PRODUCT PROFILE

MB87029 DTMF Pulse Dialer

DESCRIPTION

The Fujitsu MB87029 is a Dual Tone Multifrequency (DTMF) pulse dialer that is designed for pushbutton telephone sets and uses the Si-Gate CMOS process.

The MB87029 is used in both DTMF and PULSE modes and can be switched from PULSE mode to DTMF mode by a mode selection entry or by input from the keyboard. The MB87029 contains a 26-digit redial memory that permits the coexistence of PULSE and DTMF modes, enabling mixed redialing in both PULSE and DTMF modes by a signal key entry.
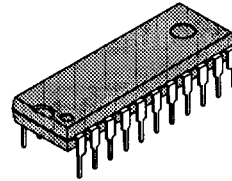
FEATURES

- Pulse 10 pps, 20 pps, or DTMF operation can be selected by the mode switch pin (MODEIN)

- On-chip 26 digits of redial memory (up to 25 digits can actually be written in the memory)

- Selectable make ratio by MA/BR: 39% or 33%

- Line Dial Tone (LDT) function is provided (switching from PULSE mode to DTMF mode by key entry)

- Output of a beep tone for input confirmation (for all effective key entry independently PULSE/DTMF modes)

- Redial inhibit function is included for redial memory overflow

- Mixed redialing of both PULSE and DTMF modes

- PAUSE function is provided and pause accumulation is possible

- Single-tone output is enabled by SCNT pin

- FLASH function is provided (ONHOOK mode is selected by keyboard input)

- FLASH output time, 0.1 second or 0.6 second, is selected by FCNT pin

- Crystal or ceramic oscillator (3.579545 MHz) can be used

- Pause release function is provided (two or more consecutive pauses can be released)

- Operating voltages:
  PULSE mode: 2.0 V to 6.0 V
  DTMF mode: 2.5 V to 6.0 V
  ($T_A = -30$ to $60°C$)

PLASTIC PACKAGE
DIP-22P-M03
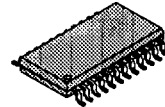
PLASTIC PACKAGE
FPT-24P-M02

PIN ASSIGNMENT

V_{DD}	1		22	DTMFOUT
COL1	2		21	ROW1
COL2	3		20	ROW2
COL3	4		19	ROW3
COL4	5	TOP VIEW	18	ROW4
MA/BR	6		17	SCNT
MODEIN	7		16	FCNT
MODEOUT	8		15	PULSEOUT
OSCIN	9		14	HKS
OSCOUT	10		13	BEEPOUT
GND	11		12	MUTE

FPT-24P-M02 PIN ASSIGNMENT
See Page 6-126

ABSOLUTE MAXIMUM RATINGS (See Note)

Rating	Symbol	Pin Name	Value	Unit
Positive Supply Voltage	V_{DD}	V_{DD}	GND – 0.3 to 7.0	V
Input Voltage	VI	All inputs	GND – 0.3 to V_{DD} + 0.3	V
Ouput Voltage	VO	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.
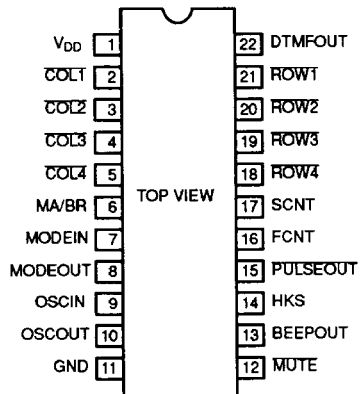
This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

Figure 1. MB87029 Block Diagram

PIN DESCRIPTIONS

| I/O | Pin No. | | Symbol | Description |
	DIP	FPT		
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.
	11	12	GND	Ground
Input	2 3 4 5 21 20 19 18	2 3 5 6 23 22 21 20	$\overline{COL1}$ $\overline{COL2}$ $\overline{COL3}$ $\overline{COL4}$ $\overline{ROW1}$ $\overline{ROW2}$ $\overline{ROW3}$ $\overline{ROW4}$	Uses key entries from 2 of 7 or 2 of 8 keyboards with common GND. This IC is available with a single contact from A type keyboard and electronic input (Low entry). Key input debouncing time is 23 ms typ. for both PULSE and DTMF modes. Key input release guard time is 23 ms typ. for both PULSE and DTMF modes. Key entry is accepted in PULSE/DTMF modes 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. If one key in $\overline{COL4}$ is pressed, the single-tone keys are ineffective. If multiple single-tone keys are pressed, and the last key is held closed longer than the debouncing time, after all other keys are released, the key is effective as the dual-tone key. Hereafter, key entries are described with the premise that keys are held closed longer than the debouncing time. Pauses 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 single-tone outputs. Key switch contact resistance up to 5kΩ is allowable.
	6	7	MA/BR	This pin selects the make rate. <table><tr><td>MA/BR</td><td>Make Rate (%)</td><td>Break Rate (%)</td></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> Make ratio switching by MA/BR is inhibited during PULSE/DTMF transmission. The input level is in the CMOS level.
	6	7	MODEIN	This pin selects the pulse mode, 10 pps, 20 pps, or the DTMF mode. <table><tr><td>MODEIN</td><td>Mode</td></tr><tr><td>V_{DD}</td><td>Pulse Mode 20 pps</td></tr><tr><td>Open (1 MΩ or more)</td><td>Pulse Mode 10 pps</td></tr><tr><td>GND</td><td>DTMF Mode</td></tr></table> Mode switching is not accepted by MODEIN. After data transmission is completed, mode switching is honored by key entry. In the ONHOOK mode, this pin is set to a high impedance state.

