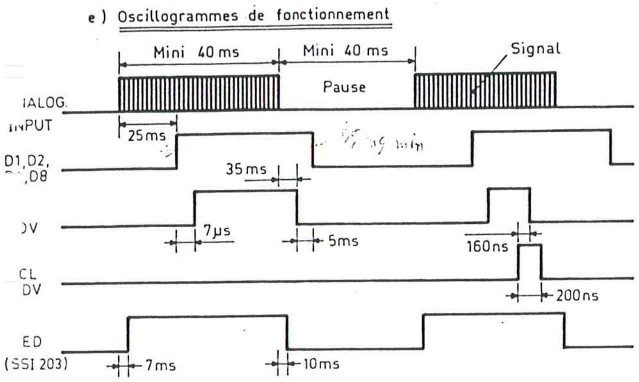
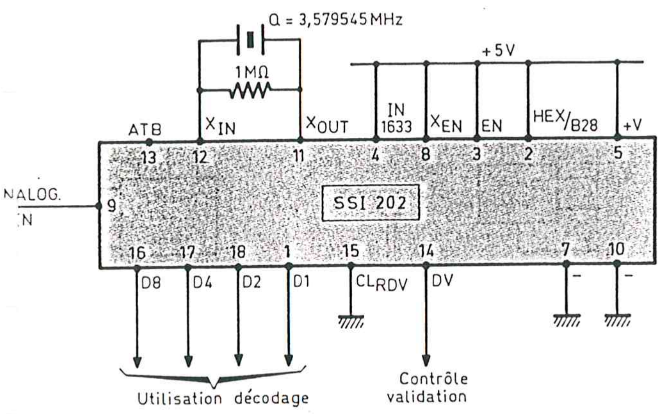
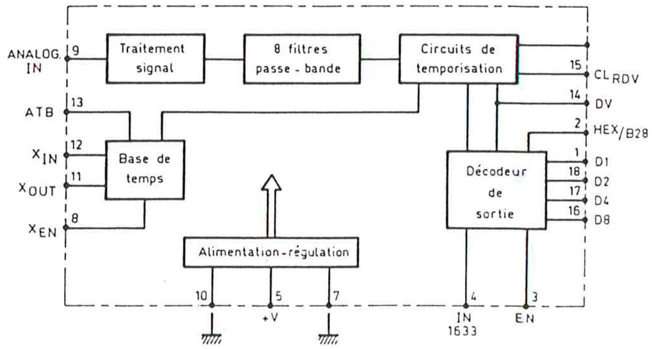
Le SSI202P



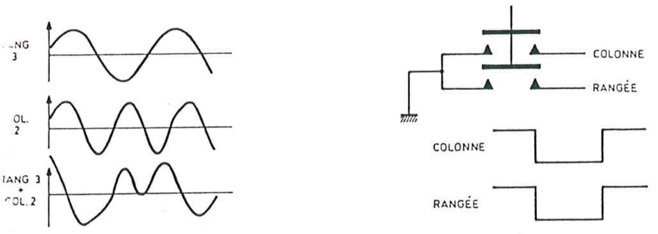


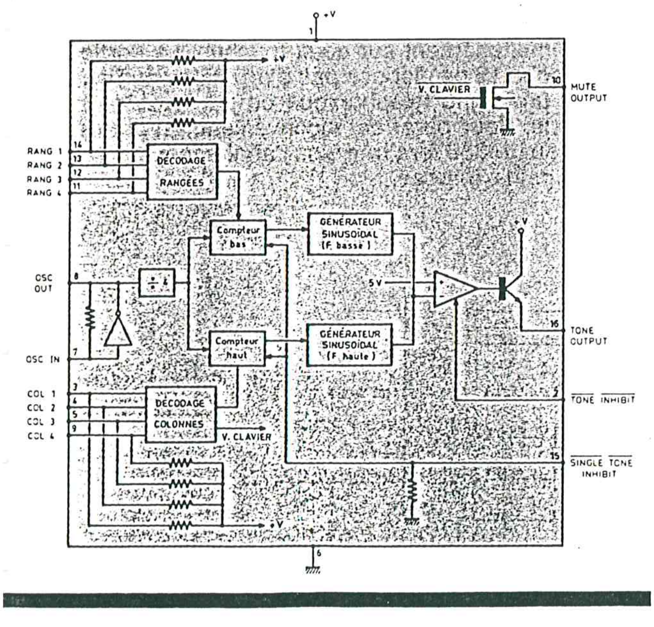
Le SSI202P

Ce circuit permet le décodage des 12 ou 16 paires des fréquences standards DTMF. La sortie s'exécute en code hexadécimal ou binaire 2 par 8 selon la programmation de la broche 2, elles se retrouvent aux broches 1, 18, 17 et 16 selon trois états, niveaux bas, haut ou haute impédance. Il rejette la fréquence secteur 50 ou 60 Hz. Sa dynamique d'entrée vaut 30 dB et évolue entre une tension de – 32 dB à – 2 dB, le 0 dB correspondant à une valeur de 0,775 V sous 600 Ω. Les fréquences DTMF s'obtiennent en utilisant un quartz de 3,58 MHz spécifique aux applications téléphoniques. L'alimentation du circuit nécessite une tension entre 5 à 7 V avec un courant de 10 mA. La sortie DV signale validité du décodage, elle passe alors à l'état haut puis dès que le signal disparaît elle revient à l'état bas.



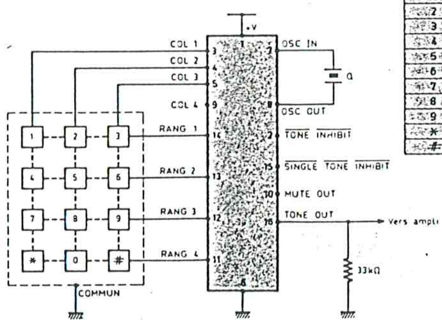
Le TCM5089





Le TCM5089

Le TCM5089 permet l'encodage des 12 ou 16 paires des fréquences vocales DTMF. Sa facilité de mise en œuvre, associée au SSI202P, en fait un produit intéressant pour les applications en télécommande. Il peut recevoir une tension d'alimentation allant de 3 à 10 V, sa consommation en veille vaut 100 nA. Les fréquences sont générées à l'aide d'un quartz standard de 3,58 MHz. Pour garder la simplicité de mise en œuvre il s'agit de prévoir un clavier matricé. Le TCM5089 dispose d'un système interne lui permettant de neutraliser la sortie dans le cas où l'utilisateur appuie simultanément sur deux touches. La sortie DTMF sur la broche 16 ne dispose pas d'un niveau suffisant pour attaquer une ligne téléphonique ou un système de télécommande. Pour parer cet inconvénient, un amplificateur TBA820 ou LM386 fera très bien l'affaire, cependant un réglage du gain s'impose.



