CMOS LSI

No. 5556

SANYO

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 (fosc = 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
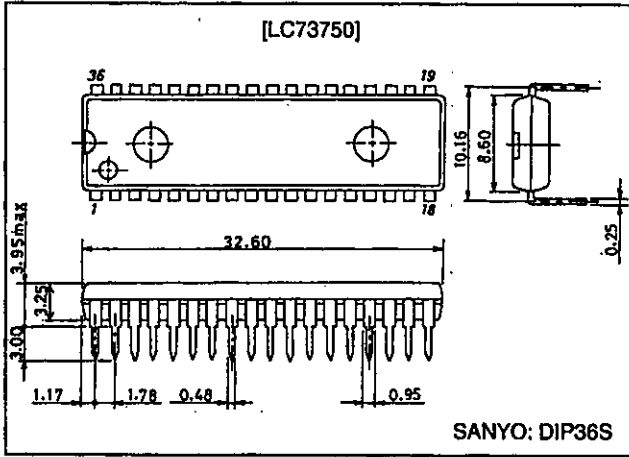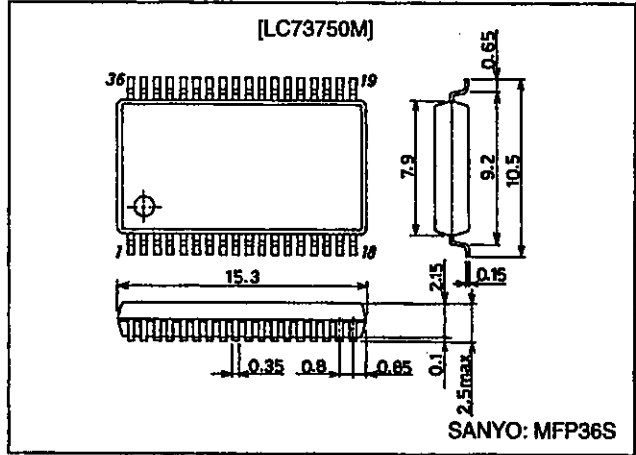- Package
  — DIP36S
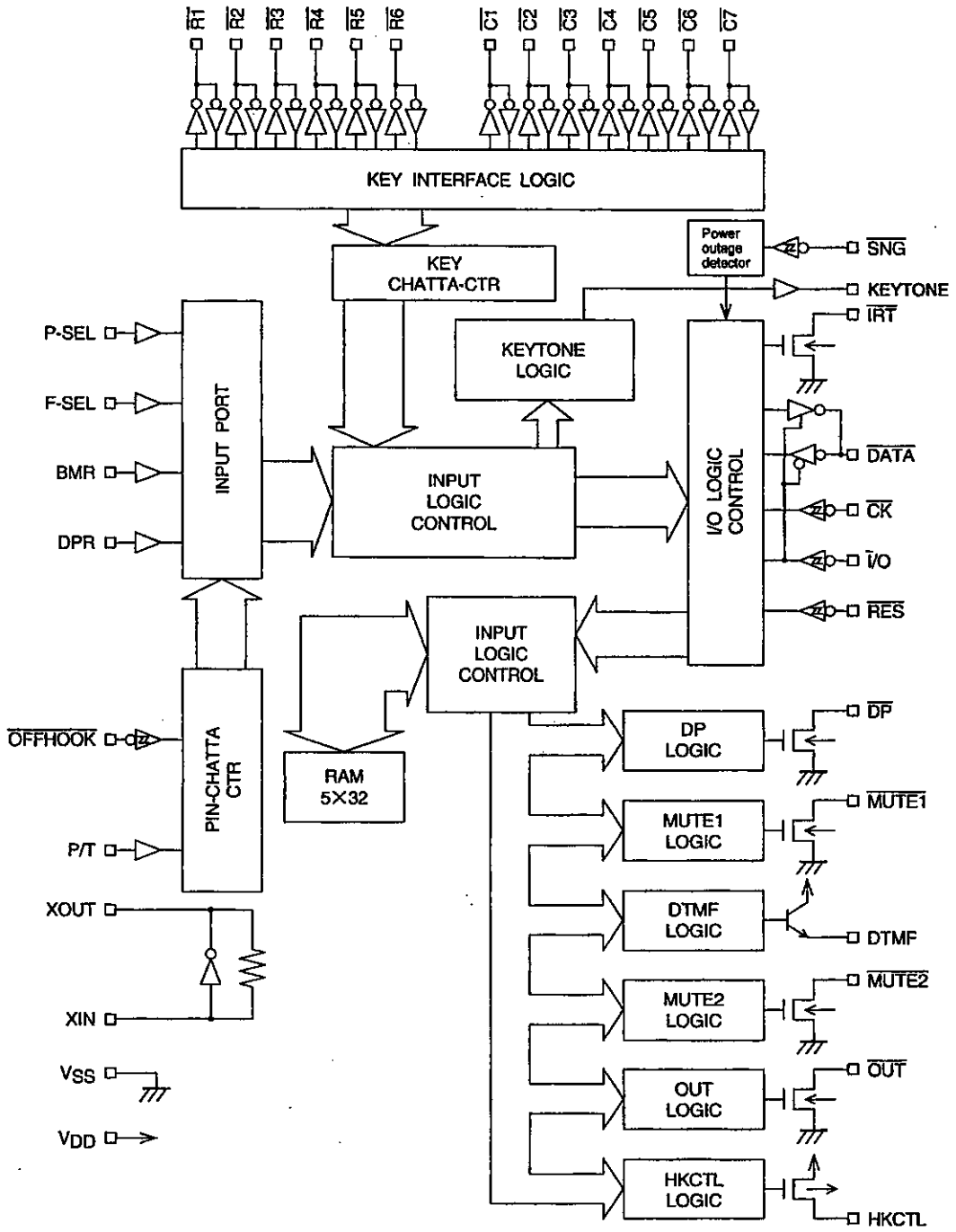 — MFP36S