PIN DESCRIPTIONS

I/O	Pin No. DIP	Pin No. FPT	Symbol	Description
Input	14	15	HKS	Hook switch input pin. <table><tr><td>ONHOOK Mode</td><td>Open or V_{DD}</td></tr><tr><td>OFFHOOK Mode</td><td>GND</td></tr></table> Output is inhibited in ONHOOK mode, and PULSEOUT, DTMFOUT, BEEPOUT, 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 resistance internally. The input level is in the CMOS level.
	9	10	OSCIN	Oscillator input pin. In the ONHOOK mode, this pin is pulled to a low level by a high resistance.
	16	17	FNCT	This pin selects FLASH time period. <table><tr><td>FNCT</td><td>FLASH output time</td></tr><tr><td>V_{DD}</td><td>0.6 second</td></tr><tr><td>GND</td><td>0.2 second</td></tr></table> Switching is prohibited during PULSE/DTMF transmission. Input level is in the CMOS level.
	17	18	SCNT	This input enables a single-tone output. <table><tr><td>SCNT</td><td>Single tone output</td></tr><tr><td>V_{DD}</td><td>Output</td></tr><tr><td>GND</td><td>Not output</td></tr></table> Switching is prohibited during a PULSE/DTMF transmission. Input level is in the CMOS level.
Output	10	11	OSCOUT	Oscillator output pin. In the ONHOOK mode, this pin is pulled to a low level by a high resistance.
	8	9	MODEOUT	The output is in the CMOS level and set to a high impedance state in the ONHOOK mode. Low level is output in the PULSE mode and high level is output in the DTMF mode, including the LDT function. MODEOUT blinks on and off at a frequency of 2.5 Hz typ., if there is no pause before and after mode switching in redial function. When the FLASH key is pressed in either PULSE or DTMF mode, High impedance is output for a 0.6 second (typical) following the BEEP tone output. The key acceptance state (OFFHOOK mode) is now entered.

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PIN DESCRIPTIONS

I/O	Pin No.		Symbol	Description
	DIP	FPT		
Output	12	13	MUTE	N-channel open drain output. In both PULSE and DTMF modes, the MUTE pin is in a high impedance state for the following conditions: 1. There is no key entry. 2. After the beep tone is output and the FLASH key is pressed, HZ is output for 0.6 second (typical). 3. During pause output state. (However, when key is pressed, 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 MUTE pin is low during output of the beep tone, pulse output (according to numeric key entry), and output of DTMF.
	13	14	BEEPOUT	The output is in CMOS level and the pin is set to a high impedance state unless beep tone is output. In PULSE/DTMF modes, the beep tone is output according to effective key entries. Beep tone is output in 41 ms typ. at 1 kHz in rectangular pulse.
	13	14	PULSEOUT	N-channel open drain output. This pin is in a high impedance state in the ONHOOK mode or DTMF mode. In PULSE mode, this pin is at low for brakes (according to numerical key entries). When the FLASH key is pressed in the PULSE or DTMF mode, a low level is output for 600 ms typ. after the beep tone is sent (even during a PULSE/DTMF send). The key acceptance state (OFFHOOK mode) then returns.
♥	22	24	DTMFOUT	This DTMFOUT output pin is a bipolar follower that can drive a 100 Ω load between pin and GND. When a single key (numerical, ✱ or #) is pressed in the DTMF modes, dual tone is output. Pressing two or more keys in the same ROW or COL on the keyboard outputs the signal tone in the ROW or COL. If a key in COL4 is pressed, then the DUAL TONE or single tone in the ROW or COL is not output. (Please see Electrical Characteristics.) 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 typ. after the key acceptance state (OFFHOOK mode) is entered. DUAL TONE output time conditions are as follows: 1. 80 ms typ. for redial output 2. 80 ms typ. when the key entry time is within 130 ms typ. and more than the debouncing time 3. DUAL TONE output is stopped at once if a key is pressed longer than 130 ms typ. and released. 4. Signal tone is output from the end of debouncing time until the key is released. This pin is set to a high impedance state unless DTMF tone is output.

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FUNCTIONAL DESCRIPTIONS

Ordinal Dialing

In OFFHOOK mode, PULSE/DTMF signals are output according to the key input, regardless of the number of key input figures. For the PULSE mode, any number of digital entries with keys 0 to 9. For the DTMF mode, any number of digital entries with 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, pause, and LDT entry. In the DTMF mode, a redial digit is counted for any numeric, [*], [#], and [P] entry.

