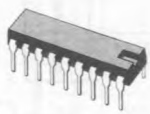
SGS-THOMSON MICROELECTRONICS

MK5370

SINGLE NUMBER PULSE TONE SWITCHABLE DIALER

- STAND-ALONE DTMF AND PULSE SIGNALING
- RECALL OF LAST NUMBER DIALED (up to 28 digits long)
- FORM-A AND 2-of -7 KEYBOARD INTERFACE
- PACIFIER TONE
- POWERED FROM TELEPHONE LINE, LOW OPERATING VOLTAGE FOR LONG LOOP APPLICATIONS



DIP18

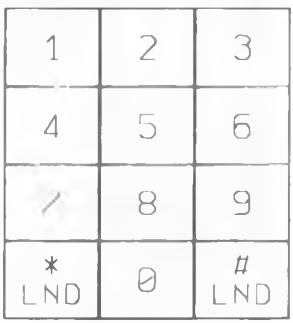
ORDER CODE : MK5370N00

DESCRIPTION

The MK5370 is a Silicon Gate CMOS IC that provides necessary signals for either DTMF or loop disconnect (pulse) dialing. The MK5370 buffers up to 28 digits into memory that can be later redialed with a single key input. This memory capacity is sufficient for local, long distance, overseas, and even computerized long-haul networks. Users can store all 12 signaling keys and redial them using either the *or # as the first key entry after going off-hook.

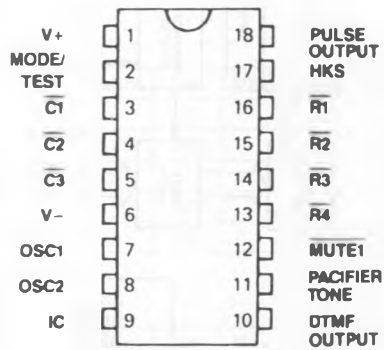
A *or # key input automatically redials the last number dialed if it is the first key entered after a transition from on-hook to off-hook (HKS input switched from a high to low logic level). Auto-dialing is momentarily interrupted (during interdigital pause period or intersignal period) while manual keys are depressed, however these inputs are not stored into memory.