Package Dimensions

unit:mm

3170-DIP36S

[LC73750]

SANYO: DIP36S

unit:mm

3204-MFP36S

[LC73750M]

SANYO: MFP36S

Block Diagram

A06360

Pin Descriptions

Pin No.	Symbol	I/O	Functions
1 to 6	R̄1 to R̄6	I	Row input pins
7	I/O	I	I/O direction control pin: LOW for input and HIGH for output. Schmitt input.
8	CK	I	Data input clock. Schmitt input.
9	DATA	I/O	Data input/output with direction controlled by I/O pin. During output, the IRT pin can also produce output, permitting combined use of the DATA and IRT pins.
10	IRT	O	This pin goes LOW when the HOOK pin changes, the 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	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	OFFHOOK	I	Hook switch input. HIGH indicates on hook; LOW, off hook. Schmitt input.
13	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	DTMF	O	DTMF output. NPN emitter follower output.
21	MUTE2	O	DTMF mute output. N-channel open drain output.
22	MUTE1	O	DP mute output. N-channel open drain output.
23	DP	O	DP output. N-channel open drain output.
24	HKCTL	O	Hook control output pin. During stand-alone operation, this produces the same output as the OFFHOOK pin. P-channel open-drain output.
25	OUT	O	Port controlled by serial data. Using this as a speaker mute signal permits hands free operation. N-channel open drain output.
26	KEYTONE	O	Output pin for key tone during valid key presses. This produces a 1.7-kHz tone for 32 ms. Complementary output.
27	DPR	I	Dial pulse rate selection pin: 20 pps (HIGH) or 10 pps (LOW).
28	P/T	I	Pulse/tone selection pin: pulse (HIGH) or tone (LOW).
29	BMR	I	Make/break ratio selection pin: 33%/67% (HIGH) or 39%/61% (LOW).
30 to 36	C1 to 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 Ta = 25, fosc = 3.579545MHz

Parameter	Symbol	Conditions	Ratings	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	Pd max	Ta ≤ 70°C	250	mW
Minimum load resistance	RL min	DTMF − V_{SS} pin	1	kΩ
Operating temperature	Topr		−30 to +70	°C
Storage temperature	Tstg		−40 to +125	°C

Permissible Operating Ranges at Ta = 25, fosc = 3.579545MHz

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	KΩ
Keyboard capacitance	C_{KI}				330	pF
Oscillator pin standard	f	Neutral frequency = 3.579545 MHz	−1.3		+1.3	%
	Rs				100	Ω

Electrical Characteristics at Ta = 25, fosc = 3.579545MHz

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

AC Characteristics at Ta = 25, fosc = 3.579545MHz

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 V, RL = 10 KΩ	165	200	240	mVrms
Tone output ratio	dBCR	V_{DD} = 2.0 to 5.5 V, RL = 10 KΩ	1	2	3	dB
Tone output distortion	%DIS	V_{DD} = 2.0 to 5.5 V, RL = 10 KΩ			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

When including IRT data with the $\overline{DATA}$ pin output, pull I/O LOW a second time after 16 clock cycles.

