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T-75-27-07

UM9203/04
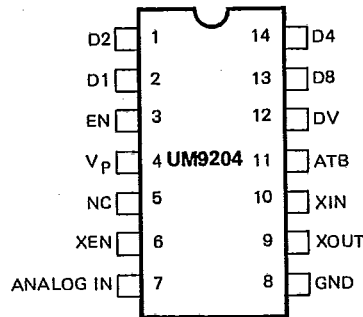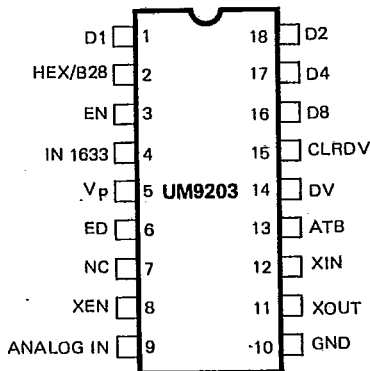
DTMF Receiver

Features

- Single 5-volt power supply.
- Detects either 12 (UM9203) or 16 (UM9203/04) standard DTMF digits.
- Output in either 4-bit hexadecimal code (UM9203/04) or 2-of-8 binary code (UM9203)
- Full DTMF receiver in a single 18-pin (UM9203) or 14-pin (UM9204) plastic DIP package.
- Tristate outputs.
- Early detect output (UM9203 only).
- Excellent speech immunity.

General Description

The UM9203/04 are single chip monolithic CMOS receivers designed to detect either 12 or 16 standard Dual Tone Multi-Frequency (DTMF) digits. The UM9203/04 includes a preprocessor, band split filters, zero crossing detectors, bandpass filters, peak-to-peak detectors and digital control circuits. No front-end pre-filtering is needed; the only external components required are a 3.579545 MHz crystal and a bias resistor. The UM9203/04 is packaged in a standard 18-pin (UM9203) or 14-pin (UM9204), plastic DIP and requires only a single voltage supply. The UM9203/04 provides tristate data outputs in either 4-bit hexadecimal code (UM9203/04) or 2-of-8 binary code (UM9203) and can be easily interfaced with a standard CMOS digital system.
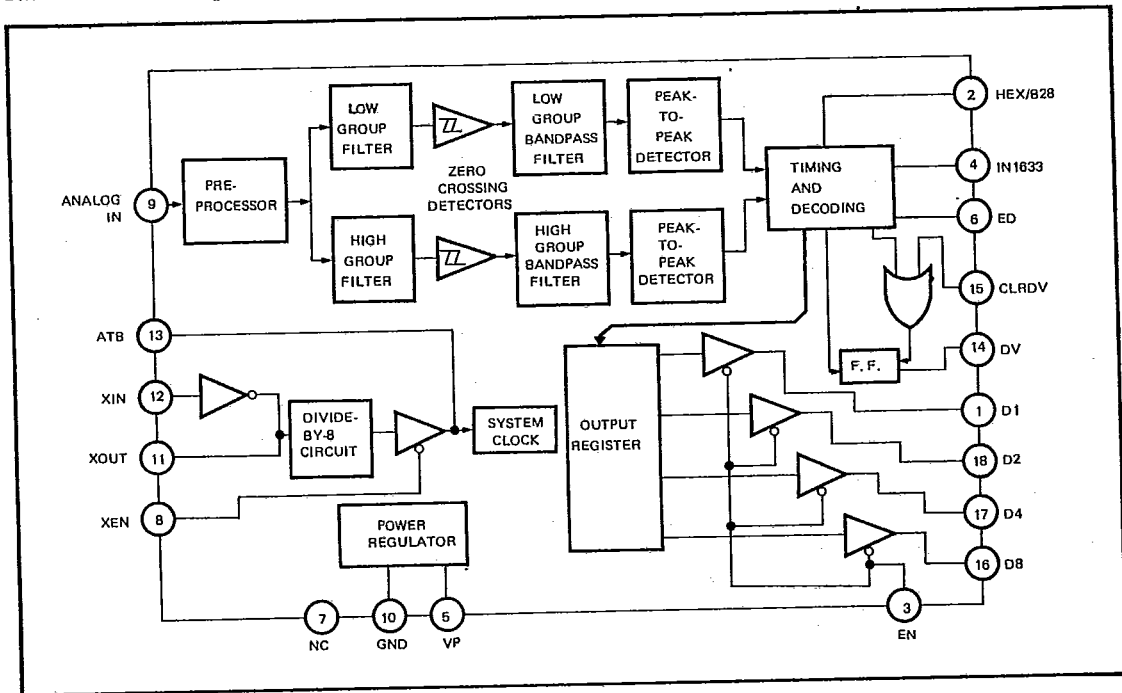
Pin Configurations

