

SANYO

No. 5556

LC73750, 73750M**Serial I/O Dialler with Keyboard Input Functions****Overview**

The LC73750 and LC73750M are dialler LSI for both dual-tone multi-frequency (DTMF) and pulse telephone equipment. This single chip combines keyboard scanner circuitry, a dial signal generator, and a serial I/O interface. It provides dialling during power outages and features user-defined keys that are ideal for such applications as facsimile machines and cordless telephones with built-in answering machines.

Operation

When the AC power is on, the serial interface passes the keyboard data to the microcontroller. The dial signal generator reads serial data from the microcontroller and converts it into the dialling signal.

During a power outage, the keyboard data goes directly to the dial signal generator for conversion into the dialling signal.

Advantages

- Reducing the keyboard inputs, pin inputs (HOOK, P/T, DPR, etc.), and output port to a single LSI eliminates the need for a dozen I/O ports on the microcontroller.
- The chip allows the creation of a dialling mechanism that operates even when the AC power is off.
- In addition to the regular dial keys, there are user-definable keys that may be used to customize the application.
- The chip eliminates the need for key scan and dial output control code in the microcontroller's ROM.

Features

- Uses CMOS technology capable of directly operating on the telephone line.
- Permits the use of a single-contact keyboard.
- Connects to the microcontroller via a serial I/O port. (Includes a built-in interrupt port.)
- Includes a built-in oscillator circuit ($f_{osc} = 3.58$ MHz) that can be used with a crystal oscillator or ceramic resonator.
- Includes a high-precision DTMF signal generator (+0.03%, -0.11%) that simplifies the task of choosing a ceramic resonator.
- Generates 16 DTMF signals.

- Offers a choice of 101 ms and 62 ms for DTMF signal duration.
- Contains a 32-digit memory buffer that doubles as a redialer.
- Supports writing of mode changes and pauses to the memory buffer.
- Automatically inserts a pause after a mode change during pulse dialling.
- Automatically inserts a hooking pause after an off-hook or flash operation.
- Supports mode changes in one direction only--from pulse dialling to DTMF.
- Supports pulse dial rates of 10 and 20 pps and make/break ratios of 33%/67% and 39%/61%.
- Supports on-hook dialling during stand-alone operation. (Supports handsfree operation with \overline{OUT} pin.)
- Permits direct control of dialler output ports ($\overline{MUTE1}$, \overline{DP} , \overline{OUT}) with serial data.
- Supports hook control.
- Offers choice of flash intervals: 280 ms and 700 ms.
- Offers choice of pause intervals: 2 s and 4 s.
- Supports keyboards with up to 43 keys--that is, a maximum of 27 user-defined keys.
- Generates key tone signals from valid key presses in stand-alone mode.
- Supports microcontroller control of key tone circuit when AC power supply is available. (Supports combined use with stand-alone mode.)
- Offers a wide selection of special key operations involving simultaneous presses.
- Operates over a broad range of voltages:
 - Pulse mode: $V_{DD} = 1.5$ to 5.5 V
 - DTMF mode: $V_{DD} = 2.0$ to 5.5 V
- Package
 - DIP36S
 - MFP36S

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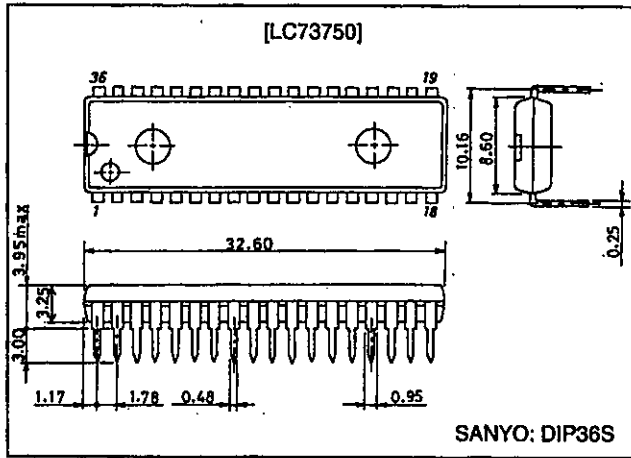
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Package Dimensions

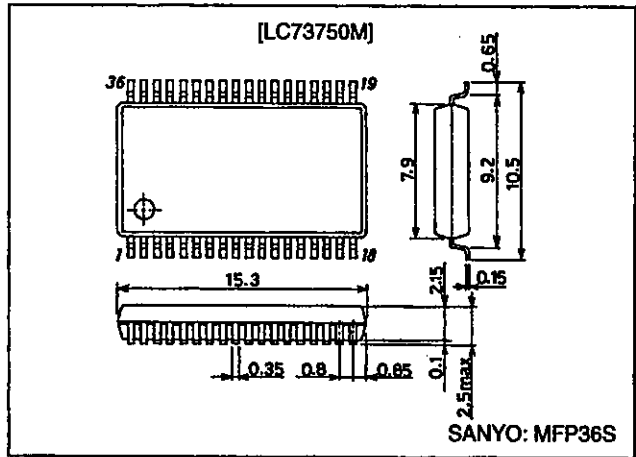
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3170-DIP36S