KEYPAD CONFIGURATION



M88MK5370-01

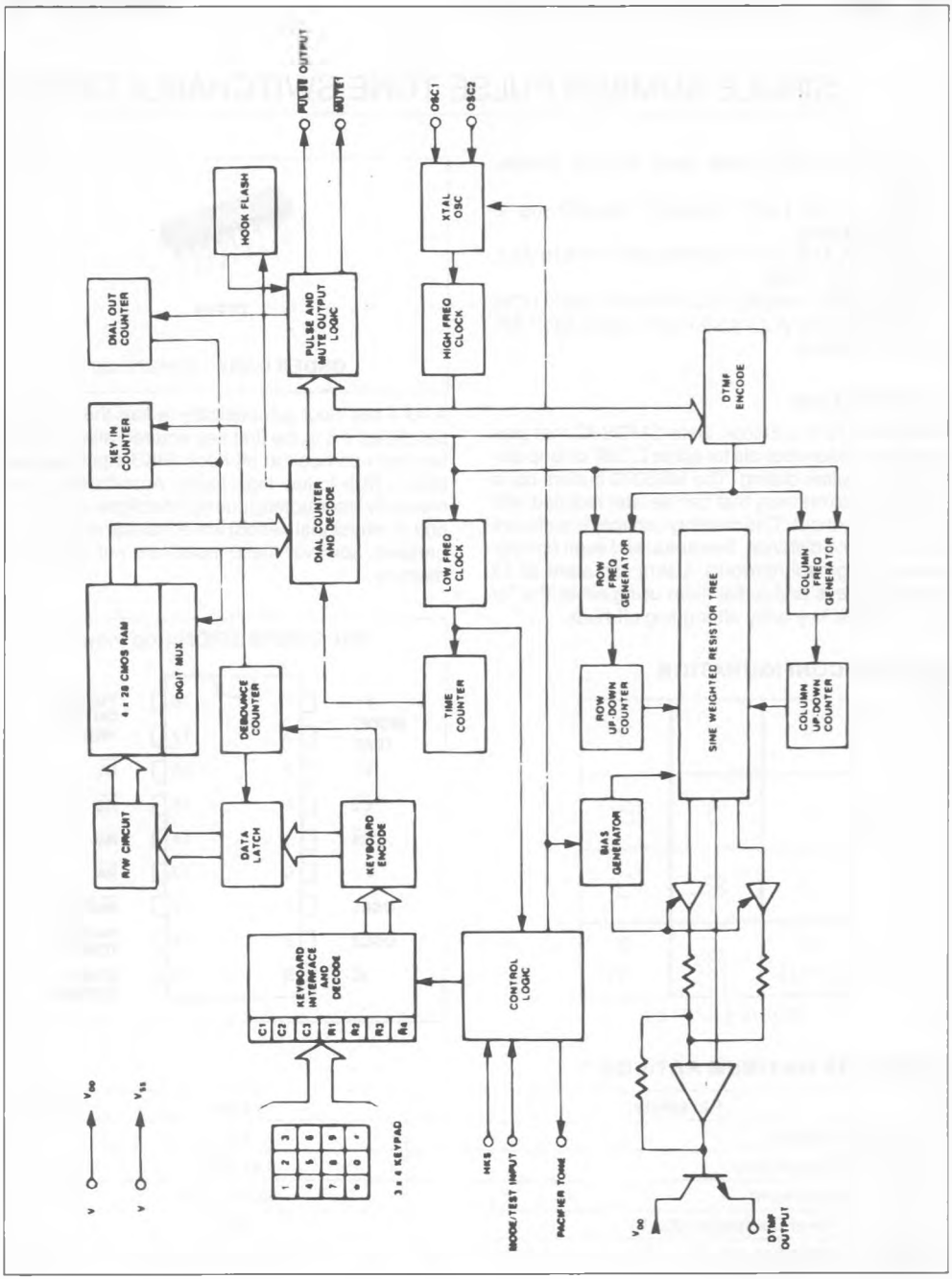
PIN CONNECTION (top view)



ABSOLUTE MAXIMUM RATINGS *

Parameter	Value	Unit
DC Supply Voltage	6.5	V
Operating Temperature	0 to + 60	°C
Storage Temperature	– 55 to + 125	°C
Maximum Power Dissipation (25 °C)	500	mW
Maximum Voltage on any Pin	(V+) + 0.3, (V–) – 0.3	V

BLOCK DIAGRAM



ELECTRICAL OPERATING CHARACTERISTICS

* All specifications are for 2.5 Volt operation and full operating temperature range unless otherwwise stated.

DC CHARACTERISTICS

N°	Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
	V+	DC Operating Voltage (all functions)	2.5		6.0	V	
	V_{MR}	Memory Retention Voltage	1.5			V	1, 6
	I_S	Standby Current		0.2	1.0	µA	1
	I_{MR}	Memory Retention Current		0.1	0.75	µA	5, 6
	V_{MUTE}	Mute Output Operating Voltage	1.8			V	7
	I_T	Operating Current (tone)		300	600	µA	2
	I_P	Operating Current (pulse)		225	350	µA	2
	I_{ML}	Mute Output Sink Current (V+ = 2.5 V)	1.0	2.0		mA	3
	I_{PL}	Pulse Output Sink Current	1.0	2.0		mA	3
	I_{PC}	Pacifier Tone Sink/Source	250	500		µA	4
	K_{RU}	Keypad Pull-up Resistance		100		kΩ	
	K_{RD}	Keypad Pull-down Resistance		750		Ω	
	V_{IL}	Keypad Input Level-low	0		0.3 V+	V	
	V_{IH}	Keypad Input Level-High	0.7 V+		V+	V	

Notes : 1. All inputs unloaded Quiescent Mode (oscillator off).
2. All outputs unloaded single key input.
3. V_{OUT} = 0.4 Volts
4. Sink Current for V_{OUT} = 0.5 volts. Source Current for V_{OUT} = 20 Volts.
5. Memory Retention Voltage is the point where memory is guaranteed but circuit operation is not.
6. Proper memory retention is guaranteed if either the minimum I_{MR} is provided or the minimum V_{MR}. The design does not have to provide both the minimum current or voltage simultaneously.
7. Minimum supply voltage where activation of mute output with key entry is ensured.