Chiffre	Fréquence basse	Fréquence haute	Rangée	Colonne
0	941	1336	4	2
1	697	1209	1	1
2	697	1336	1	2
3	697	1477	1	3
4	770	1209	2	1
5	770	1336	2	2
6	770	1477	2	3
7	852	1209	3	1
8	852	1336	3	2
9	852	1477	3	3
*	941	1209	4	1
#	941	1477	4	3

TSC

HARRIS SEMICONDUCTOR

CD22202, CD22203

5V Low Power DTMF Receiver

April 1993

Features

- Central Office Quality
- No Front End Band Splitting Filters Required
- Single, Low Tolerance, 5V Supply
- Detects Either 12 or 16 Standard DTMF Digits
- Uses Inexpensive 3.579545MHz Crystal for Reference
- Excellent Speech Immunity
- Output In Either 4-Bit Hexadecimal Code or Binary Coded 2-of-8
- Synchronous or Handshake Interface
- Three State Outputs
- Excellent Latch-Up Immunity

Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
CD22202E	0°C to +70°C	18 Lead Plastic DIP
CD22203E	0°C to +70°C	18 Lead Plastic DIP

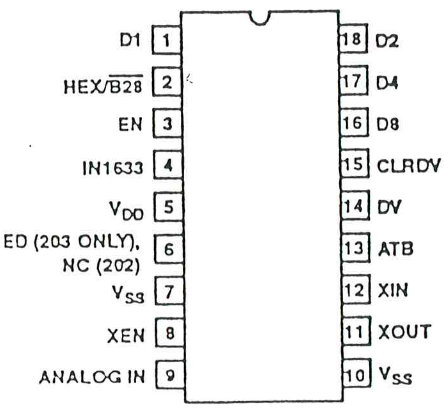
Description

The CD22202 and CD22203 complete dual-tone multiple frequency (DTMF) receivers detect a selectable group of 12 or 16 standard digits. No front-end pre-filtering is needed. The only externally required components are an inexpensive 3.579545MHz TV "colorburst" crystal (for frequency reference) and a bias resistor. Extremely high system density is possible through the use of the clock output of a crystal connected CD22202/CD22203 receiver to drive the time bases of additional receivers. This is a monolithic integrated circuit fabricated with low-power, complementary-symmetry CMOS processing. It only requires a single low tolerance power supply.

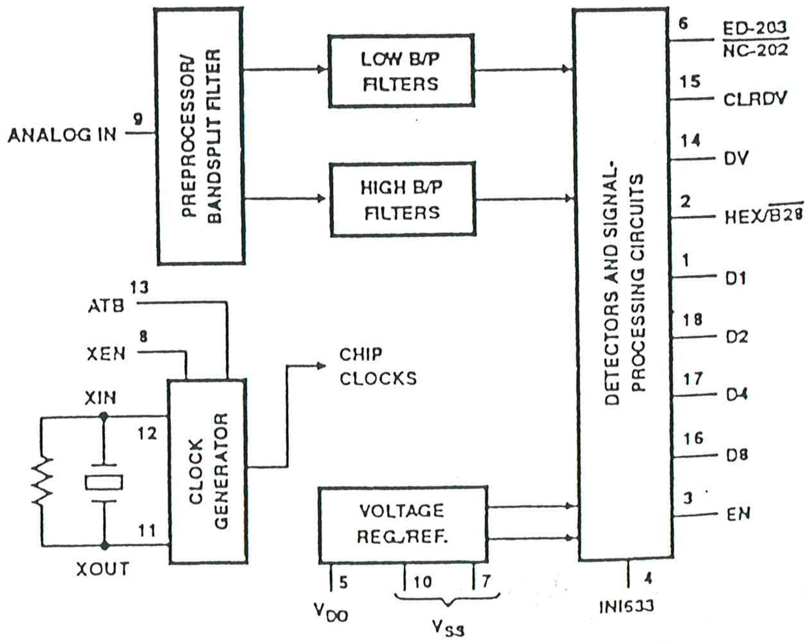
The CD22202 and CD22203 employ state-of-the-art circuit technology to combine the digital and analog functions on the same CMOS chip using a standard digital semiconductor process. The analog input is preprocessed by 60Hz reject and band splitting filters and then hard limited to provide AGC. Eight Bandpass filters detect the individual tones. The digital post processor times the tone durations and provides the correctly coded digital outputs. Outputs interface directly to standard CMOS circuitry and are tri-state enabled to facilitate bus oriented architectures.