* The dialer shifts the $\overline{DATA}$ output at the falling edge of $\overline{CK}$.

| DATA | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 | IRT data |

| KEY Q0 | KEY Q1 | KEY Q2 | KEY Q3 | KEY Q4 | KEY Q5 | OFF HOOK | KEY ON | DPR | P/T PIN | BMR | F SEL | HOOK CTL | BUSY OUT | P/T OUT | P/T IN |

6-bit key code

or

$\overline{OUT}$ Select with mode setting command.

T1, T2, T3, T4, T5, T6: min. 1μs

A06361

8-Bit Input Format

The dialer reads the $\overline{DATA}$ output at the falling edge of $\overline{CK}$.

| DATA | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 |

When the source does not generate an interrupt the output level is HIGH.

| DATA | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 |

When the source generates an interrupt the output level is LOW.
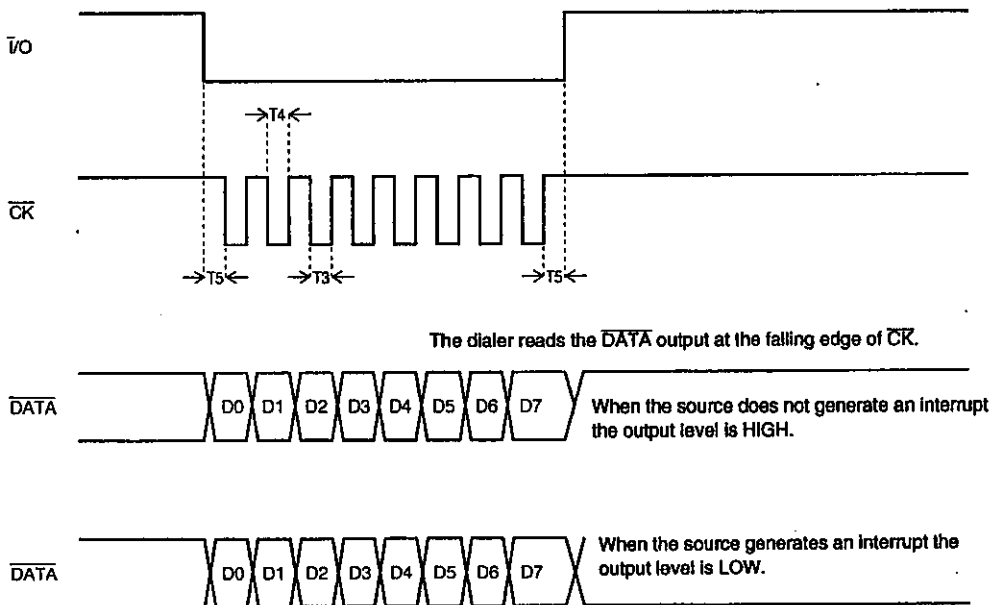
A06362

Dial Output Timing
Pulse mode

Input key

MUTE1

DP
(10pps)

33 or 39 ms

Approximately 840 ms
(Approximately 570 ms for 20-pps)

Approximately 840 ms

100 ms
(50 ms for 20-pps)

A06363

DTMF mode

Input key

MUTE2

DTMF

10ms 101ms 101ms 101ms 101ms

A06364

Flash operation

Input key

MUTE1

DP

20ms   700ms or 280ms   20ms
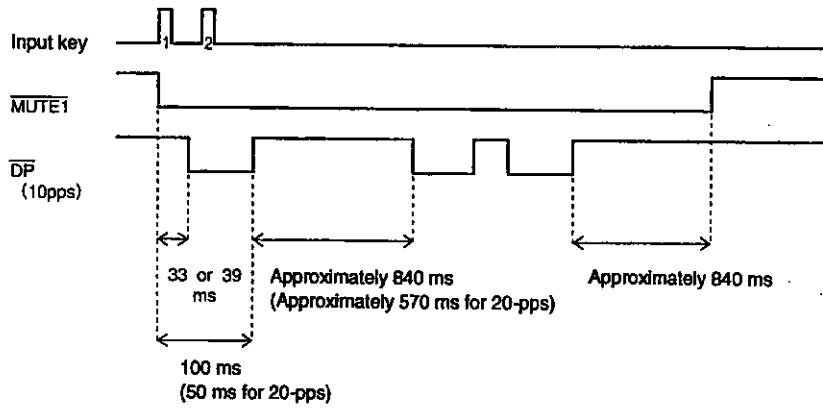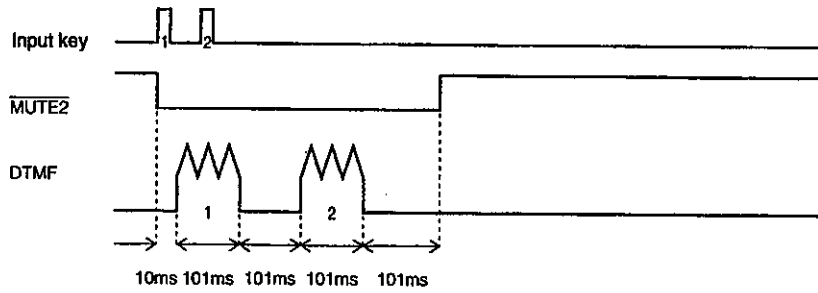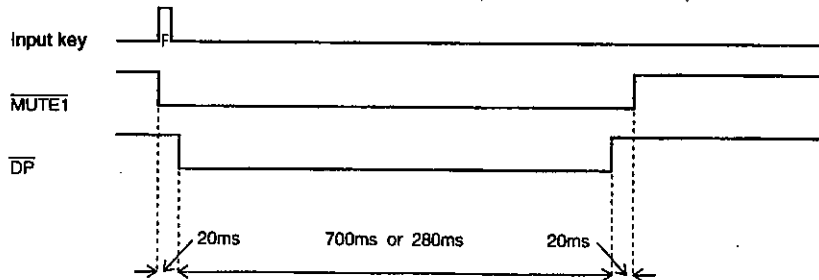
A06365