AC CHARACTERISTICS – KEYDAP INPUTS, PACIFIER TONE

N°	Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
3	T_{KD}	Keypad Debounce Time		32		ms	1
–	F_{KS}	Keypad Scan Frequency		250		Hz	1
–	T_{RL}	Two Key Rollover Time		4		ms	1
–	F_{PT}	Frequency pacifier Tone		500		Hz	1
4	T_{PT}	Pacifier Tone Duration		30		ms	1

Notes : 1. Crystal oscillator accuracy directly affects these times.

AC CHARACTERISTICS – PULSE MODE OPERATION

N°	Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
–	P_R	Pulse Rate		10		PPS	1
5	PDP	Predigital Pause		40		ms	2
6	IDP	Interdigital Pause		940		ms	2
7	T_{MO}	Mute Overlap Time		2		ms	2
8	T_B	Break Time		60		ms	2

Notes : 1. 10 PPS is the nominal rate.
2. Figure 5 illustrates this relationship.

ELECTRICAL OPERATING CHARACTERISTICS (continued)

AC CHARACTERISTICS – TONE MODE

N°	Symbol	Parameter	Min.	Typ.	Max.	Unit	Notes
–	T_{NK}	Tone Output No Key Down			– 80	dBm	1
–	T_{0d}	Tone Output (dependent)	– 13 – 173	– 12 194	– 11 218	dBm mV_{rms}	1, 2 5
–	PE_d	Pre-emphasis, High Band	2.3	2.7	3.1	dB	
–	DC_d	Tone Output DC Bias (V+ = 2.5)	1.0	1.2		V	
–	R_E	Tone Output Load			10	kΩ	5
–	T_{RIS}	Tone Output Rise Time		0.1	1.0	ms	6
–	DIS	Output Distortion		5.0	8.0	%	3
–	T_X	Tone Signaling Rate		5.0		1/sec	
1	T_{PSD}	Pre-signal Delay		100		ms	7
2	T_{ISD}	Inter-signal Delay		100		ms	

Notes : 1. 0 dBm equals 1mW power into 600 ohms or 775 mVolts.
Important Note : The mk5370 is designed to drive a 10 Kohms load. The 600 ohms load is only for reference.
2. Single tone (low group). varies when used in subscriber set.
3. Supply voltage ? 2.5 to 6 Volts. R_E =10 kohms.
4. R_E = 10 Kohms.
5. Supply voltage = 2.5 Volts. These specifications are supply-dependent.
6. Time from beginning of tone output waveform to 90 % of final magnitude of either frequency Crystal parameters suggested for proper operation are R_S = 1000 ohms L_m = 96 mH C_m = 0.2 pF C_m= 5pF f = 3.579545 MHz and C_1 = 18 pF.
7. Time from initial key input until beginning of signaling.

FUNCTIONAL DESCRIPTION

V+

Pin 1. V+ is the positive supply for the circuit and must meet the maximum and minimum voltage requirements. (see Electrical Specifications).

MODE/TEST

Input. Pin 2. MODE/TEST determines the dialer's default operating mode. When the device is powered up or the hookswitch input is switched from on-hook (V+) to off-hook (V–) the default determines the signaling mode. A V+ connection selects to pulse mode operation.

Pin 2 also forces the device into test mode.

$\overline{C1}$, $\overline{C2}$, $\overline{C3}$, $\overline{R4}$, $\overline{R3}$, $\overline{R2}$, $\overline{R1}$

Keyboard Input. Pins 3, 4, 5, 13, 14, 15, 16. The MK5370 interfaces with either the standard 2-of-7 with negative common or the inexpensive single-contract (Form A) keyboard.