In both the 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 the numeric key is counted as a mode digit. In the DTMF mode, a numeric key, [*], and [#] entry is counted as a mode digit. In either OFFHOOK or PULSE modes, the mode-information digit is written into the redial memory.

Redialing Function

The redial memory is read out to execute the redialing operation when a redial key is the first key pressed in OFFHOOK state. In the PULSE mode, the redial keys are [#] and [*]. 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 that correspond 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 change 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 the first entry in the DTMF mode is a numeric, [*], [#] or a single-tone key entry (excluding $\overline{COL4}$), the redial memory is cleared and data is written into memory according to key entry information.

Mixed Redialing

Mixed redialing is executed when the mode is changed from the PULSE to DTMF mode (done by pressing the LDT key), or when MODE is changed during key entries.

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. To redial when there is no pause before or after mode switching (including LDT), all operations must cease after mode switching and a HALT state is enabled. MODEOUT blinks (indicates that mode switching has no automatic pause) and prompts a pause release.

The pause release keys in PULSE mode are [*], [RED], and the [P] key. In the DTMF mode, the [RED] and the [P] keys are used for pause release. PULSE and DTMF signals can now be sent by key entry. The FLASH key is the only other acceptable entry.

During redial output, the [F] key is the only key entry accepted. The pause release key is only accepted when MODEOUT is blinking or during a pause at redialing.

Mode Switching

During PULSE or TONE transmissions, mode switching by MODEIN is not permitted; 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, if the first key entry is numeric in the PULSE mode, or a numeric [*] or [#] in the DTMF mode, the mode-information digit is written into redial memory.

In the PULSE mode, after the LDT key is accepted only one time, the DTMF mode is selected (regardless of MODEIN pin switching). The LDT key is not accepted in the DTMF mode. The MODEIN pin switching enables the desired mode of operation to be selected.

Line Dial Tone (LDT) Function

If the LDT key is pressed in the PULSE mode, the DTMF mode is selected and DTMF tones can be output. In PULSE mode, only the 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 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, neither dual nor single tones are output.) 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 MODEIN state and the data is written into the redial memory. However, for effective keys (not 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 the PULSE mode, a pause is introduced by pressing the (#) or (P) keys; in the DTMF mode (including LDT) only the (P) key is effective. 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; contiguous pause (N X 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 is 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 X 4 seconds becomes N X 800 milliseconds.

Flash Function

Keyboard entries enable 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 milliseconds (typical) after beep tone is sent. During this time, the key entry pin is not accepted. MODEIN, MUTE, MODEOUT, and DTMF/BEEPOUT pins are placed in the high-impedance state and the PULSEOUT pin is set low level. After 600 milliseconds (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, tie the OSCIN high and apply clock signal to OSCOUT. The internal circuit operates up to 128 times faster than normal operation.