UM9203

D1	1	18	D2
HEX/B28	2	17	D4
EN	3	16	D8
IN 1633	4	15	CLRDV
Vp	5	14	DV
ED	6	13	ATB
NC	7	12	XIN
XEN	8	11	XOUT
ANALOG IN	9	10	GND

UM9204

D2	1	14	D4
D1	2	13	D8
EN	3	12	DV
Vp	4	11	ATB
NC	5	10	XIN
XEN	6	9	XOUT
ANALOG IN	7	8	GND

UM9203 Block Diagram

UM9204 Block Diagram

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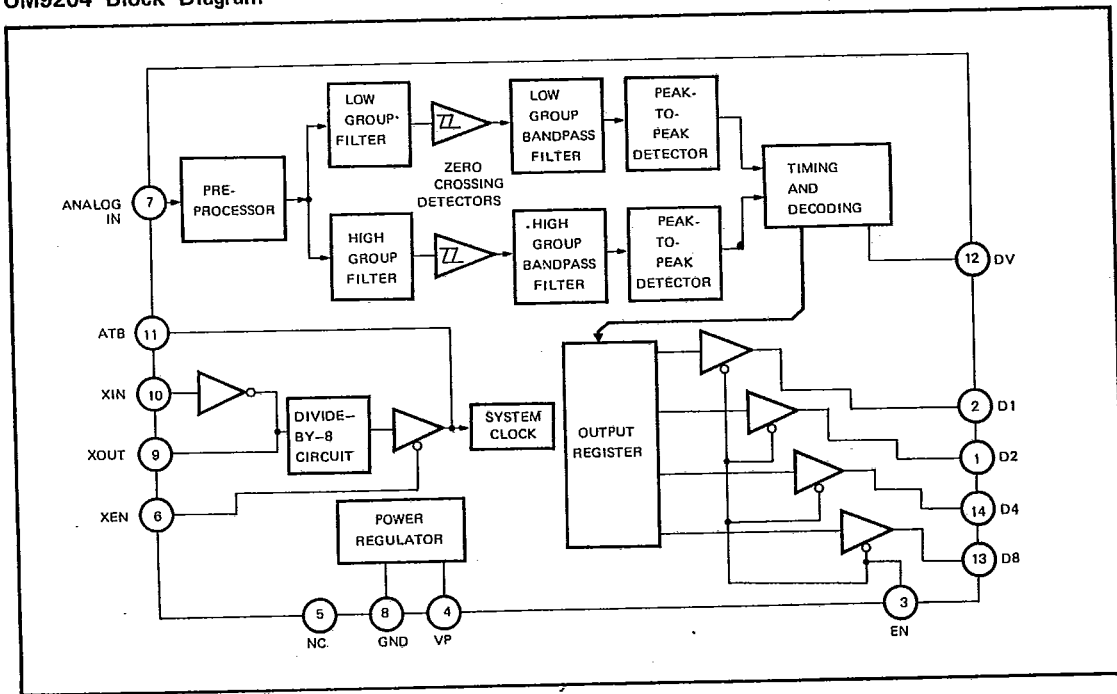
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Pin Description