Pinout

CD22202, CD22203
(PDIP)
TOP VIEW



Functional Diagram



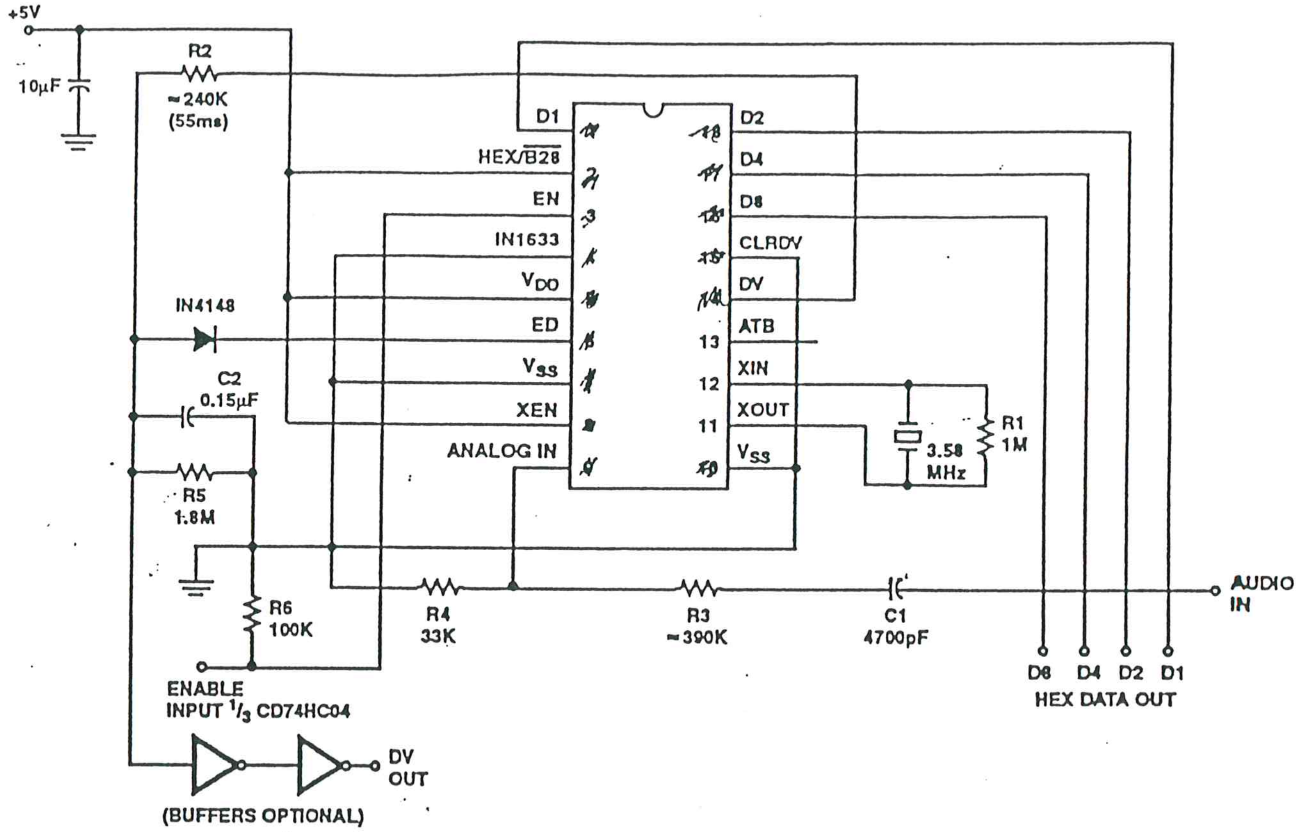


FIGURE 6. CD22203 DTMF RECEIVER WITH GUARD TIME CIRCUIT TO PROVIDE EXCEPTIONAL TALK-OFF PERFORMANCE

Operating and Handling Considerations

Handling

All inputs and outputs of CMOS devices have a network for electrostatic protection during handling. Recommended handling practices for CMOS devices are described in ICAN-6525: "Guide to Better Handling and Operation of CMOS Integrated Circuits".

Operating

Operating Voltage

During operation near the maximum supply voltage limit, care should be taken to avoid or suppress power supply turn-on and turnoff transients, power supply ripple, or ground noise; any of these conditions must not cause V_{DD} - V_{SS} to exceed the absolute maximum rating.

Input Signals

To prevent damage to the input protection circuit, input signals should never be greater than V_{DD} nor less than V_{SS}. Input currents must not exceed 20mA even when the power supply is off.

Unused Inputs

A connection must be provided at every input terminal. All unused input terminals must be connected to either V_{DD} or V_{SS}, whichever is appropriate.

Output Short Circuits

Shorting of outputs to V_{DD} or V_{SS} may damage CMOS devices by exceeding the maximum device dissipation.

above 28kHz, the simple RC filter shown below may be used to band limit the incoming signal. The cut off frequency is 3.9kHz.

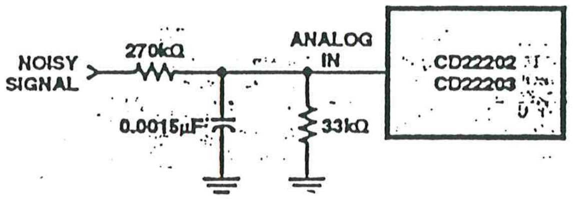
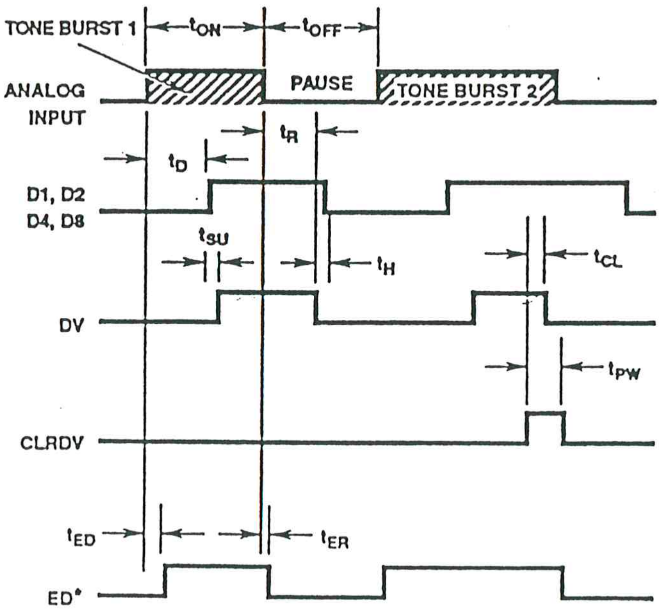


FIGURE 4. FILTER FOR USE IN EXTREME HIGH FREQUENCY INPUT NOISE ENVIRONMENT

Noise will also be reduced by placing a grounded trace around XIN and XOUT pins on the circuit board layout when using a crystal. It is important to note that XOUT is not intended to drive an additional device. XIN may be driven externally; in this case, leave XOUT floating.