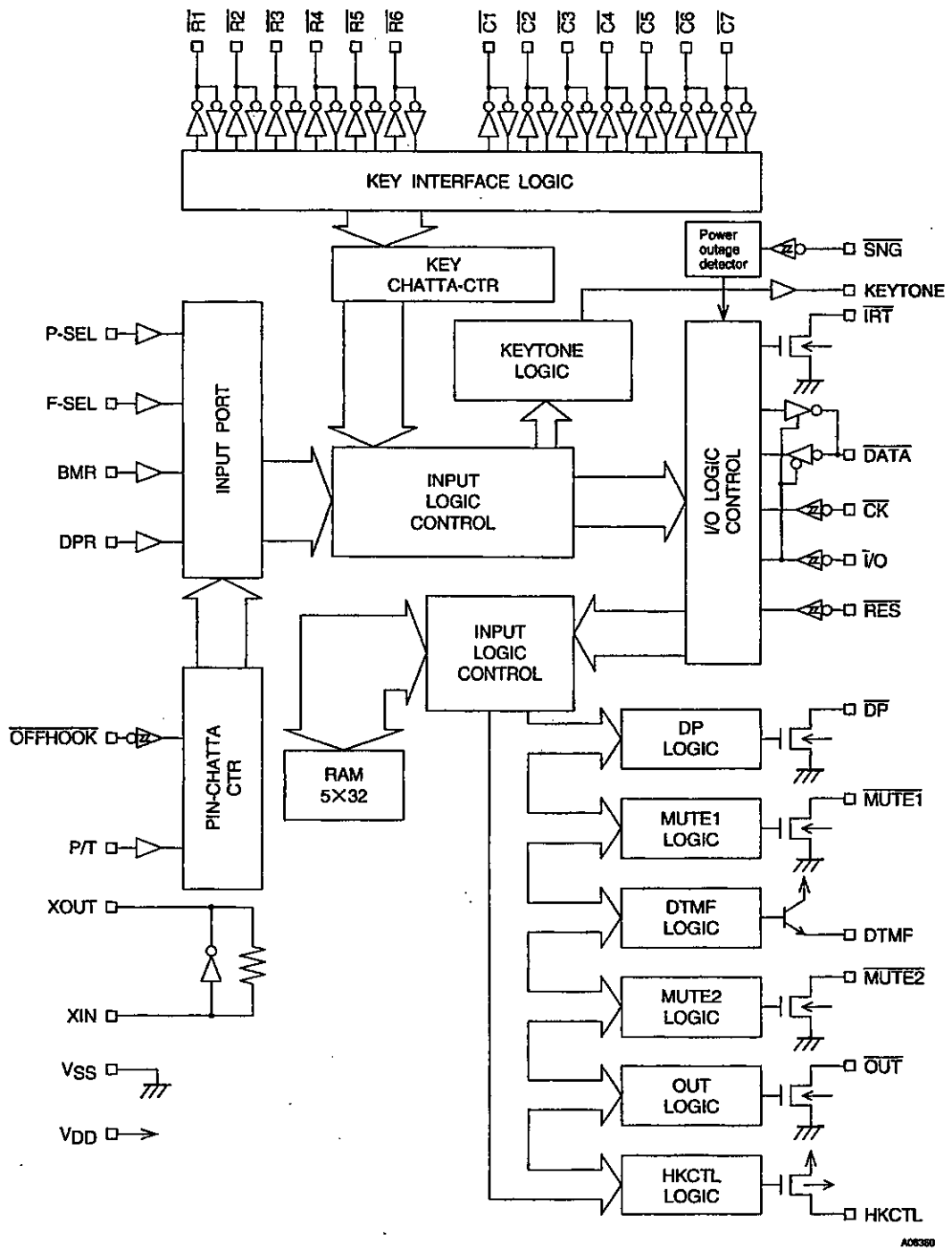


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3204-MFP36S



Block Diagram



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Pin Descriptions

Pin No.	Symbol	I/O	Functions
1 to 6	$\overline{R1}$ to $\overline{R6}$	I	Row input pins
7	$\overline{I/O}$	I	I/O direction control pin: LOW for input and HIGH for output. Schmitt input.
8	\overline{CK}	I	Data input clock. Schmitt input.
9	\overline{DATA}	I/O	Data input/output with direction controlled by $\overline{I/O}$ pin. During output, the \overline{IRT} pin can also produce output, permitting combined use of the \overline{DATA} and \overline{IRT} pins.
10	\overline{IRT}	O	This pin goes LOW when the \overline{HOOK} pin changes, the $\overline{P/T}$ pin changes, or a key switches on or off. During stand-alone operation, the pin is in a high-impedance state. N-channel open drain output.
11	\overline{RES}	I	Reset input. Pull this pin LOW when the power is applied and whenever the dialler is to be reset during operation. Schmitt input.
12	$\overline{OFFHOOK}$	I	Hook switch input. HIGH indicates on hook; LOW, off hook. Schmitt input.
13	\overline{SNG}	I	Pin that selects whether the dialler is controlled via the serial port (HIGH) or operates in stand-alone mode without going through the port (LOW). Schmitt input.
14	F-SEL	I	Flash interval selection pin: 280 ms (HIGH) or 700 ms (LOW).
15	P-SEL	I	Pause interval selection pin: 2 s (HIGH) or 4 s (LOW).
16	XIN	I	Pins for connecting a crystal or ceramic oscillator with a frequency of 3.579545 MHz.
17	XOUT	O	
18	V_{DD}		Power supply pins.
19	V_{SS}		
20	\overline{DTMF}	O	DTMF output. NPN emitter follower output.
21	$\overline{MUTE2}$	O	DTMF mute output. N-channel open drain output.
22	$\overline{MUTE1}$	O	DP mute output. N-channel open drain output.
23	\overline{DP}	O	DP output. N-channel open drain output.
24	\overline{HKCTL}	O	Hook control output pin. During stand-alone operation, this produces the same output as the $\overline{OFFHOOK}$ pin. P-channel open-drain output.
25	\overline{OUT}	O	Port controlled by serial data. Using this as a speaker mute signal permits hands free operation. N-channel open drain output.
26	$\overline{KEYTONE}$	O	Output pin for key tone during valid key presses. This produces a 1.7-kHz tone for 32 ms. Complementary output.
27	\overline{DPR}	I	Dial pulse rate selection pin: 20 pps (HIGH) or 10 pps (LOW).
28	$\overline{P/T}$	I	Pulse/tone selection pin: pulse (HIGH) or tone (LOW).
29	\overline{BMR}	I	Make/break ratio selection pin: 33%/67% (HIGH) or 39%/61% (LOW).
30 to 36	$\overline{C1}$ to $\overline{C7}$	I	Column input pins.

Z: High Impedance

Note: If an input pin is not used, connect it permanently to the appropriate logic input level (e.g., GND or V_{DD}).

Specifications

Absolute Maximum Ratings at $T_a = 25$, $f_{osc} = 3.579545\text{MHz}$

Parameter	Symbol	Conditions	Rating	Unit
Maximum supply voltage	$V_{DD\ max}$		-0.3 to +6.5	V
Maximum input voltage	$V_{IN\ max}$		-0.3 to $V_{DD}+0.3$	V
Maximum output voltage	$V_{OUT\ max}$		-0.3 to $V_{DD}+0.3$	V
Power drain	$P_d\ max$	$T_a \leq 70^\circ\text{C}$	250	mW
Minimum load resistance	$R_L\ min$	DTMF - V_{SS} pin	1	k Ω
Operating temperature	T_{opr}		-30 to +70	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

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Permissible Operating Ranges at $T_a = 25$, $f_{osc} = 3.579545\text{MHz}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply voltage	V_{DDP}	Pulse mode	1.5		5.5	V
	V_{DDT}	DTMF mode	2.0		5.5	V
Input HIGH level	V_{IH}	Non-Schmitt input pins	$0.7V_{DD}$		V_{DD}	V
	V_{IHS}	Schmitt input pins	$0.8V_{DD}$		V_{DD}	V
Input LOW level	V_{IL}	Non-Schmitt input pins	V_{SS}		$0.3V_{DD}$	V
	V_{ILS}	Schmitt input pins	V_{SS}		$0.2V_{DD}$	V
Key contact resistance	R_{KI}				10	$K\Omega$
Keyboard capacitance	C_{KI}				330	μF
Oscillator pin standard	f	Neutral frequency = 3.579545 MHz	-1.3		+1.3	%
	R_s				100	Ω

Electrical Characteristics at $T_a = 25$, $f_{osc} = 3.579545\text{MHz}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Operating current drain	I_{DDP}	Dial pulse output, outputs open, $V_{DD} = 3.0\text{V}$		0.3	0.5	mA
	I_{DDT}	DTMF output, outputs open, $V_{DD} = 3.0\text{V}$		0.5	1.0	mA
Static current drain	$I_{DD(ST)}$	Standby operation, outputs open, $V_{DD} = 1.5\text{ to }5.5\text{V}$			1	μA
Memory retention voltage	V_{DR}	Across V_{DD} and V_{SS}	1			V
Memory retention current	I_{DR}	$V_{DD} = 1.0\text{V}$			0.5	μA
Input pin current	I_{IH1}	RES, I/O, CK, SNG, DPR, P/T, BMR, FSL, PSL			1	μA
	I_{IL1}	RES, I/O, CK, SNG, DPR, P/T, BMR, FSL, PSL	-1			μA
Key pin current	I_{ILK1}	All key pins, $V_{DD} = 1.5\text{V}$, $V_{ILK} = V_{SS}$	-20			μA
	I_{ILK2}	All key pins, $V_{DD} = 5.5\text{V}$, $V_{ILK} = V_{SS}$	-300			μA
	I_{OLK1}	All key pins, $V_{DD} = 1.5\text{V}$, $V_{OLK} = 0.4\text{V}$	200			mA
	I_{OLK2}	All key pins, $V_{DD} = 5.5\text{V}$, $V_{OLK} = 0.4\text{V}$	0.7			mA
Output pin leakage current	I_{OFF}	$V_O = V_{DD}$, $V_{DD} = 5.5\text{V}$, Outputs off			1	μA
Output pin voltage	V_{OH1}	$V_{DD} = 1.5\text{V}$ $I_{OH} = -250\mu\text{A}$ KEYTONE, HOOKCTL	$V_{DD} - 0.5$			V
	V_{OH2}	$V_{DD} = 5.5\text{V}$ $I_{OH} = -1\text{mA}$ KEYTONE, HOOKCTL	$V_{DD} - 1$			
	V_{OL1}	$V_{DD} = 1.5\text{V}$ $I_{OL} = 250\mu\text{A}$ KEYTONE, OUT, MUTE1, MUTE2, IRT, DP			0.4	
	V_{OL2}	$V_{DD} = 5.5\text{V}$ $I_{OL} = 250\mu\text{A}$ KEYTONE, OUT, MUTE1, MUTE2, IRT, DP			0.4	