A valid keypad entry is either a single Row connected to a single Column or V– simultaneously presented to both a single Row and Column. In its quiescent or standby state, during normal off-hook operation, either the Rows or the Columns are at a logic level 1 (V+). Pulling one input low enables the on-chip oscillator to begin scanning the keypad. Scanning consists of Rows and Columns alternately switching high through on-chip pull-ups.

After both a Row and Column key have been detected, the debounce counter is enabled and any noise (bouncing contacts, etc.) is ignored for a debounce period (Tdb) of 32 ms. At this time, the keyboard is sampled and if both Row and Column information are valid, the information is buffered into the LND location. If switched on-hook (pin 17 to pin 1), the keyboard inputs all pull high through on-chip pull-up resistors.

IC

Input. Pin 9 Internal connection. This pin should be left during for normal operation.

V–

Input. Pin 6 is the negative supply input to the device. This is the voltage reference for all specifications.

OSC1, OSC2

Input/Output. Pins 7, 8. OSC1 and OSC2 are inputs to an on-chip inverter used as the timing reference for the circuit. It has sufficient loop gain to oscillate when used with a low-cost television color-burst crystal. The nominal crystal frequency is 3.579545 MHz and any deviation from this standard is directly reflected in the Tone output frequencies. The crystal oscillator provides the time reference for all circuit functions.

DTMF OUTPUT

Output. Pin 10. An NPN transistor emitter with a collector tied to V+ drives the DTMF OUTPUT pin. The transistor base is connected to an on-chip operational amplifier that mixes the Row and Column tones. Figure 4 shows the timing at this pin.

The DTMF OUTPUT is the summation of a single Row frequency and a single Column frequency. A typical single tone sine wave is shown in Figure 1. This waveform is synthesized using a resistor tree with sinusoidally weighted taps.

The MK5370 is designed to operate from a regulated supply and the row (low group) TONE LEVEL is related to this supply by either of the following equations :

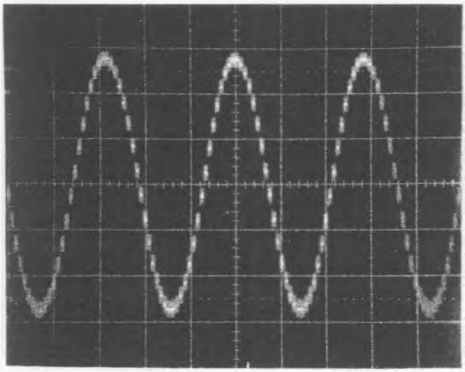
T_{O1} = 20 LOG [(0.0776 V+) / 0.775] dBm

T_{O1} = 0.0776 (V+) VRMS

The DC component of the DTMF output while active is described by the following equation :

V_{DC1} = 0.66 V + – 0.6 Volts

Figure 1 : Single Tone.



PACIFIER TONE OUTPUT

Output. Pin 11. A 500 Hz square wave is activated on pin 11 upon acceptance of a valid key input, after the 32 ms debounce time. The square wave terminates after a maximum of 30 ms or when the valid key is no longer present. In pulse mode, all key entries activate the pacifier tone. In tone mode, only a redial entry activates the pacifier tone. The pacifier tone provides audible feedback, confirming that the key has been properly entered and accepted.

Figure 2 : Dual Tone.

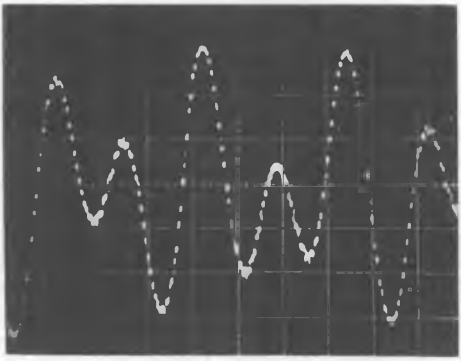
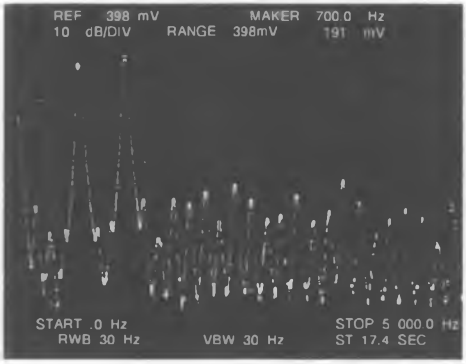


Figure 3 : Spectral Reponse.