Timing Waveforms



* Early Detect output is available only on the CD22203

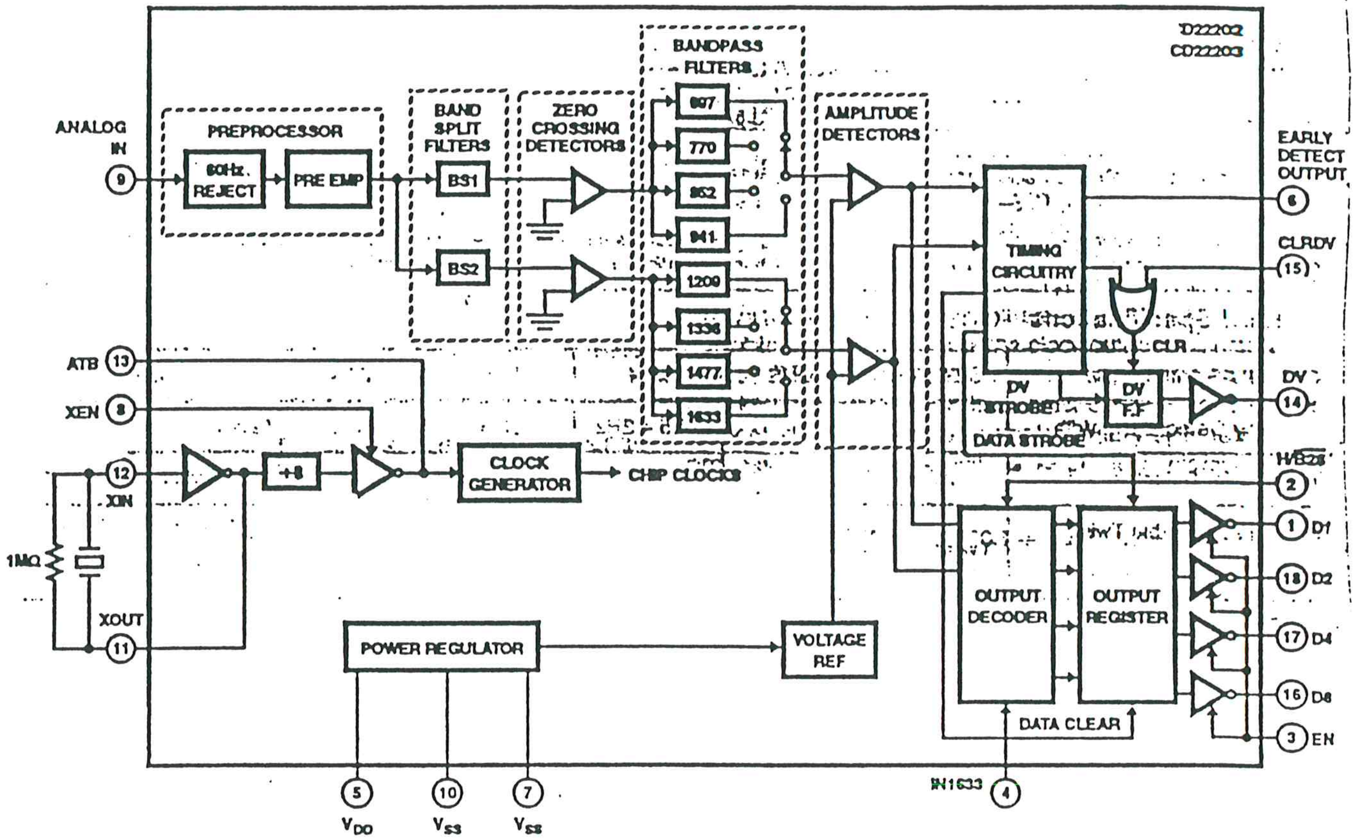
FIGURE 5.

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
Tone Time					
For Detection	t_{ON}	40	-		ms
For Rejection	t_{ON}		-	20	ms
Pause Time					
For Detection	t_{OFF}	40	-	-	ms
For Rejection	t_{OFF}		-	20	ms
Detect Time	t_D	25	-	46	ms
Release Time	t_R	35		50	ms
Data Setup Time	t_{SU}	7		-	µs
Data Hold Time	t_H	4.2		5	ms
DV Clear Time	t_{CL}	-	160	250	ns
CLRDV Pulse Width	t_{PW}	200	-		ns
ED Detect Time	t_{ED}	7	-	22	ms
ED Release Time	t_{ER}	2	-	18	ms
Output Enable Time C_L = 50pF, R_L = 1kΩ	-	-	200	300	ns
Output Disable Time C_L = 35pF, R_L = 500Ω	-	-	150	200	ns
Output Rise Time C_L = 50pF	-	-	200	300	ns
Output Fall Time C_L = 50pF	-	-	160	250	ns

Guard Time

Whenever the DTMF receiver is continually monitoring a voice channel containing distorted or musical voices or tones, additional guard time may be added in order to prevent false decoding. This may be done in software by verifying that both ED and DV are present simultaneously for about 55ms. An appropriate guard time should be selected to balance the fastest expected dialing speed against the rejection of distorted or musical voices or tones (most autodialers operate in the 65ms to 75ms range although a few generate 50ms tones). A hardware guard time circuit is shown in Figure 6. R3 and R4 should keep the voice amplitude as low as practical, while R2 and R5 adjust detection speed.

Functional Block Diagram



NOTE: Pin 6: Early detect output on CD22203 only.

System Functions

Analog In

The Analog In pin accepts the analog input. It is internally biased so that the input signal may be either AC or DC coupled, as long as it does not exceed the positive supply voltage. Proper input coupling is illustrated below.

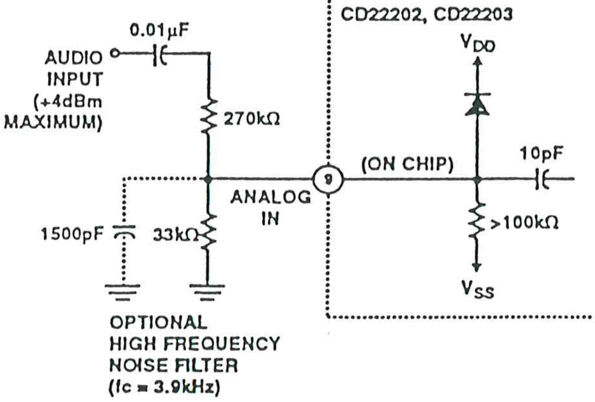


FIGURE 1. ANALOG IN

The CD22202 and CD22203 are designed to accept sinusoidal input waveforms, but will operate satisfactorily with any input that has the correct fundamental frequency with harmonics that are at least 20dB below the fundamental.