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 ($\overline{\text{OUT}}$ pin control)
X	0	0	1	0	0	0	1	NO	OUT-END ($\overline{\text{OUT}}$ 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 ($\overline{\text{MUTE1}}$ pin control)
X	0	0	1	0	1	1	1	NO	MUTE1-END ($\overline{\text{MUTE1}}$ 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)
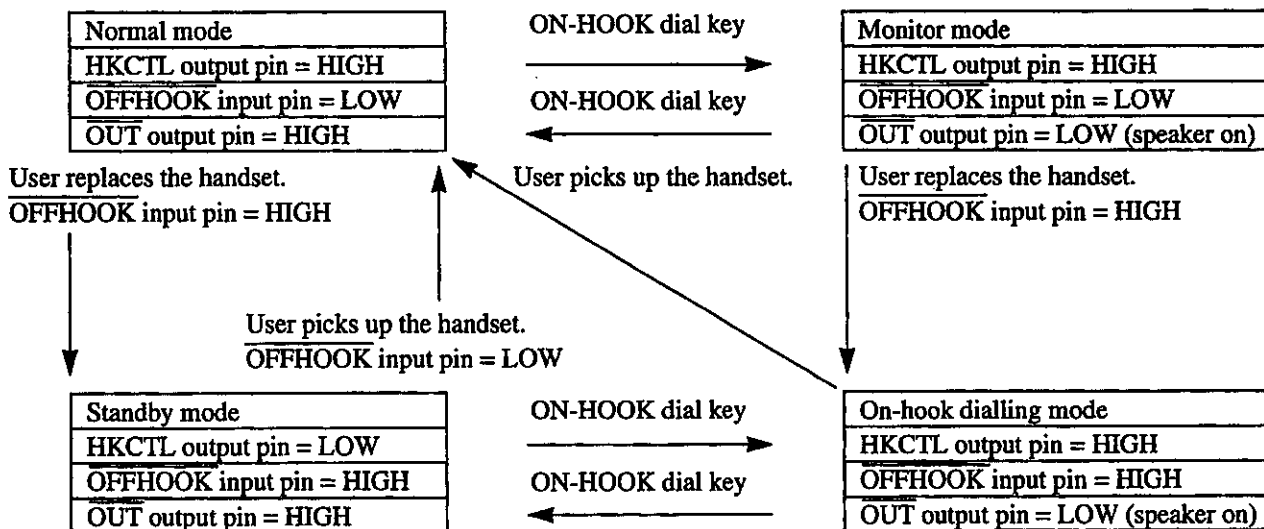
* BMR = "1" (33%) → KEY-SL = "1" (JPN)

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 ($\overline{\text{SNG}}$ = 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 $\overline{\text{OUT}}$ output pin and HKCTL output pin active states when the power fails--that is, when $\overline{\text{SNG}}$ 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 $\overline{\text{OUT}}$ and HKCTL pins. The $\overline{\text{OUT}}$ output pin is used for speaker mute control. See the state transition diagram below.