MUTE1

Output. Pin 12. This pin is the Mute Output for both tone and pulse modes. Timing is dependent upon mode.

The output consists of an open drain N-channel device. During standby, the output is high impedance and generally has an external pull-up resistor to the positive supply.

In tone mode, $\overline{\text{MUTE1}}$ removes the transmitter and the receiver from the network during DTMF signaling. During dialing, $\overline{\text{MUTE1}}$ is active continuously until dialing is completed.

In pulse mode, $\overline{\text{MUTE1}}$ removes the receiver or the network from the line. Different circuitry is required for tone and pulse muting external to the IC and applications using both modes would not necessarily share circuitry. $\overline{\text{MUTE1}}$ timing is shown in Figure 5 for pulse mode signaling and Figure 4 for tone mode signaling.

HKS

Input. Pin 17. Pin 17 is the hookswitch input to the MK5370. This is a high-impedance input and must be switched high for on-hook operation or low for off-hook operation. A transition on this input causes the on-chip logic to initialize, terminating any operation in progress at the time. The signaling mode defaults to the mode selected at pin 2.

$\overline{\text{PULSE}}$ OUTPUT

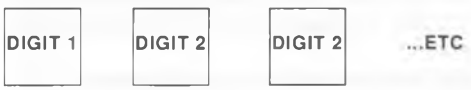
Output. Pin 18. This pin has a dual function determined by the dialing mode selected. In Pulse Mode, the pin is an output consisting of an open drain N-channel device with zener protection. The break timing at this output meets Bell Telephone and EIA specifications for loop disconnect signaling. Figure 4 shows this timing.

DEVICE OPERATION (tone mode)

When the MK5370 is not actively dialing, it consumes very little current. While on-hook, all keypad input pins are pulled high. Key entries are not recognized unless they utilize a keypad common connection to force the respective Row and Column inputs low. These inputs assume opposite states off-hook. The circuit verifies that a valid key has been entered by alternately scanning the Row and Column inputs. If the input is still valid following 32 ms of debounce, the digit is stored into memory, and dialing begins after a pre-signal delay of 100 ms. Each digit buffered into the RAM is dialed out with a 98 ms burst of DTMF and an intersignal time of 102 ms.

One important feature of the dialer is its ability to buffer data into the RAM before signaling. This feature allows less expensive keyboards to be used because signal distortion and double digit entry caused by bouncing and bounding of the keypad are eliminated. This design also ensures that data stored in the buffer exactly matches the digits actually dialed.

NORMAL DIALING (off-hook)



Normal dialing is straightforward, all keyboard entries will be stored in the buffer and signaled in succession.

LAST NUMBER DIALED (LND)

Last number dialing is accomplished by entering the * or # key as the first entry after coming off-hook.

Table 1 : DTMF Output Frequency.

Key Input	Standard Frequency	Actual Frequency	% Deviation
ROW 1	697	699.1	+ 0.31
2	770	766.2	− 0.49
3	852	847.4	− 0.54
4	941	948.0	+ 0.74
COL 1	1209	1215.9	+ 0.57
2	1336	1331.7	− 0.32
3	1477	1471.9	− 0.35

Figure 4 : Tone Mode Timing.