Crystal Oscillator

The CD22202 and CD22203 contain an on-board inverter with sufficient gain to provide oscillation when connected to a low cost television "color-burst" (3.579545MHz) crystal. The crystal oscillator is enabled by tying XEN high. The crystal is connected between XIN and XOUT. A 1MΩ resistor is also connected between these pins in this mode. ATB is a clock frequency output. Other CD22202 and CD22203 devices may use the same frequency reference by tying their ATB pins to the ATB output of a crystal connected device. XIN and XEN of the auxiliary devices must then be tied high and low, respectively. Up to ten devices may be run from a single crystal connected CD22202 and CD22203 as shown in Figure 2.

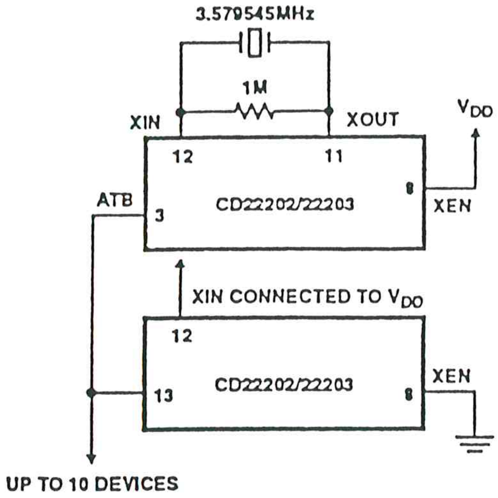


FIGURE 2. CRYSTAL OSCILLATOR

DV remains high until a valid pause occurs or CLRDV is raised high, whichever is sooner. This handshake can save microprocessor time.

DTMF Dialing Matrix

	COL 0 1209Hz	COL 1 1336Hz	COL 2 1477Hz	COL 3 1633Hz
ROW 0 697Hz	1	2	3	A
ROW 1 770Hz	4	5	6	B
ROW 2 852Hz	7	8	9	C
ROW 3 941Hz	*	0	#	D

NOTE: Column 3 is for special applications and is not normally used in telephone dialing.

HEX/$\overline{B28}$

This pin selects the format of the digital output code. When HEX/$\overline{B28}$ is tied high, the output is hexadecimal. When tied low, the output is binary coded 2-of-8. The following table describes the two output codes.

TABLE 1. OUTPUT CODES

	HEXADECIMAL				BINARY CODED 2-OF-8			
DIGIT	D8	D4	D2	D1	D8	D4	D2	D1
1	0	0	0	1	0	0	0	0
2	0	0	1	0	0	0	0	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	0	0
5	0	1	0	1	0	1	0	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	1	0	0	0
8	1	0	0	0	1	0	0	1
9	1	0	0	1	1	0	1	0
0	1	0	1	0	1	1	0	1
*	1	0	1	1	1	1	0	0
#	1	1	0	0	1	1	1	0
A	[illegible]	1	0	1	0	0	1	1
B	[illegible]	[illegible]	1	0	0	1	[illegible]	[illegible]
C	[illegible]	1	1	1	1	0	1	1
D	0	0	0	0	1	1	1	1

ED

This pin, on the CD22203 only, indicates the presence of frequencies which are likely to be DTMF digits, but have not yet been verified by a DV signal. It is comparable to a "button-down" output, and it is useful as an EARLY DETECT signal to interrupt a microprocessor for digit storage and validation.

DV and CLRDV

DV signals a detection by going high after a valid tone pair is sensed and decoded at the output pins D1, D2, D4, and D8.

IN1633

When tied high, this pin inhibits detection of tone pairs containing the 1633Hz component. For detection of all 16 standard digits, IN1633 must be tied low.

N/C Pin

This pin has no internal connection and should be left floating.

Digital Inputs and Outputs

All digital inputs and outputs of the DTMF receivers are represented by the schematic below. Only the "analog in" pin is different, and is described above. Care must be exercised not to exceed the voltage or current ratings on these pins as listed in the "maximum ratings" section.

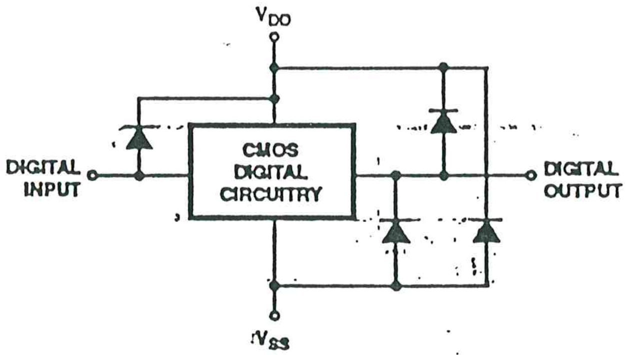


FIGURE 3. DIGITAL INPUTS AND OUTPUTS

Input Filter

The CD22202 and CD22203 will tolerate total input noise of a maximum of 12dB below the lowest amplitude tone. For most telephone applications, the combination of the high frequency attenuation of the telephone line and internal band limiting make special circuitry at the input to these receivers unnecessary. However, noise near the 56kHz internal sampling frequency will be aliased (folded back) into the audio spectrum, so if excessive noise is present

Absolute Maximum Ratings

DC Supply Voltage (V_{DD})(Referenced to V_{SS} Terminal) .... +7V
Power Dissipation
T_A = +25°C (Derate above T_A = +25°C at 6.25mW/°C 65mW
Input Voltage Range
All Inputs Except Analog In.............. (V_{DD} +0.5V) to -0.5V
Analog In Voltage Range .... (V_{DD} +0.5V) to (V_{DD} -10V)
DC Current Into any Input or Output .... ±20mA
Junction Temperature .... +175°C
Junction Temperature (Plastic Packages)............... +150°C
Lead Temperature (Soldering 10 Sec.)................. +300°C

Operating Conditions

Operating Temperature Range .... 0°C to +70°C
Storage Temperature Range .... -65°C to +150°C

NOTE: Unused Inputs must be connected to V_{DD} or V_{SS} as appropriate.