Pin		Symbol	Description
UM9203	UM9204		
1 18 17 16	2 1 14 13	D1 D2 D4 D8	Data outputs. These digital outputs provide codes (in UM9203 the code format can be pro-grammed by the HEX/B28 pin) corresponding to detected digits. These out-puts become valid after a tone pair has been detected and are cleared when a valid pause has been timed.
2	–	HEX/B28	Digital output format control. When this pin is pulled high, the UM9203's output is given in hexadecimal code. When input is low, output is in 2-of-8 binary code. Output codes are shown in Table 1.
3	3	EN	Output enable. When EN is pulled high, the data outputs are in the CMOS push-pull state and represent the contents of the register. When EN is low, the data outputs are forced to the high-impedance state.
4	–	IN1633	DTMF signal control. When this pin is pulled high, detection of tone pairs containing the 1633 Hz component is inhibited. To detect all 16 standard digits this pin must be pulled low.
5	4	V_P	Positive power supply connection.
6	–	ED	Early signal detection output. ED goes to high when the UM9203 begins to detect a DTMF tone pair and falls to low when a pause is detected. While the data outputs will definitely be valid when DV is high, they will not necessarily be valid when ED is high. Thus the ED output can be used to determine if signals are reaching the DTMF receiver.
7	5	NC	Not connected. This pin has no internal connection and may be left floating or connected to GND.
8	6	XEN	Crystal oscillator enable. Pulling XEN high will enable the crystal oscillator.
9	7	ANALOG IN	DTMF input. This pin is internally biased so that the input signal may be AC coupled. This input may also be DC coupled as long as voltage does not exceed that of the positive power supply. Proper input coupling is illustrated in Figure 1.
10	8	GND	Negative power supply connection.

Telephone Related Products

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UM9203/04

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Pin Description (Continued)

Pin		Symbol	Description
UM9203	UM9204		
12 11	10 9	XIN XOUT	Crystal connections. The XIN and XOUT pins are the input and output of an on-chip inverter. A complete oscillator circuit is formed by connecting a 3.579545 MHz color-burst crystal and a 1M resistor between XIN and XOUT.
13	11	ATB	Auxiliary time base In/Output. When XEN is pulled high, this pin can be used to provide a clock frequency time base for up to ten other UM9203/04s. When XIN is pulled high and XEN low, this pin acts as an auxiliary time base input. (Auxiliary input must equal 3.579545 MHz divided by 8 for the UM9203/04 to meet specifications.)
14	12	DV	Valid data indication output. DV goes high after a valid tone pair has been detected at Analog In and decoded at the data outputs. DV remains high until a valid pause is detected or the CLRDV input is raised high, whichever occurs first.
15	—	CLRDV	DV clear. When CLRDV is pulled high, DV is reset to the low state.

Digit	Hexadecimal				Binary Coded 2 of 8				Low Group Frequency (Hz)	High Group Frequency (Hz)
	D8	D4	D2	D1	D8	D4	D2	D1		
1	0	0	0	1	0	0	0	0	697	1209
2	0	0	1	0	0	0	0	1	697	1336
3	0	0	1	1	0	0	1	0	697	1477
4	0	1	0	0	0	1	0	0	770	1209
5	0	1	0	1	0	1	0	1	770	1336
6	0	1	1	0	0	1	1	0	770	1477
7	0	1	1	1	1	0	0	0	852	1209
8	1	0	0	0	1	0	0	1	852	1336
9	1	0	0	1	1	0	1	0	852	1477
0	1	0	1	0	1	1	0	1	941	1336
*	1	0	1	1	1	1	0	0	941	1209
#	1	1	0	0	1	1	1	0	941	1477
A	1	1	0	1	0	0	1	1	697	1633
B	1	1	1	0	0	1	1	1	770	1633
C	1	1	1	1	1	0	1	1	852	1633
D	0	0	0	0	1	1	1	1	941	1633