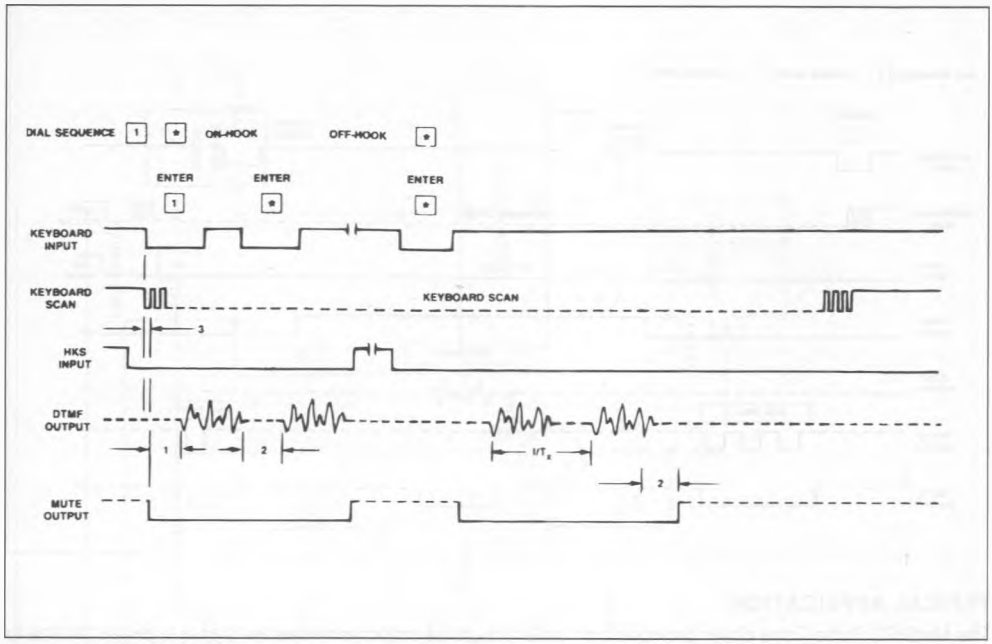


Figure 5 : Pulse Mode Timing.

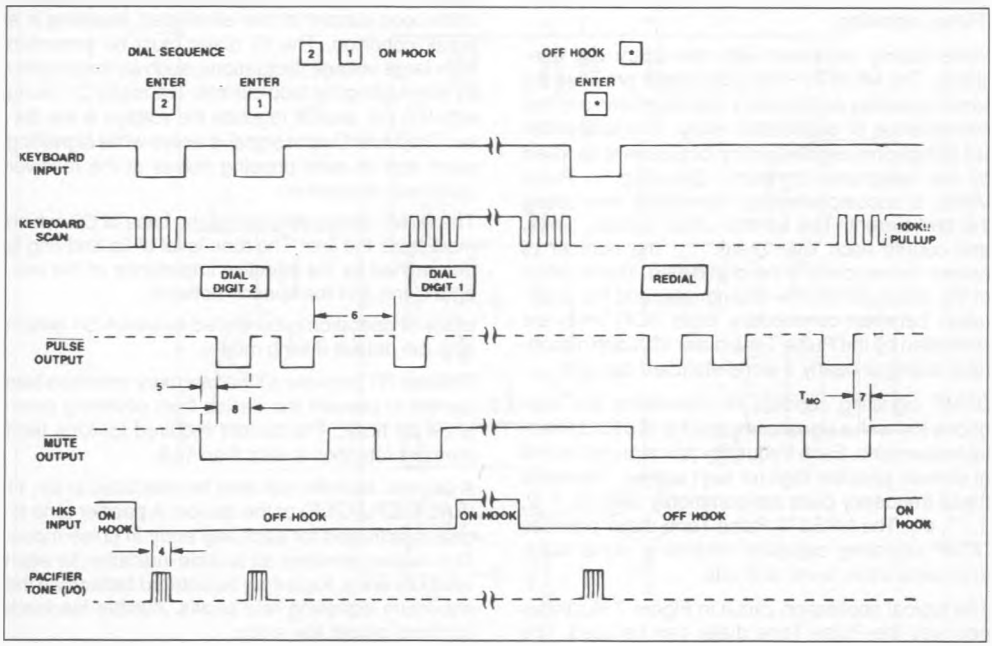
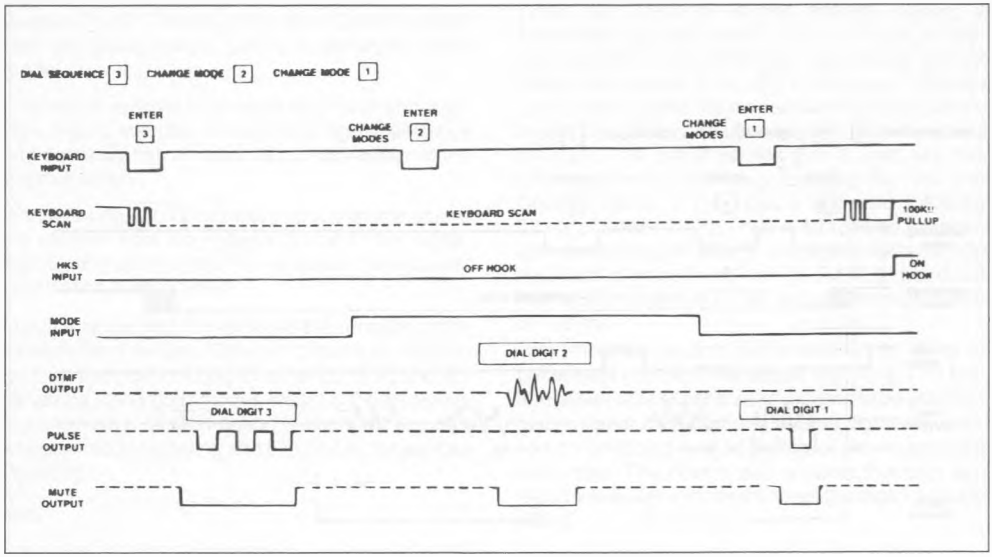