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AC Characteristics at $T_a = 25$, $f_{osc} = 3.579545\text{MHz}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Key debounce interval	T_{KD}			32.0		ms
Pin debounce interval	T_{PD}			54.9		ms
Key scan frequency	f_{KSC}			218.5		Hz
Key tone frequency	f_{KT}			1747.8		Hz
Key tone output interval	T_{KT}			32.0		ms
Pause interval	T_{AP}	P-SEL pin is LOW		4.0		s
		P-SEL pin is HIGH		2.0		s
DTMF transmission time	T_{MFON}	Mode setting bit D4 is 0		101.3		ms
		Mode setting bit D4 is 1		62.4		
DTMF interdigit pause	T_{MFOFF}	Mode setting bit D4 is 0		101.8		ms
		Mode setting bit D4 is 1		62.9		
Hooking interval	T_{HK}	F-SEL pin is LOW		700.0		ms
		F-SEL pin is HIGH		286.6		ms
Hooking pause	T_{HKP}	F-SEL pin is LOW		818.3		ms
		F-SEL pin is HIGH		1.22		ms
Low tone amplitude	V_{OR}	$V_{DD} = 3.5\text{ V}$, $R_L = 10\text{ K}\Omega$	165	200	240	mVrms
Tone output ratio	dBCR	$V_{DD} = 2.0\text{ to }5.5\text{ V}$, $R_L = 10\text{ K}\Omega$	1	2	3	dB
Tone output distortion	%DIS	$V_{DD} = 2.0\text{ to }5.5\text{ V}$, $R_L = 10\text{ K}\Omega$			10	%

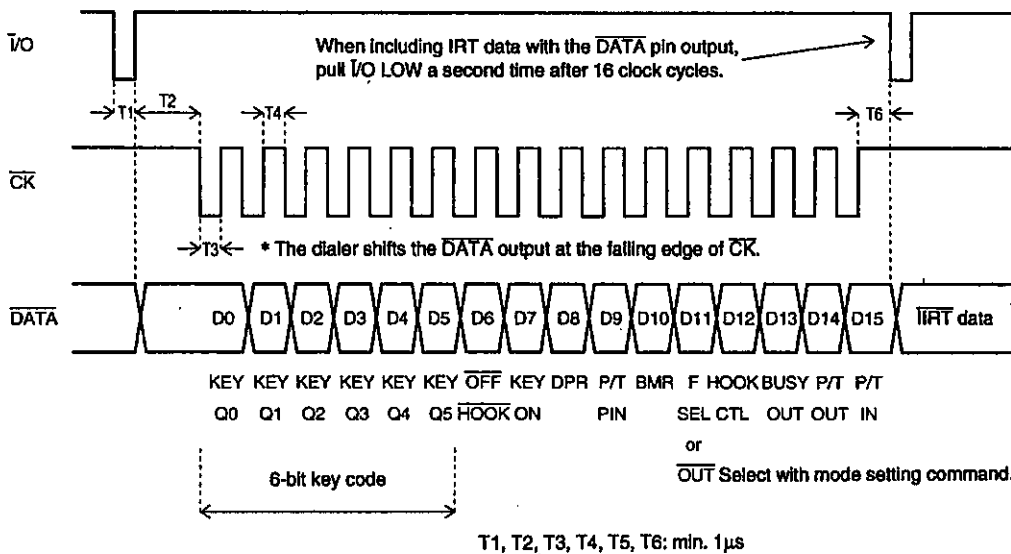
Pulse Output

DPR pin	BMR pin	Dial pulse rate	Predigit pause	Interdigit pause	Make ratio
L	H	10.0 PPS	33.0 ms	833.0 ms	33.0 %
L	L	10.0 PPS	39.3 ms	839.0 ms	39.3 %
H	H	20.0 PPS	16.5 ms	566.5 ms	33.0 %
H	L	20.0 PPS	19.7 ms	569.7 ms	39.3 %

DTMF Output Frequencies

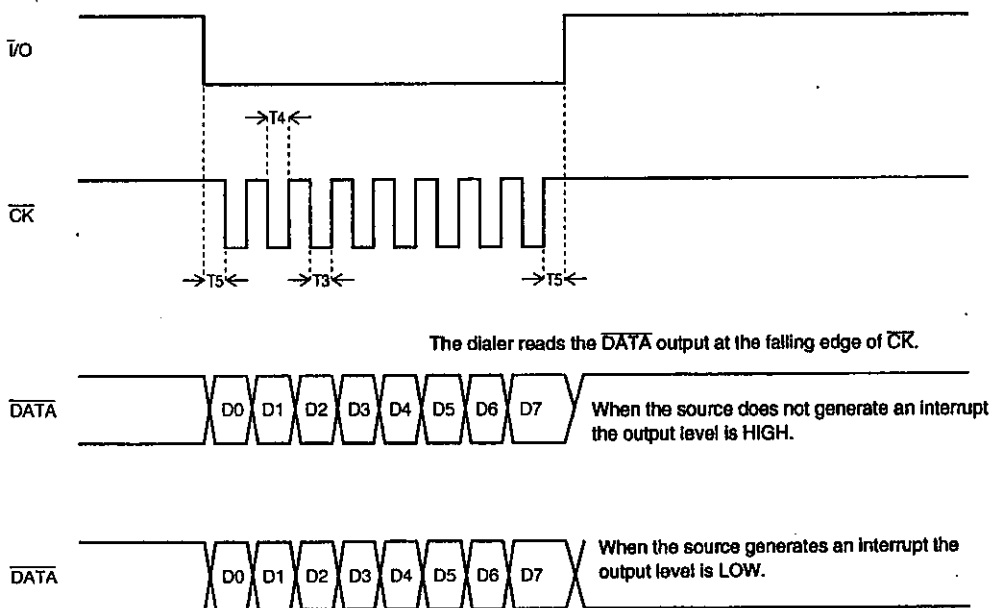
Input	Output frequency (Hz)		Deviation (%)
	Standard	LC73750	
R1	697	697.0	+0.01
R2	770	770.1	-0.02
R3	852	852.3	-0.03
R4	941	942.0	-0.11
C1	1209	1209.3	-0.03
C2	1336	1335.7	+0.03
C3	1477	1476.7	+0.02
C4	1633	1633.0	+0.00