Table 1. DTMF Signal Output Codes

Functional Description

The general operation of the UM9203/04 is described as follows:

Preprocessor

A 60 Hz reject filter and a pre-emphasis amplifier are included in the preprocessor. An input protection circuit has been placed in front of the preprocessor to prevent the chip input from damage due to high voltage. The function of the preprocessor is to emphasize the high frequency components of the input signal in order to compensate for signal loss due to transmission through the telephone lines.

Band Split Filters

The band split filters consist of two high order band rejection filters. The output signals of the band split filters are split into high and low frequency groups. The separated tones are then put through gain stages and sent to the zero-crossing detectors.

Zero-Crossing Detectors

Signals emerging from the band-split filters are converted into square waves in the zero-crossing detectors. The square waves are then sent through four bandpass filters each for both the high and low frequency groups. If the original DTMF input signals are not pure tones, then the converted square wave outputs will have variable periods.

Bandpass Filters

The eight bandpass filters are divided into two groups, corresponding to the high and low frequency groups, and are used to detect input signals corresponding to one of the eight different standard frequencies used in DTMF signaling systems. When an input signal falls inside one of these frequency bands, the corresponding bandpass filter will go to high, allowing it to be detected by the peak-to-peak detectors.

Peak-to-Peak Detectors

The output of each bandpass filter is monitored using the multiplex method. In each of the two tone groups, only one bandpass filter at a time will go to high and remain in the high state long enough to be considered valid; valid high-level outputs will then be detected by the peak-to-peak detectors.

Timing and Decoding

The outputs of the peak-to-peak detectors are decoded into either 4-bit hexadecimal code (UM9203/04) or 2-of-8 binary code (UM9203). The ED (Early Detection, UM9203) pin can be used to indicate the presence of a signal input; ED will go to high within 20 msec after a DTMF input is detected. Within 46 msec of reception of a DTMF signal the DV pin should go to high as well, indicating that valid data has been received. When an input signal is no longer present, ED and DV will both drop to low within 18 and 50 msec respectively. DV can also be reset to low by pulling CLRDV to high.

Timing Diagram

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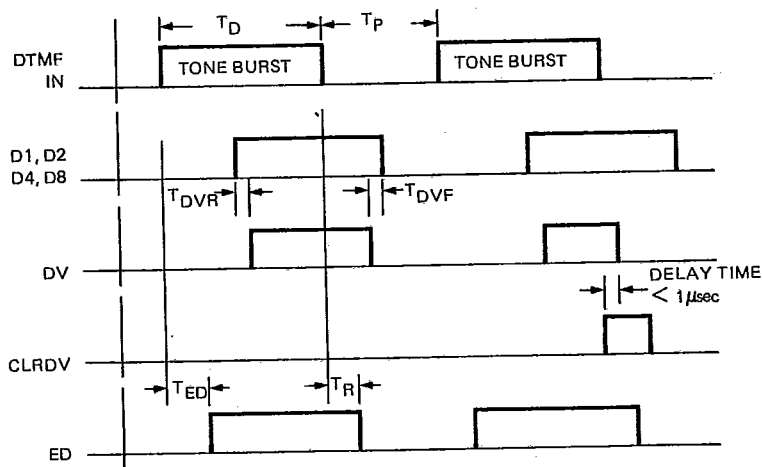
Absolute Maximum Ratings*

DC Supply Voltage (V$_P$) 7.0V
Analog In Voltage .... V$_P$ − 10V to V$_P$ + 0.5V
Input Voltage (any pin except Analog In)
.... −0.5V to V$_P$ + 0.5V
DC Current Into Any Input .... −10.0 mA to +10.0 mA
Operating Temperature (T$_{OP}$) .... 0°C to 70°C
Storage Temperature (T$_{STG}$) .... −55°C to +150°C
Power Dissipation .... 880 mW
Lead Temperature (soldering 10 sec) .... 256°C

