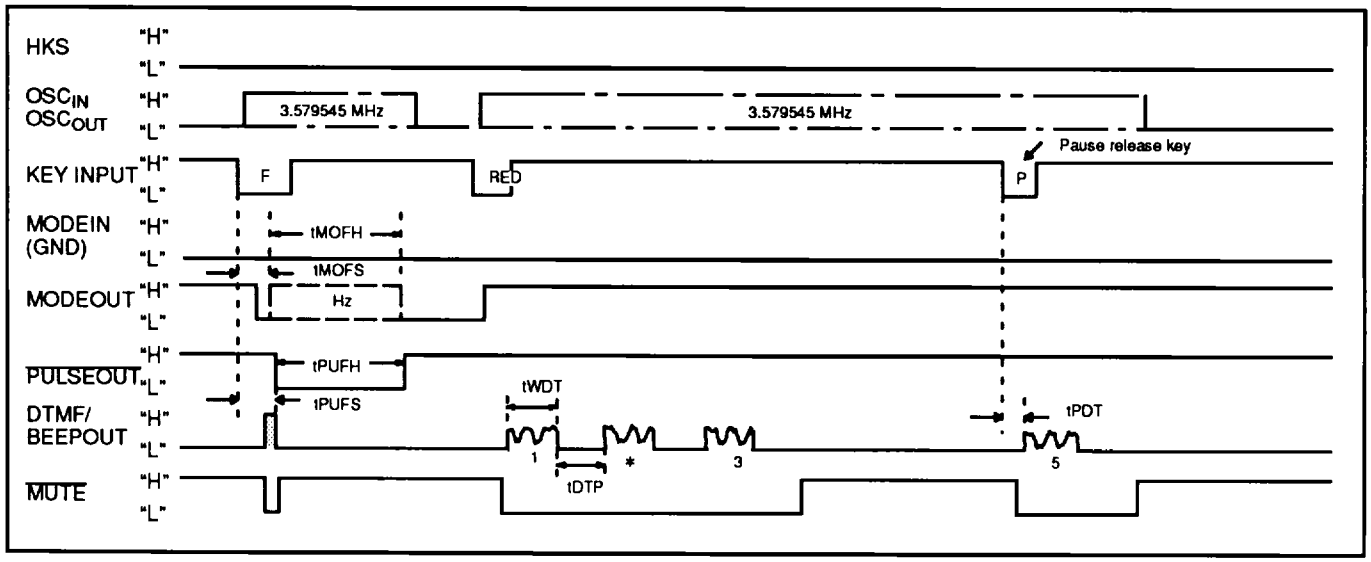


Timing Chart 3 – A

(In DTMF mode)