Normal mode	ON-HOOK dial key	Monitor mode
HKCTL output pin = HIGH	────────▶	HKCTL output pin = HIGH
$\overline{\text{OFFHOOK}}$ input pin = LOW	ON-HOOK dial key	$\overline{\text{OFFHOOK}}$ input pin = LOW
$\overline{\text{OUT}}$ output pin = HIGH	◀────────	$\overline{\text{OUT}}$ output pin = LOW (speaker on)

User replaces the handset. User picks up the handset. User replaces the handset.
$\overline{\text{OFFHOOK}}$ input pin = HIGH $\overline{\text{OFFHOOK}}$ input pin = HIGH

User picks up the handset.
$\overline{\text{OFFHOOK}}$ input pin = LOW

Standby mode	ON-HOOK dial key	On-hook dialling mode
HKCTL output pin = LOW	────────▶	HKCTL output pin = HIGH
$\overline{\text{OFFHOOK}}$ input pin = HIGH	ON-HOOK dial key	$\overline{\text{OFFHOOK}}$ input pin = HIGH
$\overline{\text{OUT}}$ output pin = HIGH	◀────────	$\overline{\text{OUT}}$ output pin = LOW (speaker on)

Note: When D3 = "1" (retain), $\overline{\text{MUTE1}}$ and $\overline{\text{OUT}}$ 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.

Key Code Table

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

Pin Assignment

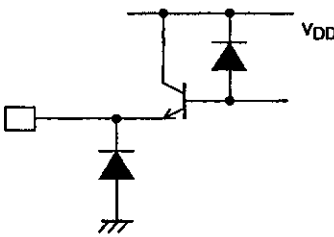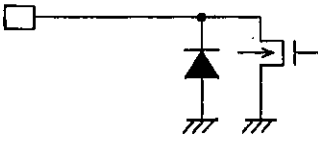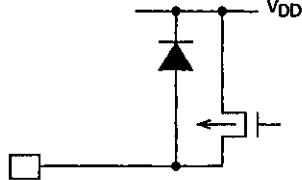|		
R̄1̄	1	36	C̄1̄
R̄2̄	2	35	C̄2̄
R̄3̄	3	34	C̄3̄
R̄4̄	4	33	C̄4̄
R̄5̄	5	32	C̄5̄
R̄6̄	6	31	C̄6̄
Ī/O	7	30	C̄7̄
C̄K̄	8	29	BMR
D̄ĀTĀ	9	28	P/T
ĪR̄T̄	10	27	DPR
R̄ĒS̄	11	26	KEYTONE
ŌF̄F̄H̄ŌŌK̄	12	25	ŌŪT̄
S̄N̄Ḡ	13	24	HKCTL
F-SEL	14	23	D̄P̄
P-SEL	15	22	M̄ŪT̄Ē1̄
XIN	16	21	M̄ŪT̄Ē2̄
XOUT	17	20	DTMF
VDD	18	19	VSS
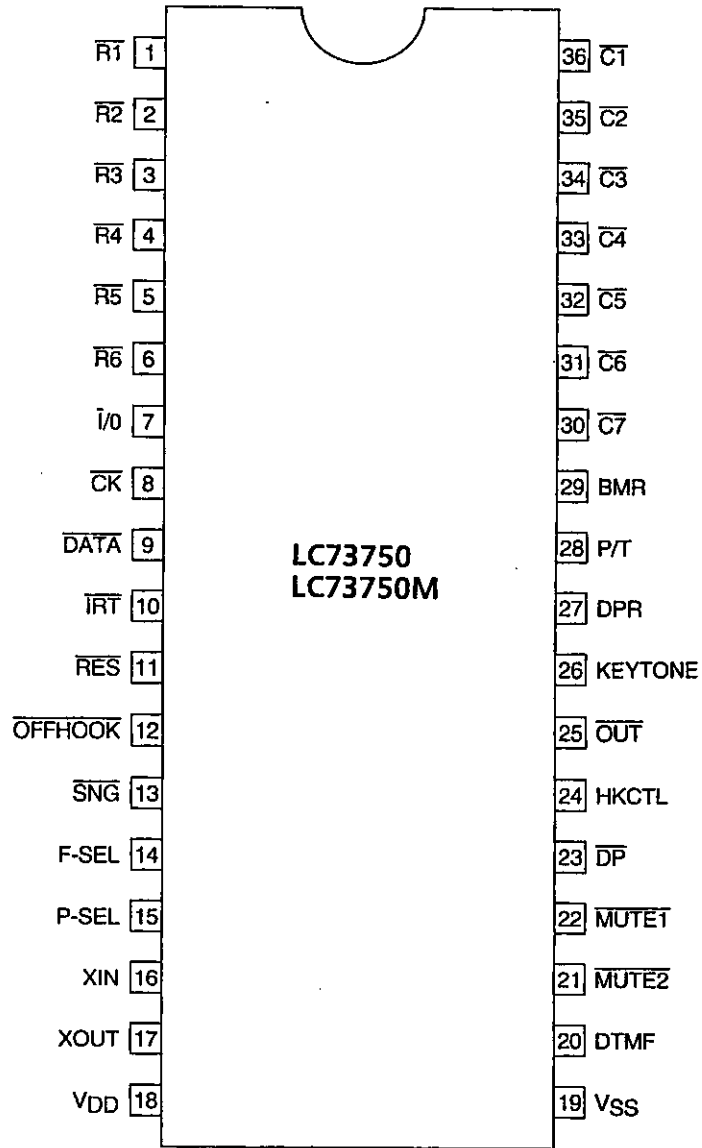
LC73750
LC73750M