*Comments

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC Electrical Characteristics

(V$_P$ = 5.0V, V$_{SS}$ = 0V, F$_{OSC}$ = 3.579545 MHz, T$_{OP}$ = 25°C, unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
High-Level Input Voltage	V$_{IH}$	0.7V$_P$	−	V$_P$	V	
Low-Level Input Voltage	V$_{IL}$	0	−	0.3V$_P$	V	
High-Level Output Voltage (Except XOUT Pin)	V$_{OH}$	V$_P$ − 0.5	−	V$_P$	V	200µA Load
Low-Level Output Voltage (Except XOUT Pin)	V$_{OL}$	0	−	0.5	V	400µA Load
Operating Voltage	V$_{DD}$	4.5	5.0	5.5	V	
Supply Current	I$_{DD}$		10	16	mA	

AC Electrical Characteristics

(V$_P$ = 5.0V, V$_{SS}$ = 0V, F$_{OSC}$ = 3.579545 MHz, T$_{OP}$ = 25°C, unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test Ckt.
Frequency Deviation Accept Limit				±1.5±2Hz	% of f$_0$	MITEL tape #7291 (See Note 1)	Fig. 8
Frequency Deviation Reject Limit		±3.5			% of f$_0$	MITEL tape #7291 (See Note 1)	Fig. 8
Amplitude for Detection		−32		−2	dBm	MITEL tape #7291	Fig. 8
Minimum Accept Twist		−10		10	dB	MITEL tape #7291	Fig. 8
Noise Tolerance				−12	dB	MITEL tape #7291	Fig. 8
60 Hz Tolerance				0.8	V$_{rms}$		
Power Supply Noise				10	mV$_{P-P}$		
Talk-off			4		hits	MITEL tape #7291	Fig. 8
Input Impedance	Z$_{IN}$		100KΩ //15pF				

Note 1: If dial tone frequency deviation is less than ±(1.5)% of f$_0$, the receiver will work very well. If dial tone frequency deviation is larger than ±(1.5)% and less than ±(3.5)% of f$_0$, it is possible to find errors on the data output. If dial tone frequency deviation is larger than ±(3.5)% of f$_0$, then the receiver will not work.

UMC

Switching Characteristics

(V_P = 5.0V, V_{SS} = 0V, F_{OSC} = 3.579545 MHz, T_{OP} = 25°C, unless otherwise specified)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Conditions	Test Ckt.
Tone Time	for detect	T_{ON}	40	—	—	.ms	MITEL tape #7291	Fig. 8
	for reject	T_{ON}	—	—	20	ms		
Pause Time	for detect	T_{OFF}	40	—	—	ms	MITEL tape #7291	Fig. 8
	for reject	T_{OFF}	—	—	20	ms		
Detect Time		T_D	25	—	46	ms		
Release Time		T_R	25	—	50	ms		
Data Setup Time		T_{SU}	7	—	—	μs		
Data Hold Time		T_H	7	9	10	μs		
DV Clear Time		T_{CL}	—	160	250	ns		
CLRDV Pulse Width		T_{PW}	200	—	—	ns		
ED Detect Time		T_{ED}	7	—	20	ms		
ED Release Time		T_{ER}	2	—	18	ms		
Output Enable Time C_L = 50 pF, R_L = 1 KΩ		T_{EN}	—	200	300	ns		
Output Disable Time C_L = 35 pF, R_L = 500 Ω		T_{DIS}	—	150	200	ns		
Output Rise Time C_L = 50 pF		T_{RISE}	—	200	300	ns		
Output Fall Time C_L = 50 pF		T_{FALL}	—	160	250	ns		