Serial Data Format
16-Bit Output Format



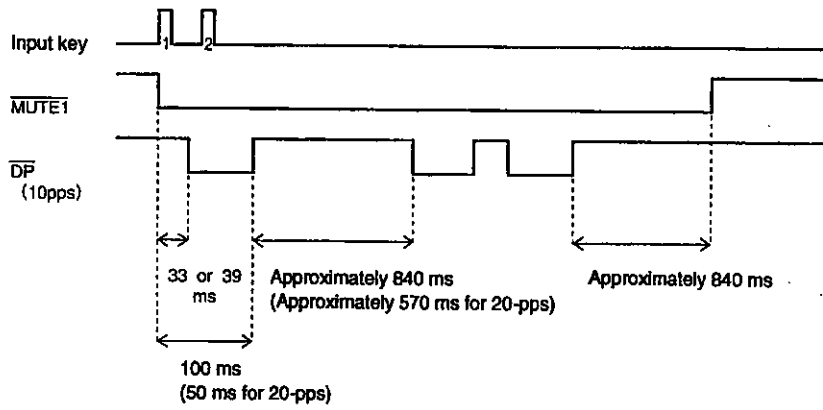
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8-Bit Input Format



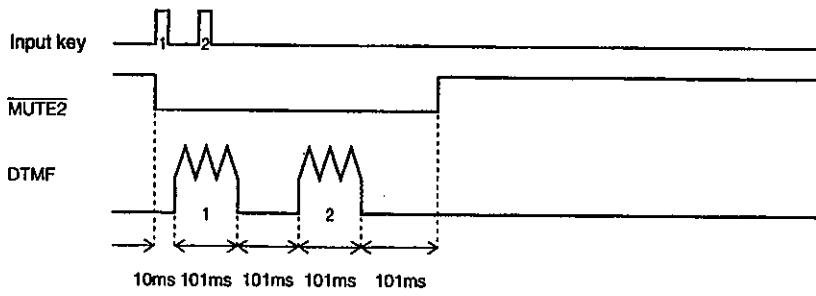
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Dial Output Timing
Pulse mode



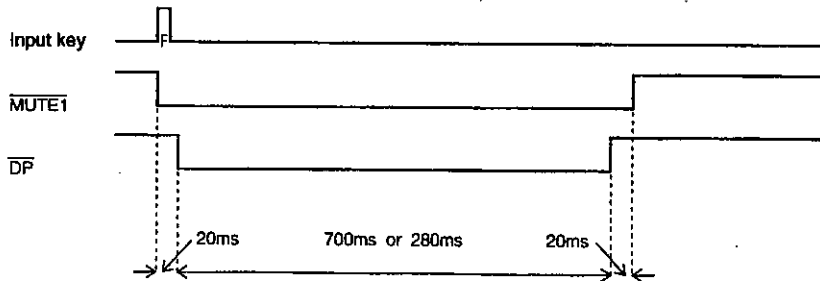
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DTMF mode



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Flash operation



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Input Code Table

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	0	0	0	0	0	YES	KEY D
X	0	0	0	0	0	0	1	YES	KEY 1
X	0	0	0	0	0	1	0	YES	KEY 2
X	0	0	0	0	0	1	1	YES	KEY 3
X	0	0	0	0	1	0	0	YES	KEY 4
X	0	0	0	0	1	0	1	YES	KEY 5
X	0	0	0	0	1	1	0	YES	KEY 6
X	0	0	0	0	1	1	1	YES	KEY 7
X	0	0	0	1	0	0	0	YES	KEY 8
X	0	0	0	1	0	0	1	YES	KEY 9
X	0	0	0	1	0	1	0	YES	KEY 0
X	0	0	0	1	0	1	1	YES	KEY *
X	0	0	0	1	1	0	0	YES	KEY #
X	0	0	0	1	1	0	1	YES	KEY A
X	0	0	0	1	1	1	0	YES	KEY B
X	0	0	0	1	1	1	1	YES	KEY C
X	0	0	1	0	0	0	0	NO	OUT-ST (OUT pin control)
X	0	0	1	0	0	0	1	NO	OUT-END (OUT pin control)
X	0	0	1	0	0	1	0	NO	PAUSE release (valid only during a pause)
X	0	0	1	0	0	1	1	NO	FLASH
X	0	0	1	0	1	0	0	NO	STOP (Stops dialling and then seizes and retains the circuit)
X	0	0	1	0	1	0	1	NO	RD (Redial)
X	0	0	1	0	1	1	0	NO	MUTE1-ST (MUTE1 pin control)
X	0	0	1	0	1	1	1	NO	MUTE1-END (MUTE1 pin control)
X	0	0	1	1	0	0	0	NO	DP-ST (Stops dialling and breaks the circuit)
X	0	0	1	1	0	0	1	NO	DP-END (Seizes the circuit and inserts a hooking pause)
X	0	0	1	1	0	1	0	NO	DTMF-OFF (Disable continuous DTMF transmission of last digit)
X	0	0	1	1	0	1	1	YES	MODE-CH (Mode change—from pulse to tone only)
X	0	0	1	1	1	0	0	NO	OSC-START
X	0	0	1	1	1	0	1	YES	PAUSE
X	0	0	1	1	1	1	0	NO	ON-HOOK (HOOKCTL = Z)
X	0	0	1	1	1	1	1	NO	OFF-HOOK (HOOKCTL = H)

Z: High Impedance

Mode Setting Command

The dialler writes input in the following format to its internal mode register, not to RAM.

D7	D6	D5	D4	D3	D2	D1	D0
X	MODE	TEST	DTMF-SL	OUT-SL	KEY-SL	P/T	D11-SL
X	1	0	*1*62 ms *0*101 ms	*1*Retain *0*Reset	*1*JPN *0*USA	*1*Pulse *0*Tone	*1*OUT *0*F-SEL

D7 controls key tone output: Enabled (HIGH) or disabled (LOW).

When the power is applied, the dialler sets KEY-SL to the following values according to the state of the BMR input pin.

* BMR = "0" (39%) → KEY-SL = "0" (USA)

* BMR = "1" (33%) → KEY-SL = "1" (JPN)

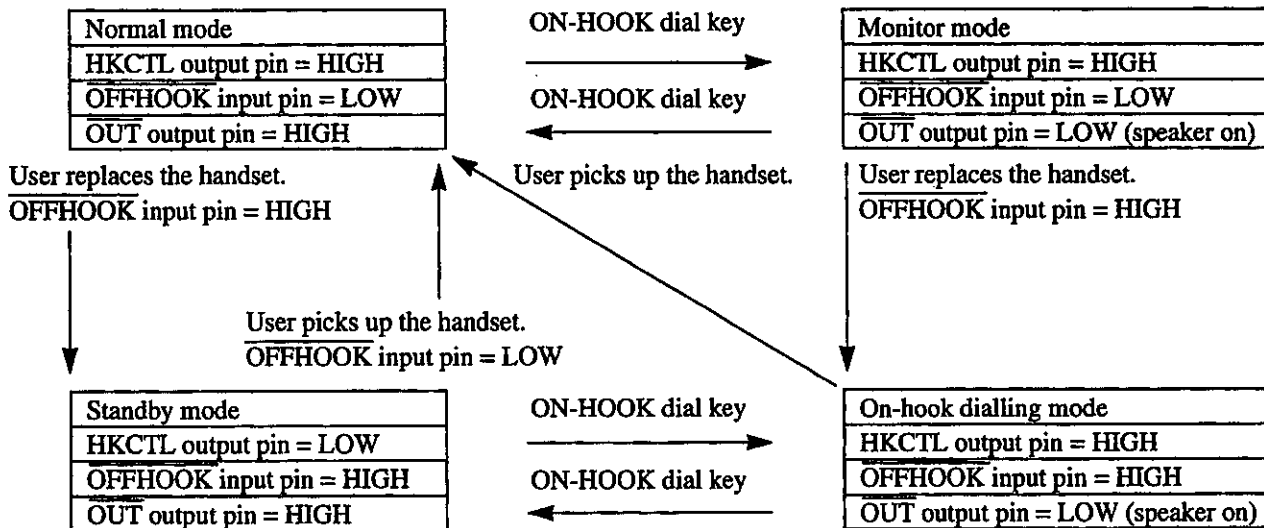
The dialler sets the other register bits to "0".