Figure 2. Keyboard Configuration
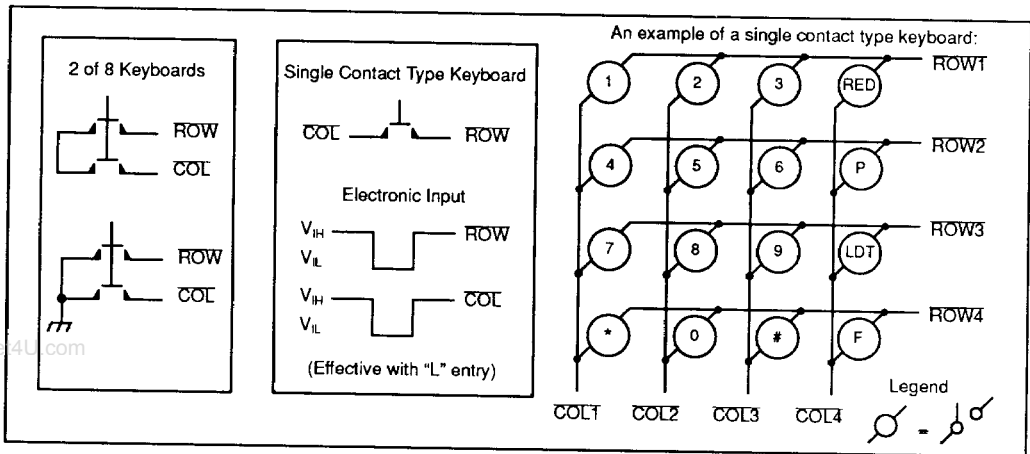
Figure 3. Reference Circuit
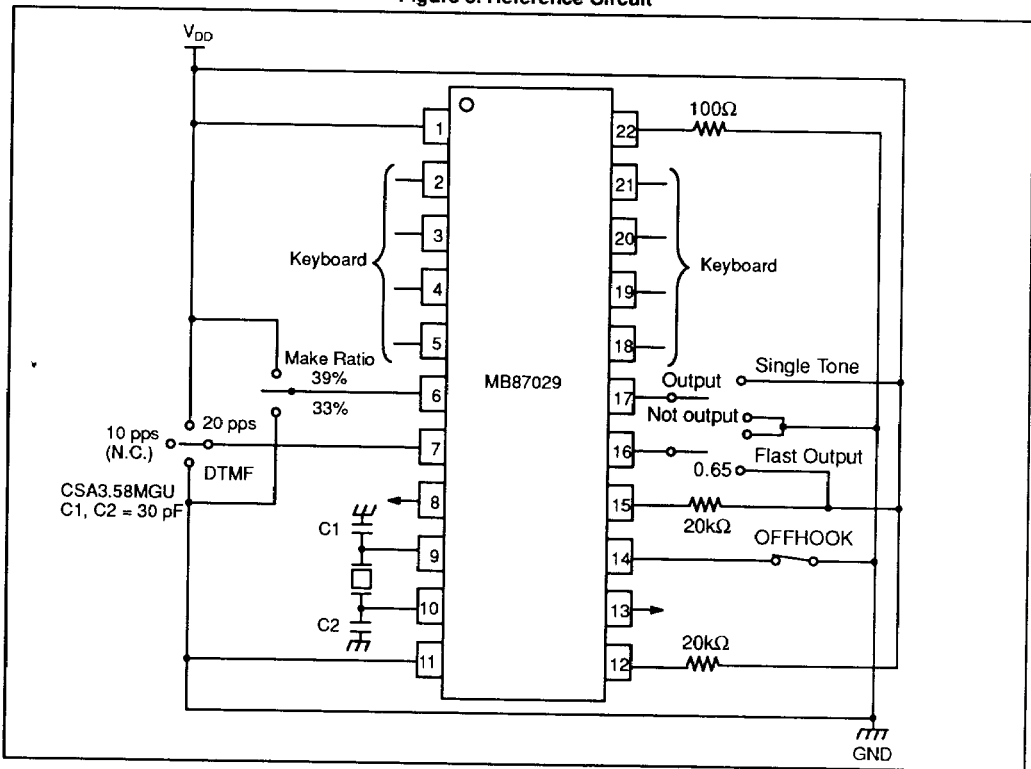
KEY OPERATION DIAGRAM

Redial key for PULSE mode	:	RED (P) = RED or #
Redial key for DTMF mode	:	RED (D) = RED
Pause key for PULSE mode	:	P (P) = P or #
Pause key for 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	:	(P) = Pause

KEY ENTRIES IN PULSE MODE

When MODEIN is set to 10 pps

HOOK	MODEIN	Key Entry	PULSE Output		DTMF Output
			10pps	20pps	
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

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KEY ENTRIES IN PULSE MODE

When MODEIN is set to 20 pps

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

KEY ENTRIES WHEN THE LDT KEY IS USED

When there is a pause after LDT

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

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KEY ENTRIES WHEN THE LDT KEY IS USED

When there is no pause before and after LDT

HOOK	MODEIN	Key Entry	PULSE Output		DTMF Output
			10pps	20pps	
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/DTMF MODE IS SWITCHED (MIXED REDIAL)

When there is a pause before mode switching

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

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KEY ENTRIES WHEN PULSE/DTMF MODE IS SWITCHED (MIXED REDIAL)

When there is a pause after mode switching

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

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REDIAL MEMORY INHIBIT FUNCTION

HOOK	MODEIN	Key Entry	PULSE Output 10pps	PULSE Output 20pps	DTMF Output
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) [2]	No output — 2		
ON / OFF	OPEN	RED (P)	2		
ON / OFF	V_DD	RED (P)	2		
ON / OFF	GND	RED (D) [3]	2		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			Unit
				Min	Typ	Max	
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		V_{DD}	V
Output Load Resistance	R_O	DTMFOUT	Between output pin and GND	0.1		20	kΩ
Operating Temperature	T_A			−30		60	°C

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ELECTRICAL CHARACTERISTICS

V_{DD}: PULSE mode = 2.0 to 6.0 V, V_{DD}: DTMF mode = 2.5 to 6.0 V, TA = −30 to 60°C

Parameter	Symbol	Pin Name	Condition		Value			Unit
					Min	Typ	Max	
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} = 2.5V	All output pins open in DTMF		1.0	2.0	mA
	I_{DP1}			All output pins open in PULSE		0.3	0.6	mA
	TDST1		TA = 25°C	All output pins HKS open in Standby		0.2	1.0	μA
Digital Input Voltage 1	V_{iH1}	$\overline{COL1}$ to $\overline{COL4}$ $\overline{ROW1}$ to $\overline{ROW4}$			0.8 V_{DD}		V_{DD}	V
	V_{iL1}				0		$\frac{1}{5}V_{DD}$	V
Digital Input Voltage 2	V_{iH2}	HKS, FCNT MODEIN, SCNT MA/BR			0.8 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}		$V_I = GND$		−0.01 V_{DD}		0.01	mA
Digital Input Leakage current 1	I_{IZ1}		Key entry HZ $GND \le V_I \le V_{DD}$		−10		10	μA
Digital Input Current 2	I_{IH2}	MODEIN	$V_I = V_{DD}$		−0.01		$\frac{1}{75}V_{DD}$	mA
	I_{IL2}		$V_I = GND$		−1/75 V_{DD}		0.01	mA
Digital Input Leakage current 2	I_{IZ2}		MODEIN HZ $GND \le V_I \le V_{DD}$		−10		10	μA
Digital Input Current 3	I_{IL3}	MA/BR, SCNT, FCNT	$V_I = GND$		−10		10	μA
	I_{IH3}	HKS, MA/BR, SCNT, FCNT	$V_I = V_{DD}$		−10		10	μA