Note: R_L and C_L are parallel impedances taken to GND
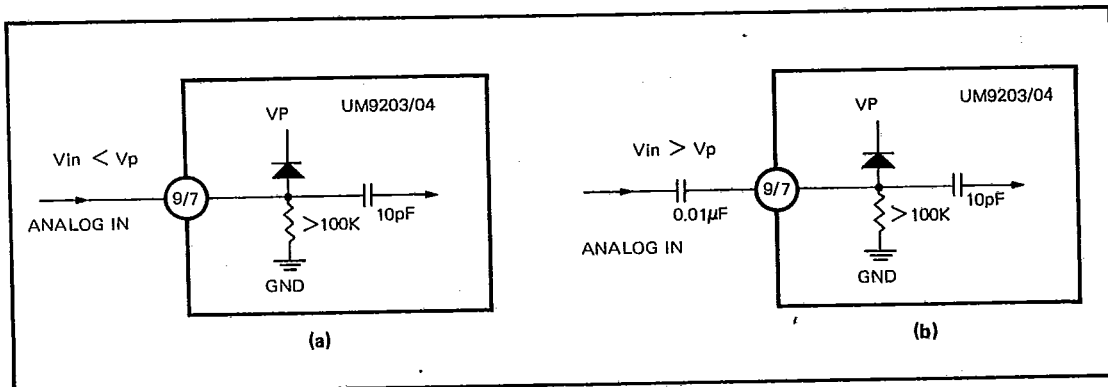
Figure 1. Input Signal Coupling

Applications

DTMF receivers have a variety of applications, including use in PBXs, toll call restrictors, answering machines with remote control, credit card verification and inquiry systems, and other automation and remote control systems. Due to their high noise immunity, DTMF signals constitute a communication method with a very low error rate, and are utilized as data carriers in a variety of communication systems.

Single-Chip DTMF signal generators and receivers greatly simplify the Implementation of a DTMF communication system. A typical DTMF communication system application is shown in Figure 2. In addition, several application circuits are described below:

Telephone Line Input Interfaces

Three suggested types of input circuits for interfacing the UM9203/04 to telephone lines are illustrated in Figures 3, 4, and 5.

Input Circuit with Dial Tone Reject Filter

The dial tone reject filter shown in Figure 6 is an elliptic highpass filter. It is a second-order RC-active filter with two operational amplifiers. The filter is designed with cutoff frequency 460 Hz and provides a minimum of 18 dB rejection at 330 Hz and 440 Hz. Hence, this filter improves

dial tone tolerance at least 18 dB for a DTMF decoding system, where dial tone tolerance is defined as the total power of precise dial tone (350 Hz and 440 Hz as equal amplitudes) relative to the lowest amplitude tone in a valid tone pair. The operational amplifiers could be UA741, LM1458 or equivalents. The component tolerance in the filter is 1% for resistors and 5% for capacitors.