Top view
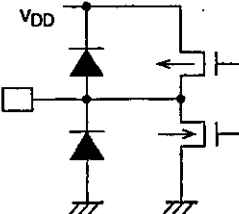
A06366

Pin Function

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

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

1. Dialer's 16-bit serial output

The following timing chart shows the dialer's 16-bit serial output.
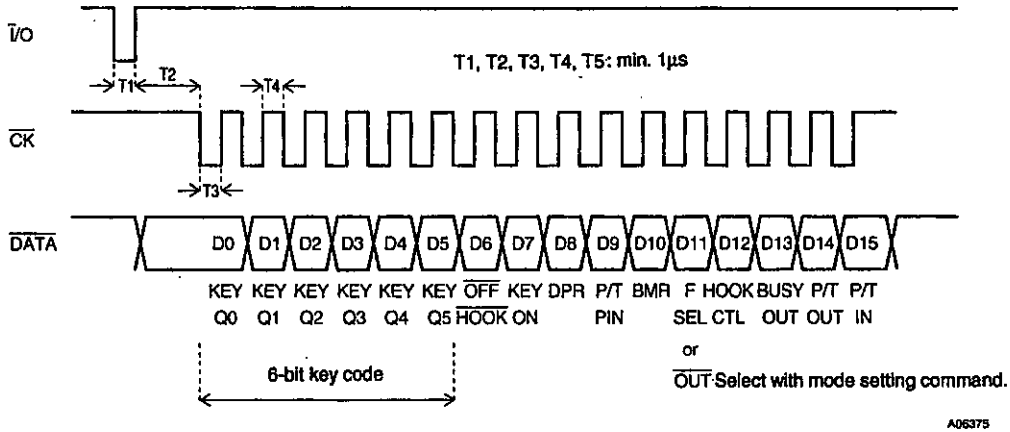
- 6-bit key code (D0 to D5)

  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.

KEY Q0	KEY Q1	KEY Q2	KEY Q3	KEY Q4	KEY Q5
↓	↓	↓	↓	↓	↓
1	0	0	0	0	0
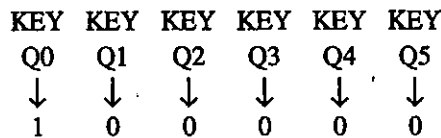
Note, however, that since DATA uses negative logic, the pin outputs reverse the bits. The key 1 key code, therefore, becomes the following.

KEY Q0	KEY Q1	KEY Q2	KEY Q3	KEY Q4	KEY Q5
↓	↓	↓	↓	↓	↓
0	1	1	1	1	1
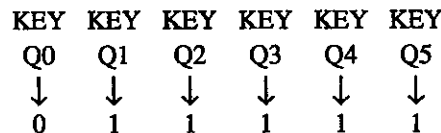
KEY Q5 and KEY Q6, the uppermost two bits of the key code, divide the key codes into the following categories.

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	

- OFFHOOK (D6)

  This bit tracks the OFFHOOK input pin state after the elimination of chatter.

OFFHOOK input pin state	OFFHOOK bit	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.

- 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	$\overline{DATA}$ (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	$\overline{DATA}$ (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	$\overline{DATA}$ (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	$\overline{DATA}$ (negative logic) pin output (D10)
"L" (39%)	"L"	"H"
"H" (33%)	"H"	"L"

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

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

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

- HOOKCTL (D12)

   This bit tracks the HKCTL output pin state.