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications $0°C \le T_A \le +70°C$, V_{DD} = 5V ±10%

PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Frequency Detect Bandwidth		±(1.5 + 2Hz)	±2.3	±3.5	% of f_o
Amplitude for Detection	Each Tone	-32	-	-2	dBm Referenced to 600Ω
Minimum Acceptable Twist	Twist = $\frac{\text{high tone}}{\text{low tone}}$	-10	-	+10	dB
60Hz Tolerance		-	-	0.8	V_{RMS}
Dial Tone Tolerance	"Precise" Dial Tone	-	-	0	dB Referenced to Lower Amplitude Tone
Talk Off	MITEL Tape #CM7291	-	2	-	Hits
Digital Outputs (except XOUT)	"0" Level, 400μA Load	0	-	0.5	V
	"1" Level, 200μA Load	V_{DD} -0.5	-	V_{DD}	V
Digital Inputs	"0" Level	0	-	0.3V_{DD}	V
	"1" Level	0.7V_{DD}	-	V_{DD}	V
Supply Current	T_A = +25°C	-	10	16	mA
Noise Tolerance	MITEL Tape #CM7291 (Note 1)	-	-	-12	dB Referenced to Lowest Amplitude Tone
Input Impedance	$V_{DD} \ge V_{IN} \ge (V_{DD}$ -10)	100kΩ//15pF	300kΩ	-	

NOTE:
1. Bandwidth Limited (3kHz) Gaussian noise.

EN SAVOIR PLUS SUR LE SSI 202

1. Généralités (fig. 9)

Le système de chiffrage par impulsions a pour ainsi dire totalement disparu pour laisser la place à la DTMF *(Dual Tone Multi Frequency)*. Il s'agit d'un procédé consistant, pour un chiffre donné, à superposer deux fréquences sinusoïdales de la gamme musicale. Le tableau de la **figure 9** indique les fréquences retenues. Il s'agit d'une normalisation au niveau international.

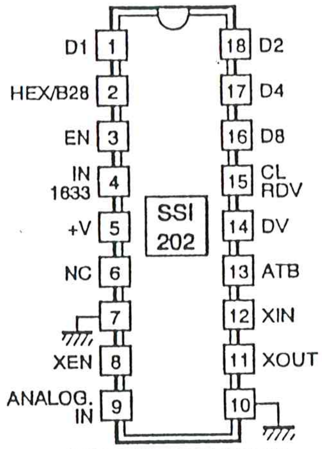
Le SSI 202 est un circuit intégré spécifique dont le rôle consiste à décoder les signaux DTMF pour restituer en sortie une indication binaire sur 4 bits. Il est alimenté sous un potentiel de 5 V.

	1209Hz	1336Hz	1477Hz	1633Hz
697Hz	1	2	3	A
770Hz	4	5	6	B
852Hz	7	8	9	C
941Hz	*	0	#	D

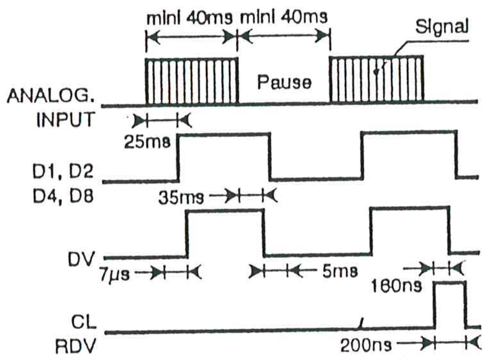
LES FREQUENCES DTMF

	HEX/B28=1				HEX/B28=0			
	D8	D4	D2	D1	D8	D4	D2	D1
1	0	0	0	1	0	0	0	0
2	0	0	1	0	0	0	0	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	0	0
5	0	1	0	1	0	1	0	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	1	0	0	0
8	1	0	0	0	1	0	0	1
9	1	0	0	1	1	0	1	0
0	1	0	1	0	1	1	0	1
*	1	0	1	1	1	1	0	0
#	1	1	0	0	1	1	1	0
A	1	1	0	1	0	0	1	1
B	1	1	1	0	0	1	1	1
C	1	1	1	1	1	0	1	1
D	0	0	0	0	1	1	1	1

TABLEAU DE DECODAGE



BROCHAGE DU SSI 202



LE FONCTIONNEMENT

LE FONCTIONNEMENT DU SSI 202P.

2. Fonctionnement

L'entrée IN 1633

Si l'on relie cette entrée à l'état haut, il se produit la neutralisation de la détection de la colonne correspondant à 1 633 Hz ; il s'agit des touches A, B, C et D non disponibles généralement sur un clavier téléphonique classique.

Les signaux d'entrée

Les signaux analogiques à décoder sont à présenter sur l'entrée « ANALOG IN ». Si la composante continue du signal est inférieure à 5 V, le couplage peut être direct. Dans le cas contraire, il y a lieu d'intercaler une capacité de couplage de 0,47 µF à 1 µF. L'amplitude des signaux doit être comprise entre – 32 et – 2 dB, ce qui correspond à des valeurs crête de quelque dixièmes de volt. L'impédance de cette entrée est de 100 kΩ.

La base de temps

La chronométrie interne est entièrement gérée par un quartz externe de 3,579545 MHz. Ce quartz est à relier aux broches X_{IN} et X_{OUT} avec une résistance de 1 MΩ montée en parallèle.

La base de temps est opérationnelle à condition que l'entrée X_{EN} soit soumise à un état haut. Si l'on relie cette entrée à un état bas, la base de temps est neutralisée.

La sortie ATB peut être utilisée pour reporter la base de temps vers d'autres circuits SSI 202, qui n'auront plus besoin d'être équipés de quartz. Dans cette configuration, les SSI ainsi pilotés auront :

— leur entrée X_{IN} reliée à un état haut ;

— leur entrée X_{EN} reliée à un état bas ;

— leur broche ATB (qui devient ainsi une entrée) reliée à la sortie ATB du circuit « piloté ».