Microcomputer or Microprocessor Interfaces

The UM9203 can be connected directly to a microprocessor or single-chip microcomputer such as the 8048 or 8051. In Figure 7a, the data outputs of the UM9203 are connected to the I/O ports of the microcontroller in such a way that the EN pin on the UM9203 will remain in a constant high state. In Figure 7b, the UM9203 data outputs share the same data bus as the microcontroller. Thus the UM9203 EN pin must be controlled by the microcontroller in order to differentiate DTMF data from other data sources that will be using the same data bus. In this case, when the output signal P27 of the microcontroller is pulled high, the microcontroller 8048 will read the UM9203 output data, when P27 is set to low, the microcontroller 8048 will read data from other sources. In order to prevent the microcontroller from being reset during the execution of an interrupt service routine, the UM9203 DV pin can be reset to low state by pulling CLRDV to high.
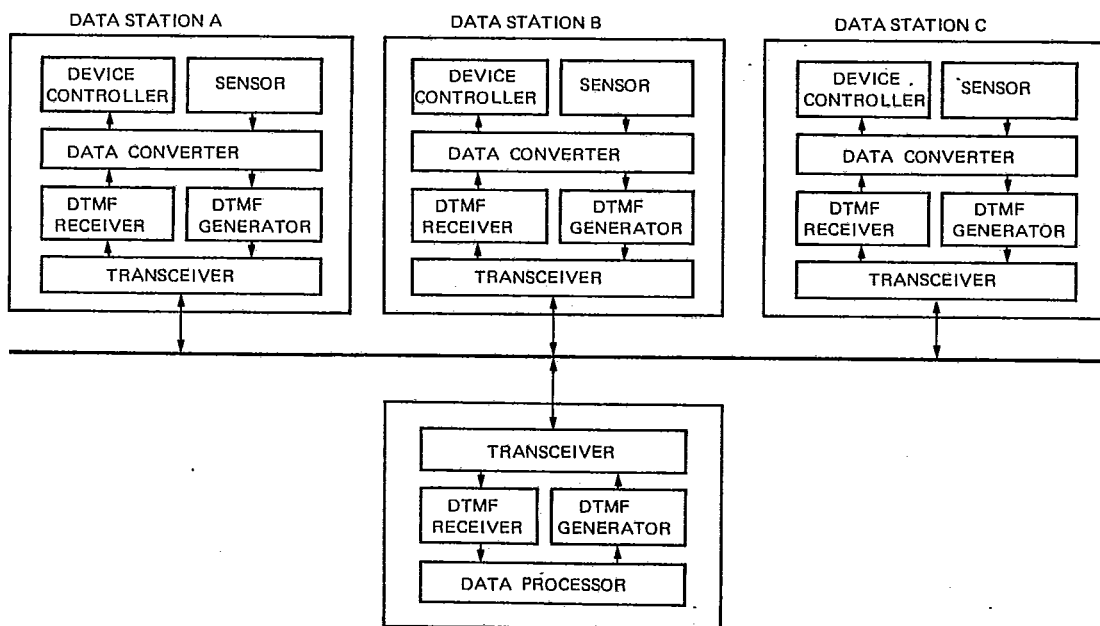
Figure 2. DTMF Data Communication System
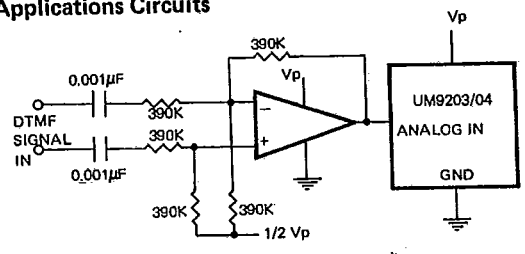
Applications Circuits
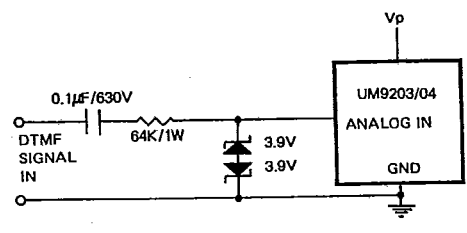
Figure 3. Line input circuit (A)
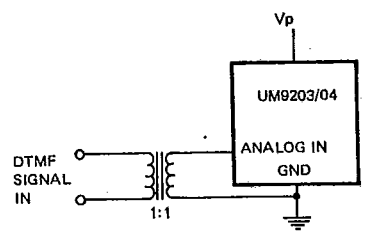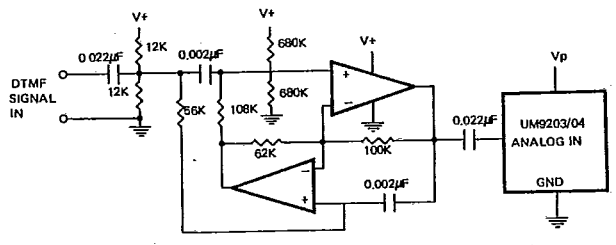
Figure 4. Line input circuit (B)