DTMF-SL (D4)

- This bit controls the minimum DTMF transmission time.
- This bit is "0" when the power is first applied, during a power outage ($\overline{SNG} = \text{LOW}$), and after a reset.
- When $D4 = "1"$ (for a time of 62 ms), continuous DTMF transmission is impossible, so a DTMF-OFF command is not necessary.

OUT-SL (D3)

- This bit controls whether the dialer retains or resets the \overline{OUT} output pin and HKCTL output pin active states when the power fails--that is, when \overline{SNG} switches from HIGH to LOW.
- This bit is "0" when the power is first applied and after a reset.
- When $D3 = "1"$ (retain) and the power is off, pressing the ON-HOOK dial key changes the states of the \overline{OUT} and HKCTL pins. The \overline{OUT} output pin is used for speaker mute control. See the state transition diagram below.



Note: When $D3 = "1"$ (retain), $\overline{MUTE1}$ and \overline{OUT} pins are the same output.

- When $D3$ is "0" (reset), a power outage breaks the connection (i.e., HKCTL becomes high impedance) even if, for example, the dialer is in the on-hook dialling mode.

KEY-SL (D2)

- This bit switches key operation specifications between Japanese and American standards. The Japanese specifications require detection of an all-off state for the keys before recognizing a valid key. The American specifications do not require this detection.
- When the power is applied, the dialer sets this bit to the following values according to the state of the BMR input pin.
 - BMR = LOW (39%) → $D2 = "0"$ (USA)
 - BMR = HIGH (33%) → $D2 = "1"$ (JPN)

P/T (D1)

- This bit controls the dialling mode: pulse or tone.
- When the power is applied, the dialer sets this bit to the following values according to the state of the P/T input pin.
 - P/T = LOW (Tone) → D1 = "0"
 - P/T = HIGH (Pulse) → D1 = "1"
- During a power outage, an $\overline{\text{OFFHOOK}}$ signal and flash input causes the dialer to reread the pin state.

D11-SL (D0)

- This bit specifies whether bit 11 of the 16-bit serial output contains the F-SEL input state or the $\overline{\text{OUT}}$ output state.
- When the power is applied, the dialer sets this bit to "0," the F-SEL input setting.
- For a configuration supporting handsfree operation during a power outage and allowing the user to toggle between the normal and monitor modes with the ON-HOOK dial key, this bit is necessary to determine which mode the dialer was in when the power is restored.

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Key Code Table

	C1	C2	C3	C4	C5	C6	C7	GND
R1	1	2	3	F	F1	F2	F3	
	000001	000010	000011	010011	100001	100010	100011	
R2	4	5	6	P	F4	F5	F6	
	000100	000101	000110	011101	100100	100101	100110	
R3	7	8	9	RD	F7	F8	F9	
	000111	001000	001001	010101	100111	101000	101001	
R4	*	0	#	F0	F10	F11	F12	
	001011	001010	001100	100000	101010	101011	101100	
R5	F13	F14	F15	F16	F17	F18	F19	
	101101	101110	101111	110000	110001	110010	110011	
R6	F20	F21	F22	F23	F24	F25	F26	ON-HOOK DIAL
	110100	110101	110110	110111	111000	111001	111010	011111

Note: The ON-HOOK DIAL is for toggling the state of the HKCTL pin during stand-alone operation. This key code is generated by short-circuiting the R6 line with the ground.

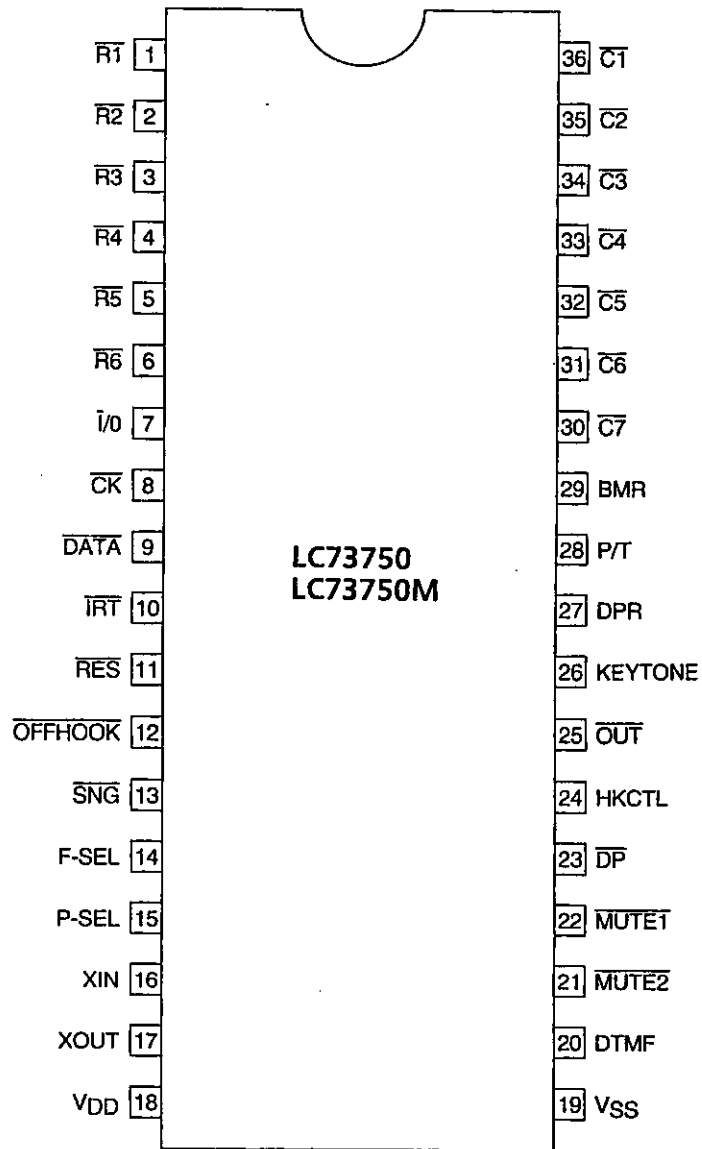
The dialer also produces test mode key codes for the combinations shown in the following Table.