Le décodage

Suivant que l'entrée HEX/B28 est soumise à un état haut ou à un état bas, le circuit intégré génère deux types de décodage repris dans le tableau de la **figure 9.**

Les sorties D_1, D_2, D_4, D_8 et l'entrée « EN »

Le décodage évoqué ci-dessus n'est opérationnel que si l'entrée « EN » est reliée à l'état haut. Si cette entrée est reliée à l'état bas, les sorties D_i sont découplées de la structure interne du circuit intégré.

Le contrôle du décodage

Si le décodage est reconnu valable, la sortie DV passe à l'état haut. Cette sortie repasse à l'état bas si les signaux d'entrée cessent avec un retard mis en évidence par les graphes de la **figure 9**.

Il existe un second moyen de faire passer DV à l'état bas, après décodage d'un signal reconnu comme conforme : ce moyen consiste à soumette, même très brièvement, l'entrée CLR DV à un état haut. Dans ce cas, la sortie DV passe à l'état bas, même si l'entrée « ANALOG IN » n'a pas encore détecté de pause et continue de recevoir le signal analogique à décoder.

BROCHAGES DU SSI202P

2) sélection binaire/hexadécimal, à 1 : hexadécimal, à 0 : binaire – 3) validation des sorties à l'état haut, à 0 : sorties à haute impédance – 4) validation de la colonne 1 633 Hz, touches A B C D, si état bas – 8) validation de la base de temps si état haut – 9) entrée DTMF – 11) sortie de la base de temps – 12) entrée de la base de temps – 13) sortie de la base de temps – 14) contrôle du décodage, si OK, elle passe à l'état haut – 15) mise à zéro de la sortie 14 en la soumettant à un état haut.

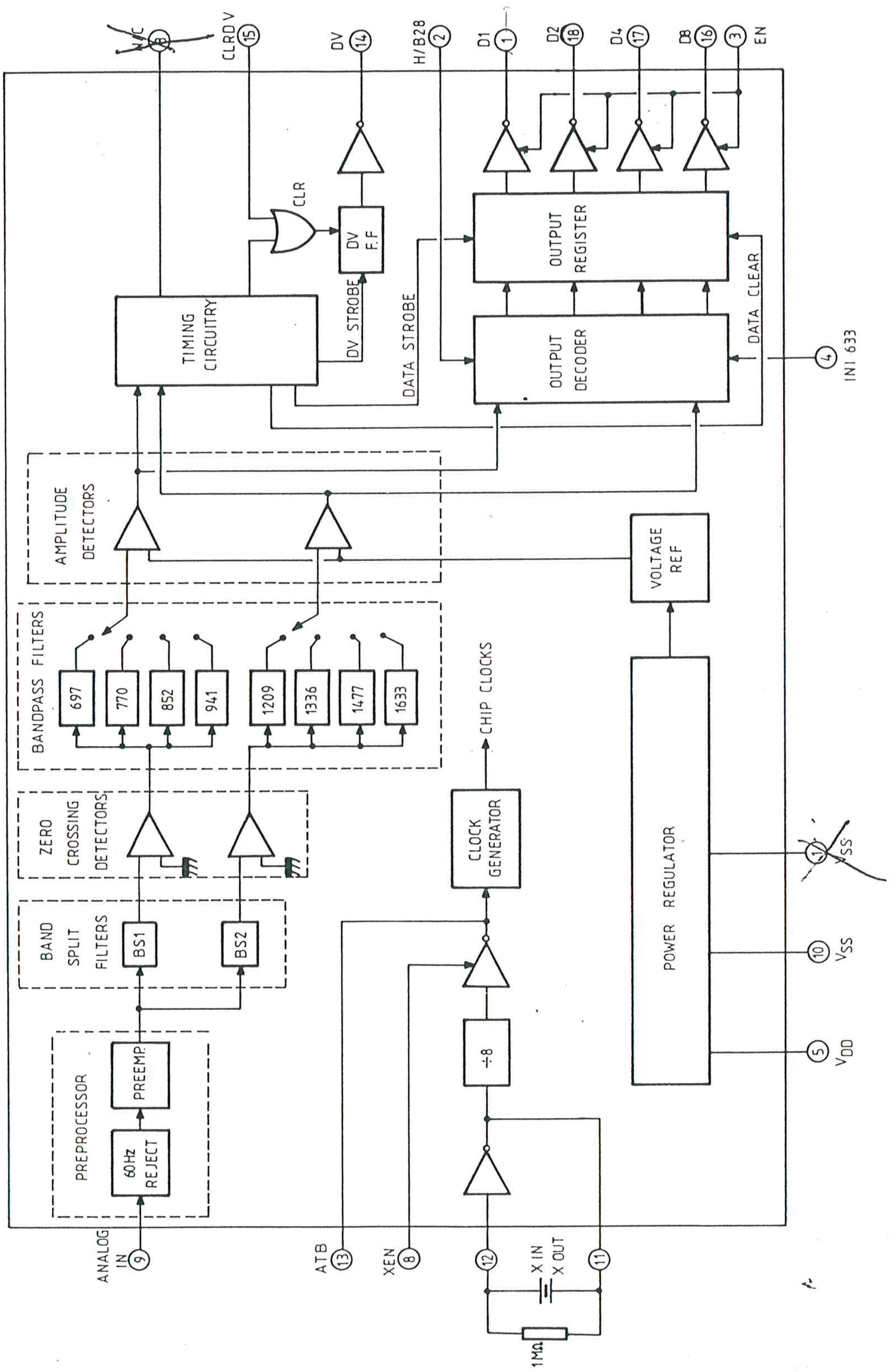


Fig. 4. – Synoptique interne simplifié du SSI 202.