HKCTL output pin state	HOOKCTL	$\overline{DATA}$ (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	$\overline{DATA}$ (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	D̄A̅T̄A̅ (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.
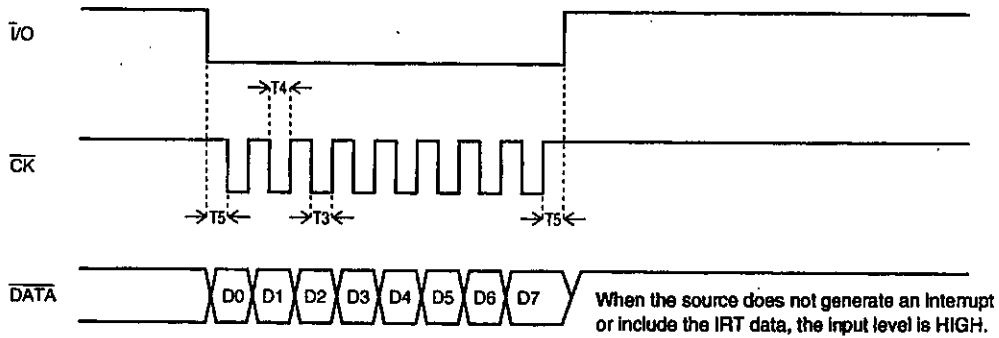
- P/T IN (D15)

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

	P/T IN	D̄A̅T̄A̅ (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.

When the source does not generate an interrupt or include the IRT data, the input level is HIGH. A06376

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    Setting D7 to HIGH produces key tone output.
↓   ↓   ↓   ↓   ↓   ↓   ↓   ↓     Here, D7 is LOW.
1   0   0   0   0   0   0   0
```

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

When the source does not generate an interrupt or include the IRT data, the input level is HIGH.