Test Mode Key Codes

Key matrix		Key operation	Key code
Row	Column		
R1, R4	C5	Two-member combination F1-F10	010000
R2, R3	C5	Two-member combination F4-F7	010001
R1, R3, R4	C5	Three-member combination F1-F7-F10	111111
R1, R3	C1, C5	Two-member combinations 7-F1 and 1-F7, four-member combinations 1-7-F1-F7, and three-member combinations 1-7-F1, 1-7-F7, F1-F7-1, and F1-F7-7.	111100
R1, R3	C4, C5	Two-member combinations RD-F1 and F-F7, four-member combinations F-RD-F1-F7, and three-member combinations F-RD-F1, F-RD-F7, F1-F7-F, and F1-F7-RD.	111101
R2, R3	C1, C2, C5	Three-member combinations 4-8-F7, 4-8-F4, and 5-7-F7 plus other combinations mixing R2, R3, C1, C2, and C5.	010010
R1, R2, R4	C1, C2, C3	Three-member combinations 1-5-# and 2-4-# plus other combinations mixing R1, R2, R4, C1, C2, and C3.	111110

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Pin Assignment



Top view

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Pin Function

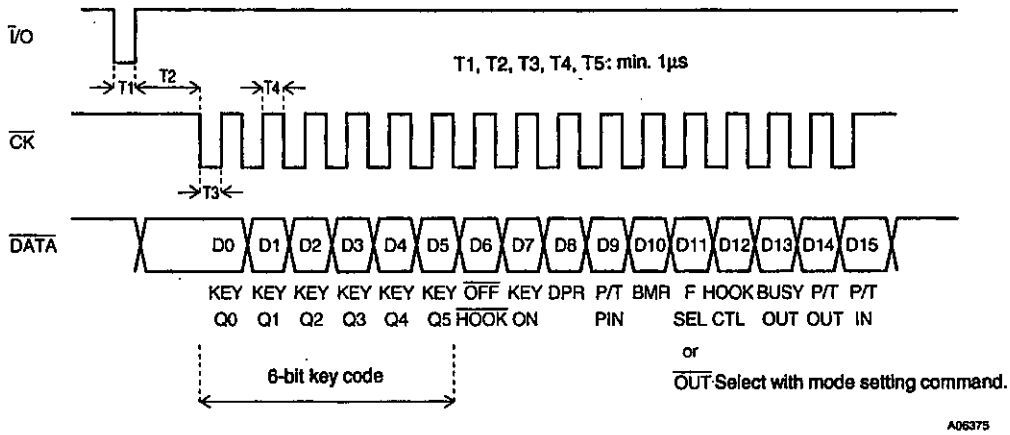
Pin No.	Pin name	Internal connections
1 to 6 30 to 36	$\overline{R1}$ to $\overline{R6}$ $\overline{C1}$ to $\overline{C7}$	<p>A06367</p>
7 8 11 12 13	$\overline{I/O}$ \overline{CK} \overline{RES} $\overline{OFFHOOK}$ \overline{SNG}	<p>A06368</p>
9 14 15 27 28 29	DATA F-SEL P-SEL DPR P/T BMR	<p>A06369</p>
16 17	XIN XOUT	<p>A06370</p>

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Pin No.	Pin name	Internal connections
20	DTMF	<p>A06371</p>
10 21 22 23 25	$\overline{\text{IRT}}$ $\overline{\text{MUTE2}}$ $\overline{\text{MUTE1}}$ $\overline{\text{DP}}$ $\overline{\text{OUT}}$	<p>A06372</p>
24	HKCTL	<p>A06373</p>
9	$\overline{\text{DATA}}$	<p>A06374</p>

1. Dialer's 16-bit serial output

The following timing chart shows the dialer's 16-bit serial output.

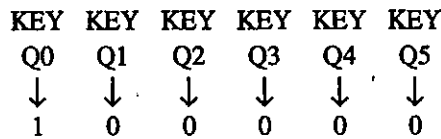


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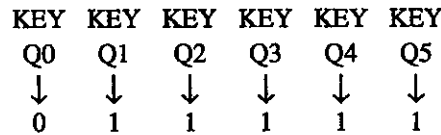
• 6-bit key code (D0 to D5)

This field gives the key code for the key just pressed (KEY ON, transition from LOW to HIGH) or released (KEY OFF, transition from HIGH to LOW). If the interrupt is not for a key on/off event, this field retains the previous key code.

The bits are transmitted LSB first. The bits for the key 1 key code of 000001, for example, become the following.



Note, however, that since $\overline{\text{DATA}}$ uses negative logic, the pin outputs reverse the bits. The key 1 key code, therefore, becomes the following.



KEY Q5 and KEY Q6, the uppermost two bits of the key code, divide the key codes into the following categories.

KEYQ5	KEYQ4	Category
0	0	Dial data: 0-9, *, #
0	1	F, P, RD, F32, two-key combinations, three-key combinations
1	0	User-defined keys
1	1	

• $\overline{\text{OFFHOOK}}$ (D6)

This bit tracks the $\overline{\text{OFFHOOK}}$ input pin state after the elimination of chatter.

$\overline{\text{OFFHOOK}}$ input pin state	$\overline{\text{OFFHOOK}}$ bit	$\overline{\text{DATA}}$ (negative logic) pin output (D6)
HIGH (on hook)	"H"	"L"
LOW (off hook)	"L"	"H"

The chattering interval for this pin is approximately 55 ms.

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• **KEYON (D7)**

This bit tracks the key state (pressed/released = HIGH/LOW) for valid key events (including simultaneous pressing) after the elimination of chattering. The chattering interval is approximately 30 ms.

	KEYON	$\overline{\text{DATA}}$ (negative logic) pin output (D7)
Key pressed	"H"	"L"
Key released	"L"	"H"

• **DPR (D8)**

This bit tracks the DPR input pin state.

DPR input pin state	DPR	$\overline{\text{DATA}}$ (negative logic) pin output (D8)
"L" (10PPS)	"L"	"H"
"H" (20PPS)	"H"	"L"

• **P/T pin (D9)**

This bit tracks the P/T input pin state after the elimination of chattering.

P/T input pin state	P/T PIN	$\overline{\text{DATA}}$ (negative logic) pin output
"L" (tone)	"L"	"H"
"H" (pulse)	"H"	"L"

• **BMR (D10)**

This bit tracks the BMR input pin state.

BMR input pin state	BMR	$\overline{\text{DATA}}$ (negative logic) pin output (D10)
"L" (39%)	"L"	"H"
"H" (33%)	"H"	"L"

• **F-SEL or $\overline{\text{OUT}}$ (D11)**

This bit tracks the state of the F-SEL input pin or $\overline{\text{OUT}}$ output pin.

State of F-SEL input pin or $\overline{\text{OUT}}$ output pin	F-SEL or $\overline{\text{OUT}}$	$\overline{\text{DATA}}$ (negative logic) pin output (D11)
"L" (700ms) or $\overline{\text{OUT}} = \text{"L"}$	"L"	"H"
"H" (280ms) or $\overline{\text{OUT}} = \text{"H"}$	"H"	"L"

• **HOOKCTL (D12)**

This bit tracks the HKCTL output pin state.

HOOKCTL output pin state	HOOKCTL	$\overline{\text{DATA}}$ (negative logic) pin output (D12)
"L" (off hook)	"L"	"H"
"H" (on hook)	"H"	"L"

• **BUSYOUT (D13)**

This bit indicates whether the dialer is in the process of dialling. (The process includes flash operations hooking pauses.)

	BUSYOUT	$\overline{\text{DATA}}$ (negative logic) pin output (D13)
Dialling	"H"	"L"
Not dialling	"L"	"H"

• P/T OUT (D14)

This bit indicates whether the dialer output represents pulse or tone dialling.

	P/T OUT	DATA (negative logic) pin output (D14)
Pulse dial output	"H"	"L"
Tone dial output	"L"	"H"

This bit indicates whether the most recent output was pulse or tone dialling.