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min	Typ	Max	
Pull-up Resistor	RPLU	HKS		100	200	400	kΩ
Digital Output Voltage	V_{OH}	MODEOUT BEEPOUT	$I_{OH} = -0.2mA$	V_{DD} −0.5		V_{DD}	V
	V_{OL}	MODEOUT, PULSEOUT, MUTE, BEEPOUT	$I_{OL} = 0.5mA$	0		0.5	V
Digital Output Off Leakage Current	I_{OL}	MUTE, PULSEOUT, MODEOUT, BEEPOUT	$GND \leq V_O \leq V_{DD}$	−10		10	μA
External Resistance when digital input is open	R_{DIO}	ROW1 TO ROW4 COL1 to COL4 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}	OSCIN, OSCOUT	ONHOOK mode	75	150	300	kΩ
Oscillator Frequency	O_{SCIN}				3.579545		MHz
DTMF Output Voltage 100Ω placed between output pin and GND.	A_{OUT}	DTMFOUT	No signal is output		0		V
			Offset voltage when signals are output		0.6 V_{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	N_{RKEY}	COL1 to COL4 ROW1 TO ROW4				26	digits
Make Ratio	W_{MAKE}	PULSEOUT	MA/BR = V_{DD}		39		%
			MA/BR = GND		33		%
Oscillation Start time	t_{OSS}	OSCIN, OSCOUT		0	8	16	ms
Oscillation Stop time	t_{OSSP}			0	8	16	ms

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ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min	Typ	Max	
Key Entry HZ Hold time	t_{HZKH}	COL1 to COL4 ROW1 TO 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}	COL1 to COL4 ROW1 TO 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}	PULSEOUT, DTMFOUT		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 Time by F key entry	t_{MOFH}		FCNT = V_{DD}	0.59	0.6	0.61	s
			FCNT = GND	0.09	0.1	0.11	
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
DTMFOUT Output Start time when mode is switched	t_{MST}	DTMFOUT		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}	PULSEOUT	FCNT = V_{DD}	0.59	0.6	0.61	s
			FCNT = GND	0.09	0.1	0.11	
PULSEOUT OUTPUT Start time by F key entry	t_{PUFS}				72		ms

6

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Pin Name	Condition		Value			Unit
					Min	Typ	Max	
Key Entry Width1	t_{WK1}	COL1 to COL4 ROW1 TO ROW4			50			ms
Key Entry Width2	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
MUTE LOW Output Start time	t_{MUS}	MUTE				31		ms
MUTE LOW Output Hold time 1	t_{MUSP1}		10 pps		26	30	34	ms
			20 pps		13	15	17	
			Dual Tone Output		100	110	120	
Pulse Predigital Pause Time	t_{PDP}	PULSEOUT	MA/BR = V_{DD}	10 pps mode	950	980	1016	ms
				20 pps mode	480	510.5	556	
			MA/BR = GND	10 pps mode	950	974	1016	ms
				20 pps mode	480	507.5	556	
Pulse Make Width	t_{WMA}		MA/BR = V_{DD}	10 pps mode	38	39	40	ms
				20 pps mode	19	19.5	20	
			MA/BR = GND	10 pps mode	32	33	34	ms
				20 pps mode	16	16.5	17	
Pulse Break Width	t_{WBR}		MA/BR = V_{DD}	10 pps mode	60	61	62	ms
				20 pps mode	30	30.5	31	
			MA/BR = GND	10 pps mode	66	67	68	ms
				20 pps mode	33	33.5	34	
Pulse Interdigital Pause Time	t_{IDP}		MA/BR = V_{DD}	10 pps mode	900	939	960	ms
				20 pps mode	450	469.5	480	
			MA/BR = GND	10 pps mode	900	933	960	ms
				20 pps mode	450	466.5	480	

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Pin Name	Condition	Value			Unit
				Min	Typ	Max	
MUTE LOW Output Hold time 2	t_{MUSP2}	MUTE	Single Tone Output	0		8	ms
DUAL TONE Output Time	t_{WDT}			78	80	82	ms
DTMF Interpause Time	t_{DTP}			78	80	82	ms
Single Tone Output start time	t_{SIS}	DTMF/BEEPOUT	SCNT = V_{DD}		31		ms
Single Tone Output stop time	t_{SISP}			0		45	ms
DUAL TONE Output start time	t_{DTS}				39		ms
DUAL TONE Output stop time	t_{DTSP}			0		5	ms
MUTE Hold Time 1 by PAUSE key entry	t_{PSM1}	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 SIGNALS

| Item	Symbol	Standard DTMF (Hz)	DTMF Output Signal* (Hz)	Error to standard TDMF (%)
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: *Oscillation frequency 3.579545 MHz