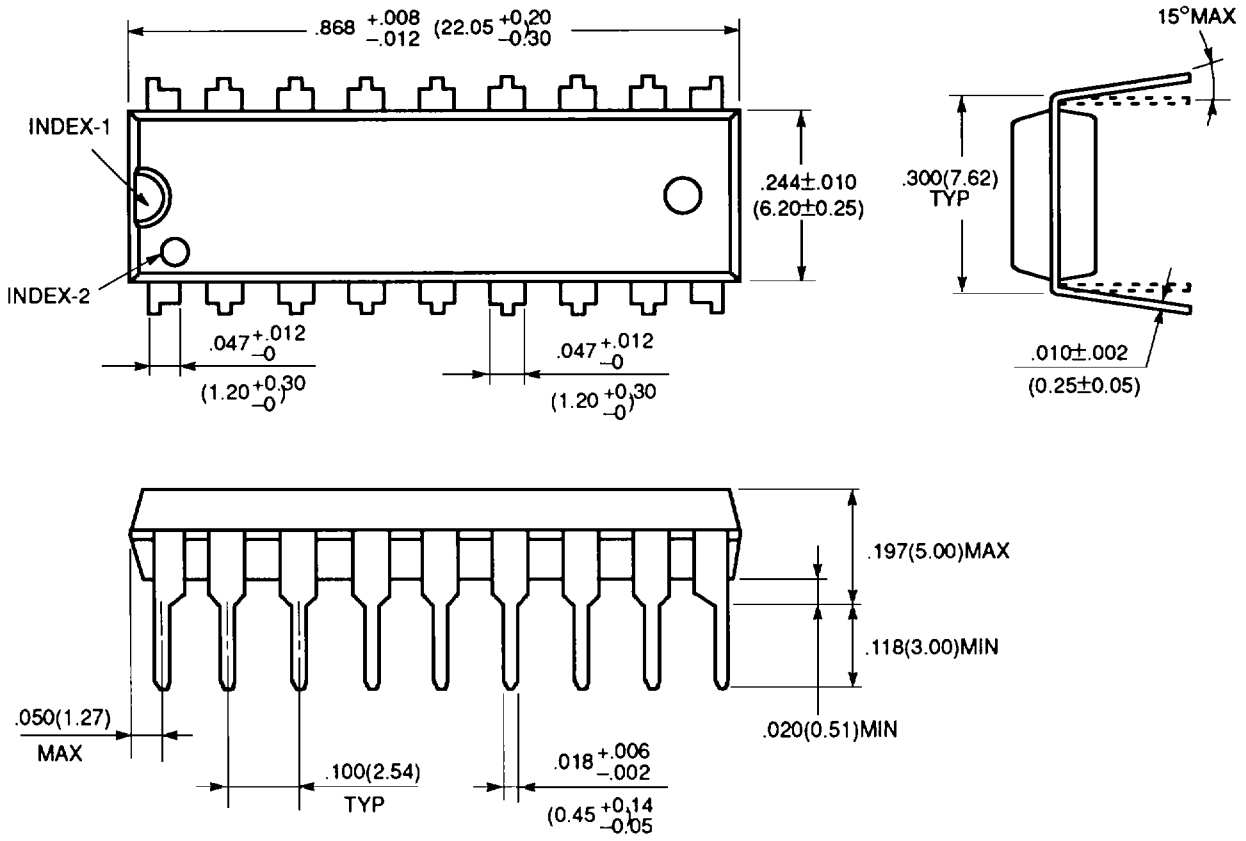


Timing Chart 3 – B



Package Dimensions

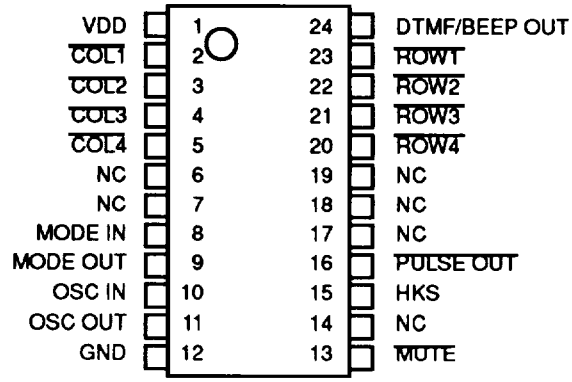
18-LEAD PLASTIC DUAL IN-LINE PACKAGE
(CASE No.: DIP-18P-M02)



Dimensions in inches (millimeters)

Package Dimensions

PIN ASSIGNMENT



[FPT-24P-M02]

24-LEAD PLASTIC FLAT PACKAGE
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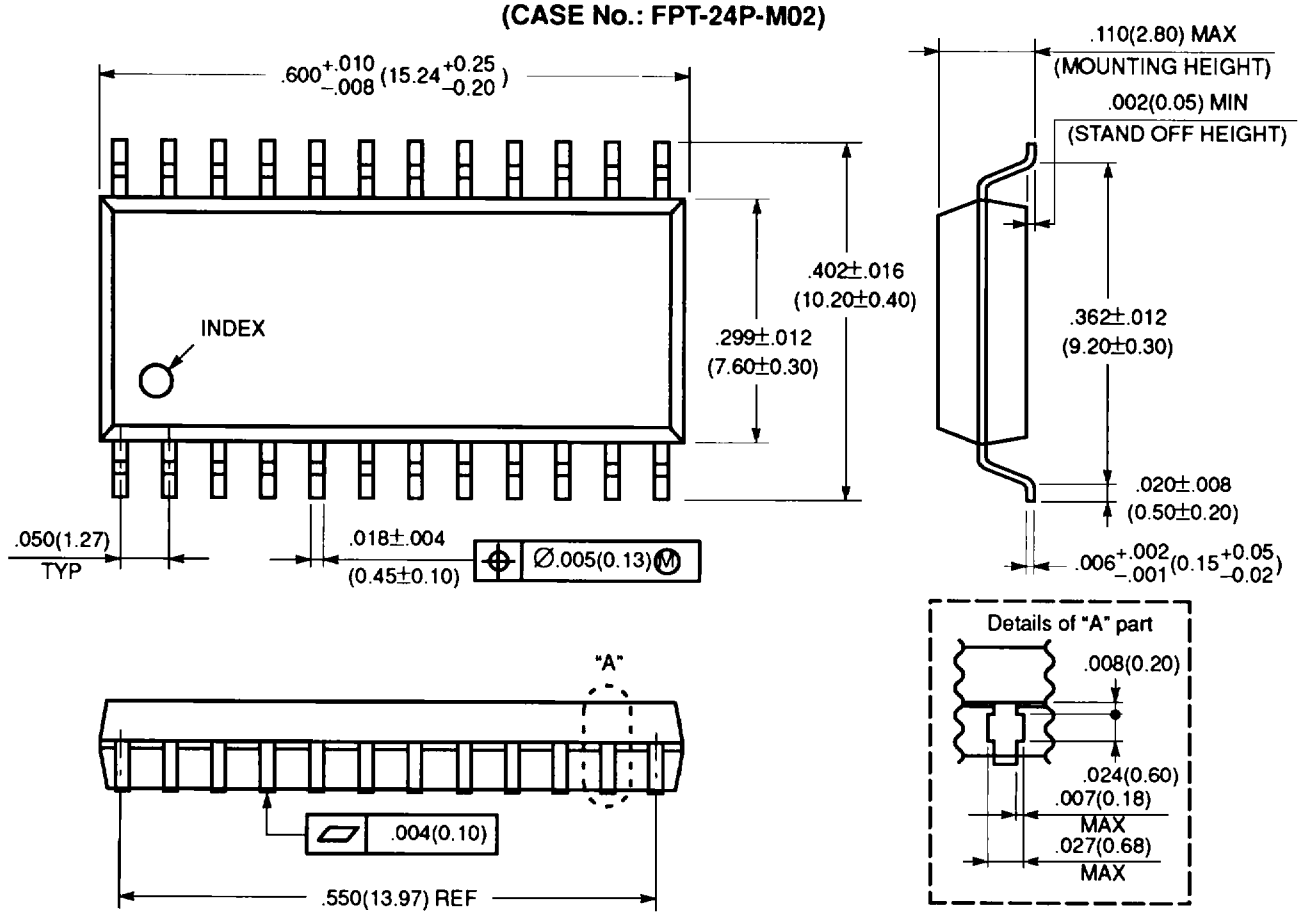

Dimensions in
inches (millimeters)

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