• P/T IN (D15)

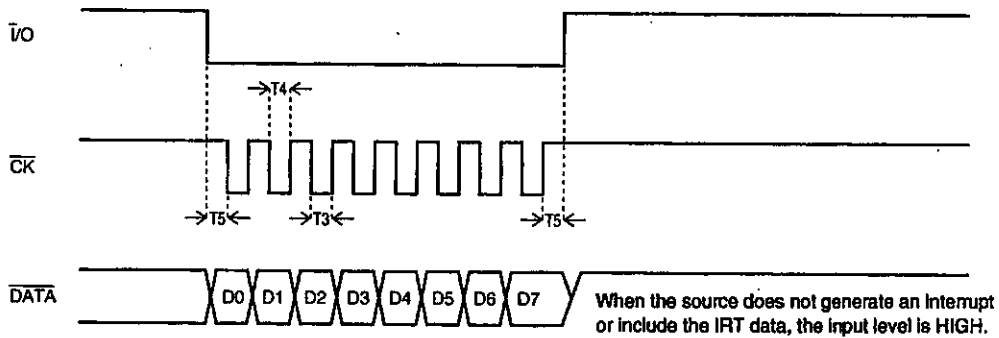
This bit indicates whether the dialer input represents pulse or tone dialling.

	P/T IN	DATA (negative logic) pin output (D15)
Pulse dial input	"H"	"L"
Tone dial input	"L"	"H"

For example, if the dialer is in pulse mode (P/T IN = HIGH), a mode change command changes it to tone mode (P/T IN = LOW).

2. Dialer 8-bit serial data input

The following is the data format for the dialer's 8-bit serial input.



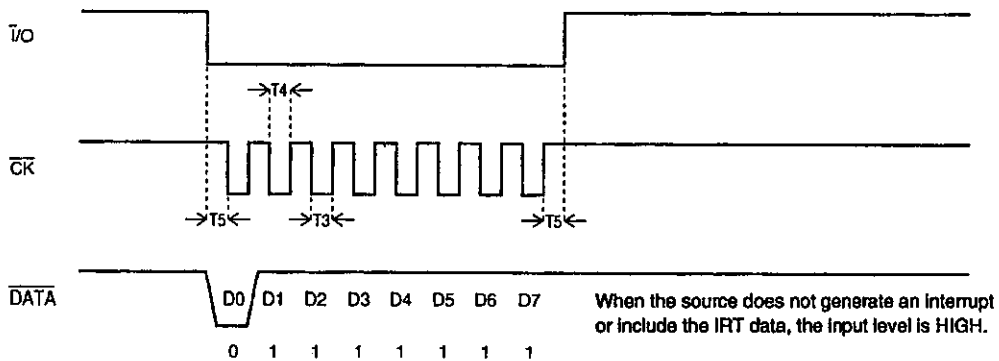
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For example, if the dial data input is for key 1, the bit stream becomes the following when transferred LSB first.

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	0	0	0	0	1	YES	KEY 1

D0 D1 D2 D3 D4 D5 D6 D7
 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓
 1 0 0 0 0 0 0 0
 Setting D7 to HIGH produces key tone output. Here, D7 is LOW.

Since DATA uses negative logic, the pin outputs reverse the bits, producing the following.



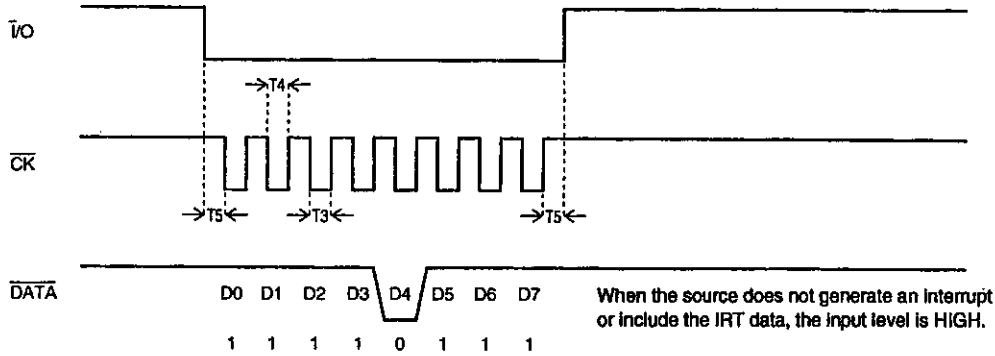
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• $\overline{\text{OUT-ST}}$ command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	0	0	0	NO	$\overline{\text{OUT-ST}}$ ($\overline{\text{OUT}}$ pin control)
10 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

* This command sets the $\overline{\text{OUT}}$ pin output (N-channel open drain output) to LOW. Since $\overline{\text{DATA}}$ uses negative logic, the pin outputs reverse the bits, producing the following.



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• $\overline{\text{OUT-END}}$ command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	0	0	1	NO	$\overline{\text{OUT-END}}$ ($\overline{\text{OUT}}$ pin control)
11 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

• This command sets the $\overline{\text{OUT}}$ pin output to high impedance.

• PAUSE release command

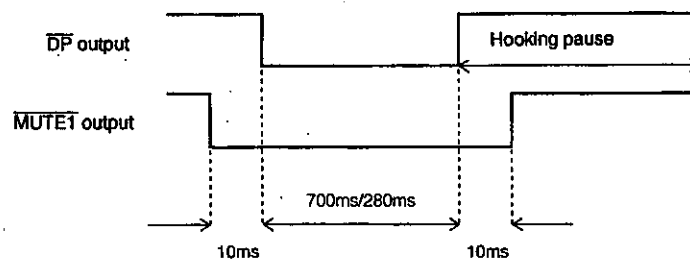
D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	0	1	0	NO	PAUSE release (valid only during a pause)
12 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

• This command terminates a pause during dialling. If the dialer is not in the middle of a pause, this command is ignored.

• Flash command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	0	1	1	NO	FLASH
13 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command produces a flash operation and inserts a hooking pause.
- After the hooking pause, the dialer generates an interrupt.
- Flash commands cannot be overlapped. Any flash commands during the execution of a flash command are ignored.
- The $\overline{\text{DP}}$ output is LOW for 700 or 280 ms. The $\overline{\text{MUTE1}}$ output takes the following form.

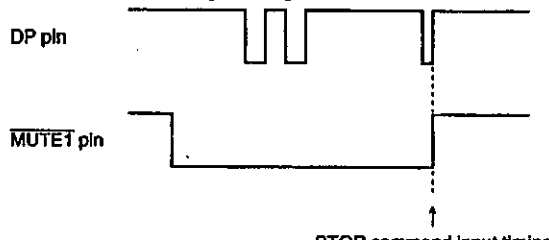


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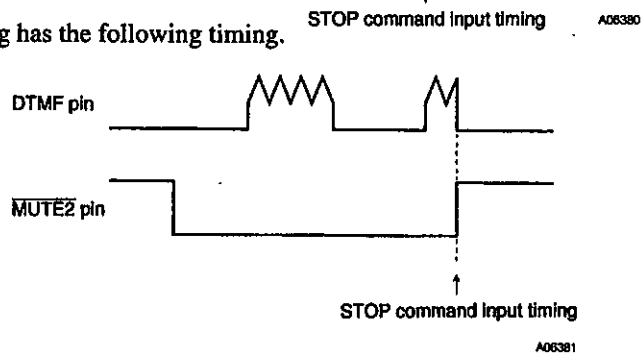
• Stop command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	1	0	0	NO	FLASH
14 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command forces dialling to terminate.
- It also terminates a hooking pause.
- The dialer does not generate a dialling complete interrupt.
- A stop command during pulse dialling has the following timing.