Figure 4. Key Input Timing
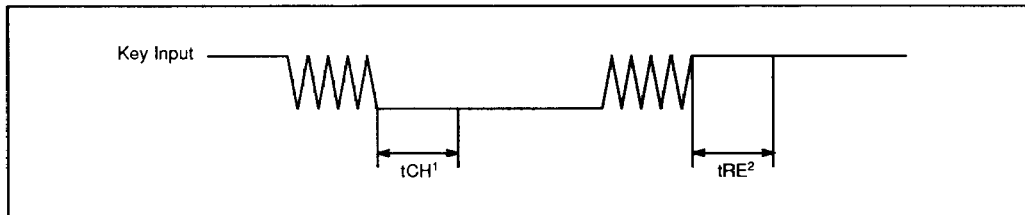
Notes: [1] Key Input Debouncing Time tCH
Key entry is accepted if low level is longer than 23 ms typ.
[2] Key Input Release Guard Time tRE
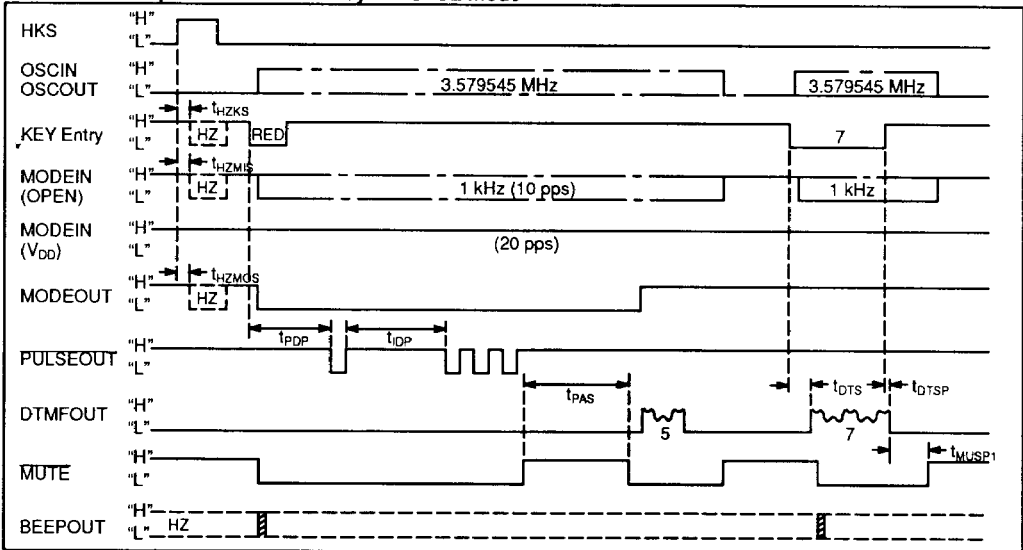Key release is recognized if low level is longer than 23 ms typ.