```
0   1   1   1   1   1   1   1
```
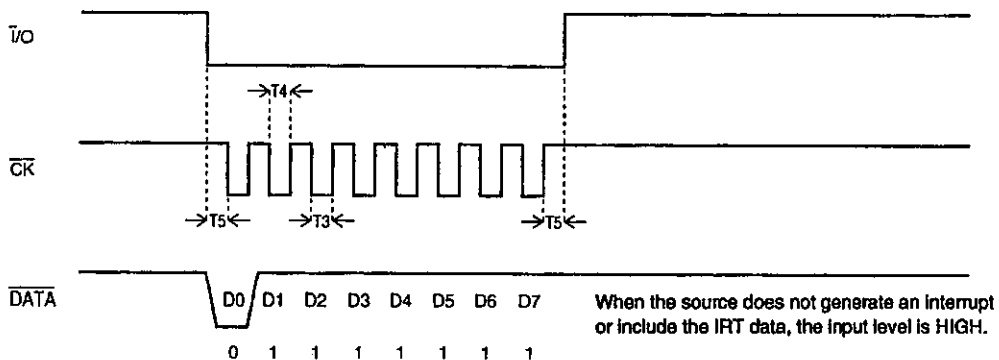
A06377

• $\overline{\text{OUT}}$-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	OUT-ST (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.

• $\overline{\text{OUT}}$-ST command
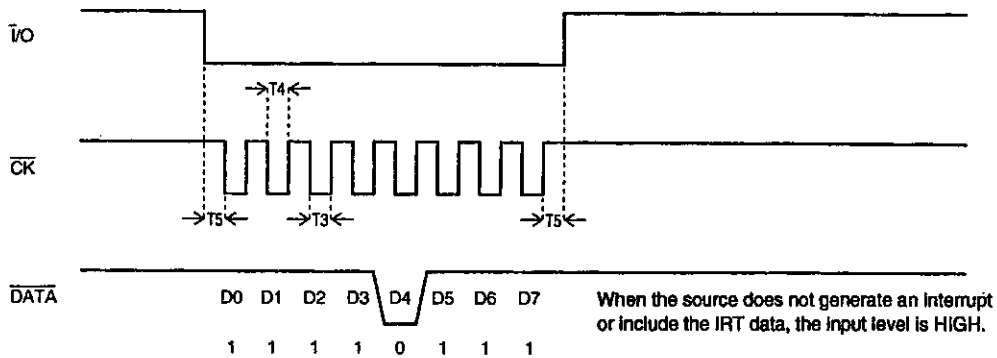
D7	D6	D5	D4	D3	D2	D1	D0	Written to RAM	Data meaning and comment
X	0	0	1	0	0	0	1	NO	OUT-END (OUT pin control)

| 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.
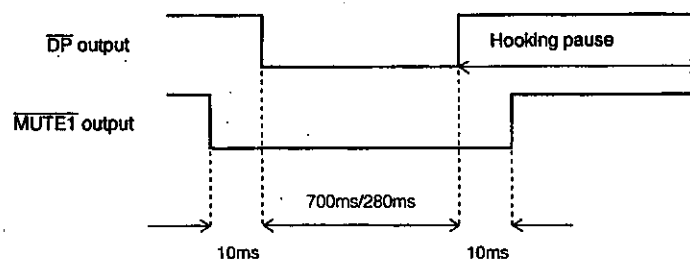
• PAUSE release command

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.

• 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.

DP pin

MUTE1 pin
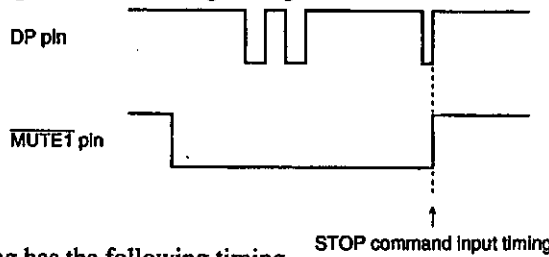
↑
STOP command input timing   A06380

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

DTMF pin

MUTE2 pin

↑
STOP command input timing
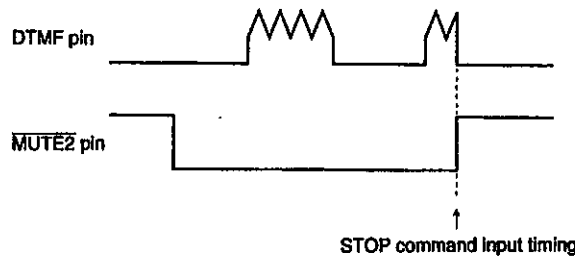
A06381

• 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.

- $\overline{\text{MUTE1}}$-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	$\overline{\text{MUTE1}}$-END ($\overline{\text{MUTE1}}$ 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.

A06382
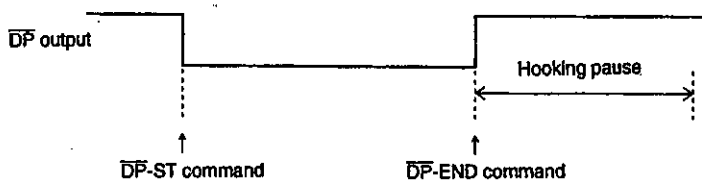
- DTMF-OFF command

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.

- 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 $\overline{SNG}$ input is LOW (i.e., during a power outage), when $\overline{RES}$ 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	D8	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.
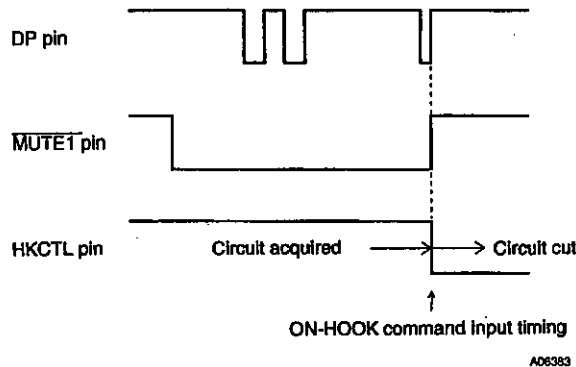
DP pin

$\overline{MUTE1}$ pin

HKCTL pin   Circuit acquired ——→ ——→ Circuit cut

↑
ON-HOOK command input timing

A06383

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

DTMF pin

MUTE2 pin

HKCTL pin   Circuit acquired ——→ ——→ Circuit cut

↑
ON-HOOK command input timing

A06384
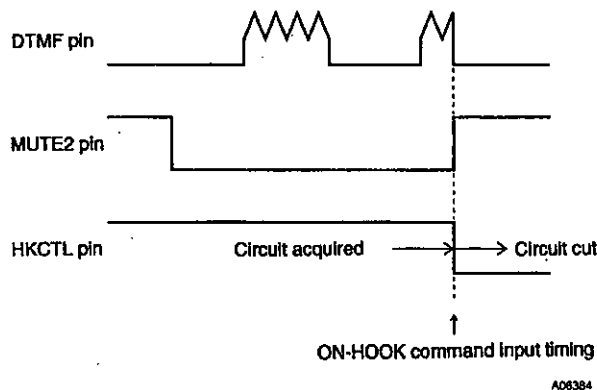
• OFF-HOOK command

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.
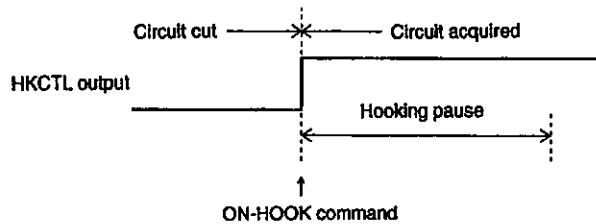
3. Port states after a reset

The power on sequence must always send a reset pulse to the $\overline{RES}$ 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