- A stop command during tone dialling has the following timing.



• RD command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	1	0	1	NO	RD (Redial)
15 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command produces a redial using the contents of the dialer's RAM buffer. This redial is subject to the following conditions.
- Any dial data following a command seizing the circuit (i.e., the OFF-HOOK, \overline{DP} -END, or FLASH command) is ignored.
- If the preceding dial string contained more than 32 digits, it is ignored.

• $\overline{MUTE1}$ -ST command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	1	1	0	NO	$\overline{MUTE1}$ -ST ($\overline{MUTE1}$ pin control)
16 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command changes the $\overline{MUTE1}$ output (N-channel open drain output) to LOW.
- The output level remains LOW after a dial pulse.
- Normally, the level remains LOW until there is a $\overline{MUTE1}$ -END command.
- When the power is first applied, when the \overline{RES} input is LOW, or when the \overline{SNG} input is LOW, $\overline{MUTE1}$ is reset, and the level returns to high impedance.

• **MUTE1-END** command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	1	1	1	NO	MUTE1-END (MUTE1 pin control)
17 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command changes the $\overline{\text{MUTE1}}$ output (N-channel open-drain output) to high impedance.
- During dial pulse output, the $\overline{\text{MUTE1}}$ pin is LOW in synchronization with the dial output.

• **$\overline{\text{DP}}$ -ST** command

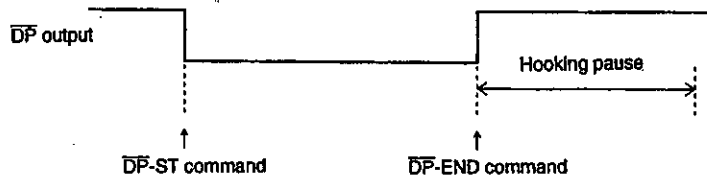
D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	0	0	0	NO	$\overline{\text{DP}}$ -ST (Stops dialling and breaks the circuit)
18 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command changes the $\overline{\text{DP}}$ output (N-channel open-drain output) to LOW.
- This command takes precedence over dialling output, forcing the latter to terminate. The dialer does not generate a dialling complete interrupt.

• **$\overline{\text{DP}}$ -END** command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	0	0	1	NO	$\overline{\text{DP}}$ -END (Changes $\overline{\text{DP}}$ output to high impedance)
19 (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command changes the $\overline{\text{DP}}$ output (N-channel open-drain output) to high impedance.
- It also inserts a hooking pause.
- The following chart shows the timing.



• **DTMF-OFF** command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	0	1	0	NO	DTMF-OFF (Disable continuous DTMF transmission of last digit)
1A (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command turns off DTMF output.
- This command is only available in the tone mode during the last digit of DTMF output. Otherwise, it is ignored.
- In the absence of this command, the dialer produces continuous DTMF transmission of the last digit.
- After this command, the dialer generates a dialling complete interrupt.

• **MODE-CH** command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	0	1	1	YES	MODE-CH (Mode change--from pulse to tone only)
1B (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command switches from pulse dialling to tone dialling.
- This command is stored as one byte in the memory buffer.
- This command is stored in the memory buffer even if there is a preceding MODE-CH command.

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• **OSC-ST command**

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	1	0	0	NO	OSC-START
1C (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command produces continuous output from the 3.58-MHz oscillator circuit.
- This command makes it possible to share the 3.58-MHz oscillator.
- When SNG input is LOW (i.e., during a power outage), when RES input is LOW, or there is an ON-HOOK command, the continuous oscillation stops.
- The dialer normally activates the oscillator only during operation and stops it at other times.

• **PAUSE command**

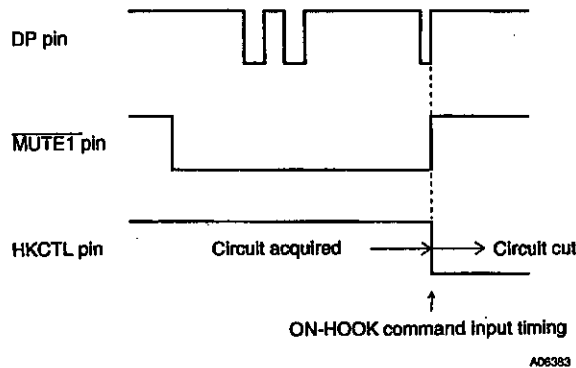
D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	1	0	1	YES	PAUSE
1D (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command produces a 2- or 4-second pause in the output.
- The dialer generates an interrupt after a pause that is the last byte in the memory buffer.

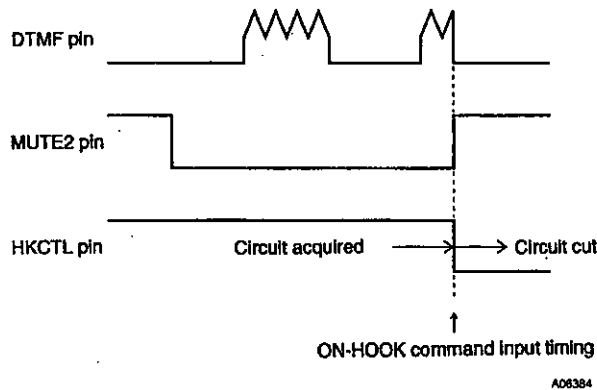
• **ON-HOOK command**

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	1	1	0	NO	ON-HOOK (Sets HKCTL pin to high-impedance state)
1E (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command sets the HKCTL pin output (P-channel open-drain output) to its high-impedance state, breaking the circuit connection.
- Issuing this command forcibly terminates dialling. The dialer does not generate a dialling complete interrupt.
- The following gives the timing for an ON-HOOK command during pulse dialling.



- The following gives the timing for an ON-HOOK command during tone dialling.

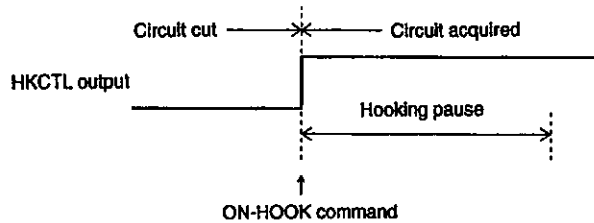


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• OFF-HOOK command

D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	1	1	1	1	NO	OFF-HOOK (Sets HKCTL pin to HIGH)
1F (HEX)								Setting D7 to HIGH produces key tone output. Here, D7 is LOW.	

- This command sets the HKCTL pin output (P-channel open-drain output) to HIGH, making the circuit connection.
- The dialer automatically inserts a hooking pause.
- The dialer generates an interrupt after the hooking pause.
- It is possible to overlap OFF-HOOK commands. Issuing an OFF-HOOK command during the hooking pause for a preceding OFF-HOOK command restarts the hooking pause.



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3. Port states after a reset

The power on sequence must always send a reset pulse to the $\overline{\text{RES}}$ pin. This reset signal initializes the dialer to the following states.

OFFHOOK Input	HKCTL output	DP output	MUTE1 output	DTMF output	MUTE2 output	OUT output
"L"	"H"	"Z"	"Z"	"Z"	"Z"	"Z"
"H"	"Z"	"Z"	"Z"	"Z"	"Z"	"Z"

Z: High-impedance state

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