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TIMING CHART 1–A

When there is a pause before LDT key in PULSE mode
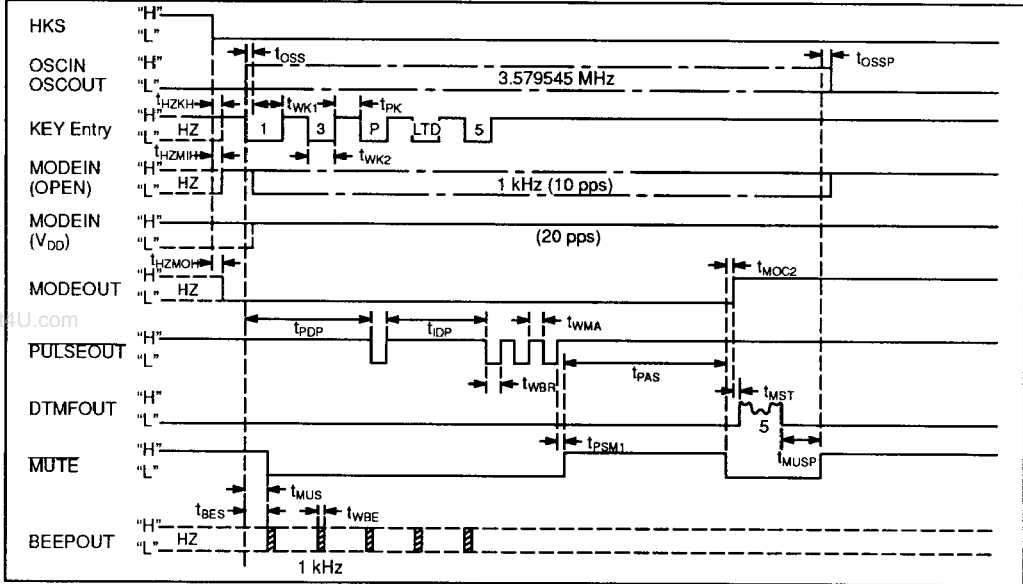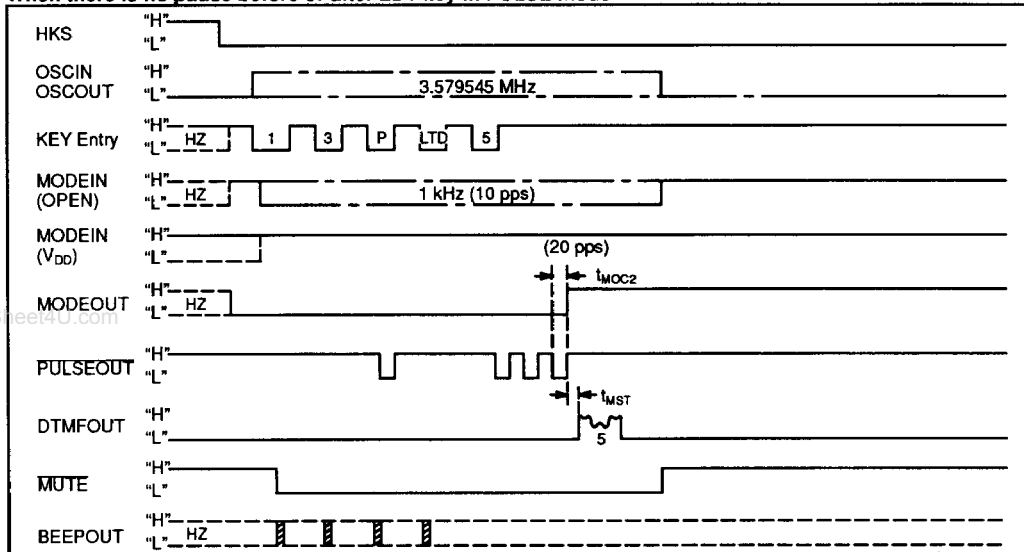

TIMING CHART 1–B

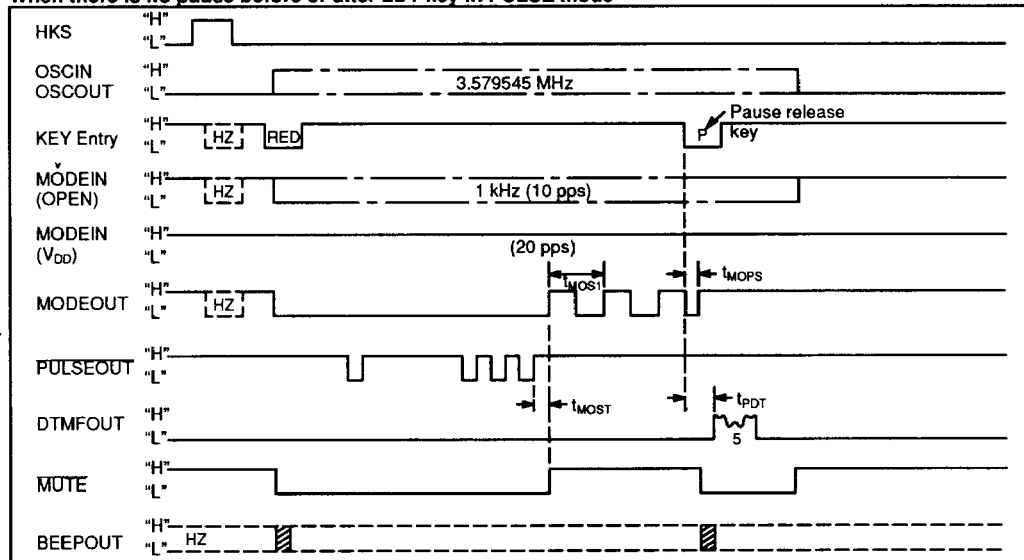When there is a pause before LDT key in PULSE mode