Figure 6 : Pulse and Tone Mode Timing.



TYPICAL APPLICATION

The MK5370 Pulse Tone dialer provides both cost-effective telephone-line interface and the logic required for DTMF (Tone) and Loop Disconnect (Pulse) signaling.

Pulse dialing originated with the rotary dial telephone. The MK5370 Pulse Tone dialer provides the same capability as the rotary dial telephone and the convenience of pushbutton entry. The subscriber set (telephone) is powered by loop current supplied by the telephone company. Signaling, in Pulse Mode, is accomplished by repeatedly interrupting the low current. The central office senses, times, and counts each line "break" ; the number of breaks corresponds to the digit dialed. The duration of the break period, the dialing rate, and the separation between consecutive digits (IDP time) are controlled by the Pulse Tone dialer IC. Loop disconnect dialing is nearly a world-standard concept.

DTMF signaling consists of modulating the telephone line with a signal comprised of two fundamental frequencies. Each frequency pair represents one of sixteen possible digit (or key) entries. Twelve of these frequency pairs are commonly used (0, 1, 2, ..., *, #). The MK5370 Pulse Tone dialer provides DTMF signalling capability controlling signal duration, separation, level, and rate.

The typical application circuit in Figure 7 illustrates one way the Pulse Tone dialer can be used. The pulse output provides the signal to break the line to transistor Q3. Q3 switches off, eliminating the base current to Q4, which also switches off. The majority of the loop current is then eliminated, resulting in a break condition. The IC dialer must be protected from large voltage fluctuations, such as that caused by interrupting the loop current. Transistor Q1 along with R2, C1, and Z1 regulate the voltage to the dialer. The Mute Output signal is active while signalling each digit to mute popping noises at the receiver (earpiece or speaker).

The DTMF tone output drives the base of Q8, which modulates the line. The tone level at tip and ring is determined by the effective impedance of the telephone line and the speech network.

Mode of operation is controlled by switch S1 (which sets the default dialing mode).

Resistor R1 provides a small memory-retention bias current to prevent the device from powering down while on hook. The current required for long term memory retention is less than 1μA.

A ceramic sounder can also be interfaced to pin 11 (PACIFIER TONE) of the device. A pacifier tone signal is activated for each key entry in pulse mode. This feature provides an audible indication for each valid key entry. Keys may be entered faster than the maximum signalling rate allows. Audible feedback confirms proper key entry.

Figure 7 : MK5370 Typical Application.