Figure 5. Line input circuit (C)

Figure 6. Dial tone reject filter
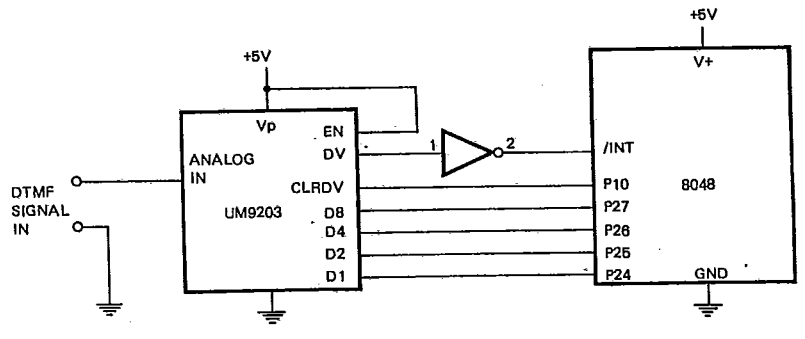
Figure 7(a). Interface with microprocessor
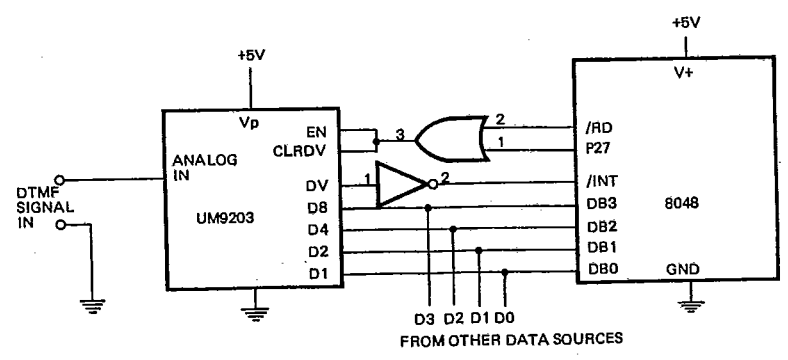
Figure 7(b). Interface with microprocessor

FROM OTHER DATA SOURCES

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UMC

UM9203/04

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Test Circuit

The test circuit for the UM9203/04 is shown in Figure 8. The Mitel CM7291 Tone Receiver Cassette should be used to evaluate the UM9203/04. Other testing equipment should include a digital counter, an AC voltmeter, a cassette tape player, and a small amplifier for adjusting the level of the tone at the receiver input. The CM7291 tape contains a series of tests consisting of recorded tone bursts with the parameters varied in a number of ways. Tests are performed by sending the tone bursts to the receiver and counting the number of bursts to which the receiver responds. Results from these tests provide a direct indication of the receiver's performance.
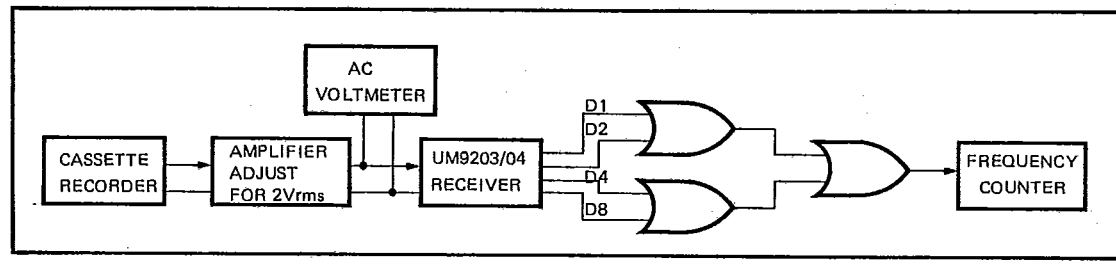

Figure 8 UM9203/04 Test Circuit

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