TIMING CHART 2–A

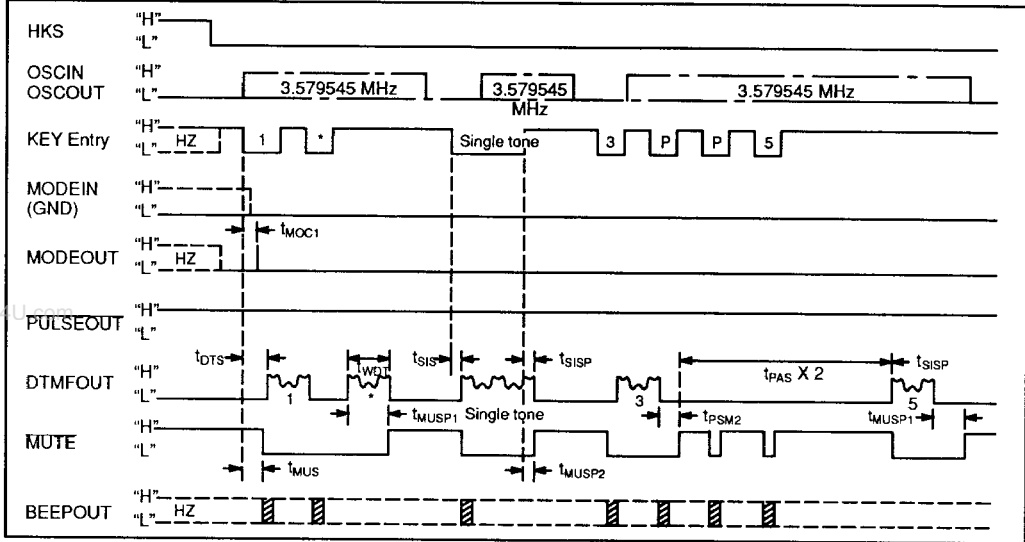**When there is no pause before or after LDT key in PULSE mode**

TIMING CHART 2–B

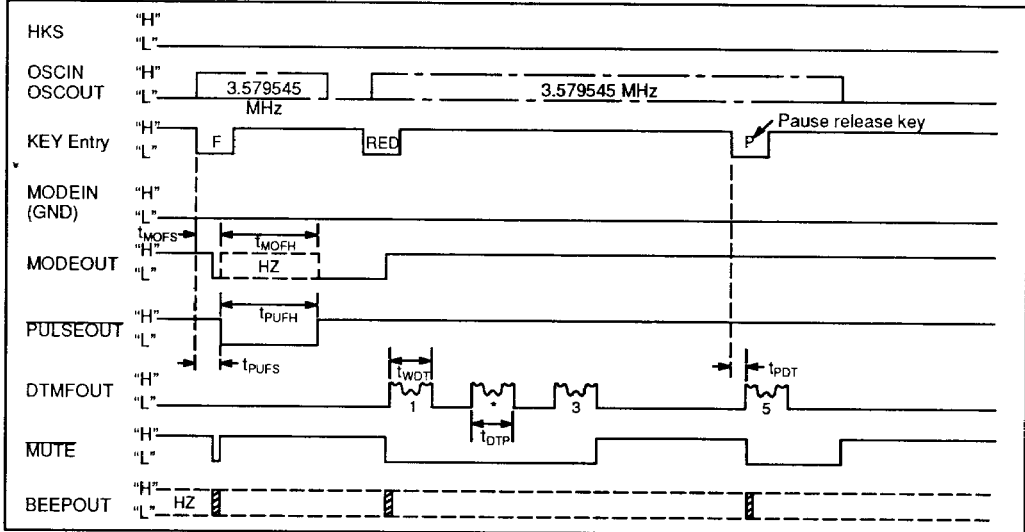**When there is no pause before or after LDT key in PULSE mode**

TIMING CHART 3–A

In DTMF mode

TIMING CHART 3–B

In DTMF mode

PACKAGE DIMENSIONS

22-LEAD PLASTIC DUAL IN-LINE PACKAGE
(Case No.: DIP-22P-M03)

INDEX - 1

INDEX - 2

1.085 $^{+.008}_{-.012}$ (27.55 $^{+.020}_{-.030}$)

.358 ± .008
(9.10 ± 0.20)

.400 (10.16)
TYP

15° MAX

.010 $^{+.004}_{-.0004}$
(0.25 $^{+0.11}_{-0.01}$)

.047 $^{+.012}_{-0}$
(1.20 $^{+.030}_{-0}$)

.047 $^{+.012}_{-0}$
(1.20 $^{+.030}_{-0}$)

.197 (5.00) MAX

.118 (3.00) MIN

.050 (1.27)
MAX

.100 (2.54)
TYP

.018 $^{+.005}_{-.003}$
(0.45 $^{+.013}_{-.07}$)

.020 (0.51) MIN

Dimensions in inches (millimeters)

24-LEAD PLASTIC FLAT PACKAGE
(Case No.: FPT-24P-M02)

INDEX

.110 (2.80) MAX
(SEATED HEIGHT)

.002 (0.05) MIN
(STAND OFF)

.600 $^{+.010}_{-.008}$ (15.24 $^{+.025}_{-.020}$)

.402 ± .016
(10.20 ± 0.40)

.299 ± .012
(7.60 ± 0.30)

.362 ± .012
(9.20 ± 0.30)

.020 ± .008
(0.50 ± 0.20)

.050 (1.27)
TYP

.018 ± .004
(0.45 ± 0.10)

⊕ Ø .005 (0.13) Ⓜ

.006 $^{+.002}_{-.001}$ (0.15 $^{+0.05}_{-0.02}$)

Details of "A" part

.008 (0.20)

.024 (0.60)

.007 (0.18)
MAX

.027 (0.68)
MAX

'A'

.004 (0.10)

.550 (13.97) REF

Dimensions in inches (millimeters)

6