TS2e

TCM5089A
TONE ENCODER

features

- Fixed-Supply voltage operation
- Minimal standby power requirement
- Use of inexpensive television color burst crystal (3.579545 MHz) to provide highly accurate and stable tones
- Minimum external parts required
- Total Harmonic Distortion complies with industry standards
- Dual-tone and single-tone capability
- Single Tone Inhibit selects DTMF only
- Tone Inhibit capability to allow keyboard to be used for non-DTMF functions
- Any key depressed control capability
- Device power delivered directly from the telephone lines or small batteries (e.g., 9 Volts) due to CMOS low power circuitry
- Electronic input capability
- PEP 3 processing available
- Designed to be interchangeable with Mostek MK5089

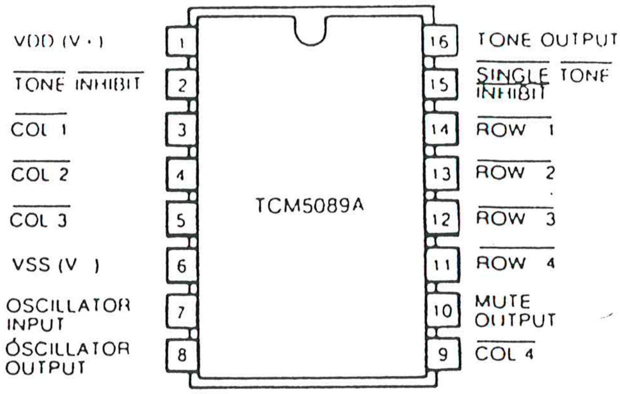


FIGURE 1 - PIN CONFIGURATION

general description

The TCM5089A is specifically designed for the dual-tone telephone dialling system. It is a monolithic integrated circuit using the CMOS technology.

In addition to fixed supply voltage operation, the Tone Encoder provides negative-true keyboard input, tone inhibit input, stable output tone level, any key depressed feature as well as a single tone inhibit pin.

An inexpensive TV crystal is used to generate eight different audio sinusoidal frequencies.

The tones suitable for dual-tone multi-frequency (DTMF) telephone dialling are digitally synthesized on the chip. The conventional R-2R ladder network is used to provide on-chip digital to analog conversion. The current-to-voltage transformation for D-to-A converter is accomplished by the same operational amplifier which sums up the « low-group » and « high-group » signals.

The waveforms generated in the manner described above have very low Total Harmonic Distortion. Moreover, the frequency stability of this Tone Encoder complies with standard DTMF specifications without need for any frequency adjustments.

absolute maximum ratings[2]

DC supply voltage V_{DD}	+10.5 V
Pin voltage relative to V_{DD} (except pin 10)	+0.30 V
Pin voltage relative to V_{SS} (except pin 10)	−0.30 V
Maximum package power capability	1150 mW at 25 °C
Operating ambient temperature	−30 °C to +70 °C
Storage ambient temperature	−50 °C to +150 °C

electrical characteristics at 25°C free-air temperature

PARAMETER CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNITS	COMMENTS
Voltage Supply	V_{DD}	3.0		10.0	V	
Input "low"		V_{SS}		.3 V_{DD}	V	
Input "high"		.7 V_{DD}		V_{DD}	V	
Input Resistor (pull up)	R_{IN}	20		100	kOhms	
$\overline{\text{Tone Inhibit}}$		V_{SS}		.3 V_{DD}	V	1
Tone Output	V_O	- 10.0		- 7.0	dBm	2
High Band Pre-Emphasis		2.4	2.7	3	dB	3
Output Distortion	D			- 20	dB	3, 4
Tone Output Rise Time	t_{RISE}		2.8	5.0	msec	5, 6
Sink Current to Vss (any key depressed) @ .5 V	I_{AKD}	500			μA	
Any key depressed off leakage @ .5 V	I_{AKDL}			2.0	μA	
Operating Supply Current at V_{DD} = 3.5 V	I_{OP}			2.0	mA	7
Standby Supply Current at V_{DD} = 10 V	I_{SB}			200.0	μA	8
Output Tone No key depressed. RL = 10kOhms	V_{NKD}			- 80	dBm	

comments :

1 When $\overline{\text{Tone Inhibit}}$ is tied to V_{SS} supply (logic "0"), tones are inhibited. However, other chip functions remain unchanged.

2 « Low-group » frequencies, single-tone, 3.4 V < V_{DD} < 3.6 V, −0 dBm .775 V, load resistor R_L = 10 kOhms

3 3.4 V < V_{DD} < 10.0 V for any dual-tone, R_L = 10 kOhms.

4 Distortion measurements are in terms of the total out-of-band power relative to the total RMS column and row fundamental power.

5 Time required for a valid keystroke with no bounce to cause the wave to travel from minimum to 90 % of the final value of either frequency.

6 Crystal parameters are the following : F = 3.579545 MHz ± .02 %, R_S = 100 Ohms, C_L = 18 pf, C_H = 5 pf, C_M = 0.02 pf, and L_M = 96 mH, V_{DD} = 3.4 V.

7 Outputs are unloaded and only one key is depressed.

8 No keys are depressed. $\overline{\text{Tone Inhibit}}$ = logical 1 and $\overline{\text{Single Tone Inhibit}}$ = logical 0.

design specification

Two voice frequency signals are linearly added to create the dual-tone signal. One frequency is selected from a « low-group » and the other from a « high-group » of frequencies. The « low-group » consists of four frequencies 697, 770, 852, and 941 Hertz. The « high-group » consists of four frequencies 1209, 1336, 1477, and 1633 Hertz.

The number entry is accomplished by a keyboard arranged in a row, column format. In order to select one appropriate row and one appropriate column, a push button corresponding to a digit is pushed. One of the « high-group » frequencies is selected by the active column input and one of the « low-group » frequencies is selected by the active row input. The highest « high-group » frequency of 1633 Hertz is not used in standard dual-tone implementation.

The Total Harmonic and Intermodulation Distortions of the dual-tone should be less than 10 % at the telephone terminals. The frequency tolerance is ±1.0 %. TCM5089 Tone Encoder provides accuracy of less than .75 %. The « high-group » to « low-group » signal amplitude ratio should be 2.7 ± .3 dB. The above mentioned specifications hold over the safe operating temperature range for either short loop or long loop telephone application.

FREQ.	STANDARD DTMF	OUTPUT TONE	% ERROR
f_1 (R_1)	697	701.3	+0.62
f_2 (R_2)	770	771.4	+0.19
f_3 (R_3)	852	857.2	+0.61
f_4 (R_4)	941	935.1	-0.63
f_5 (C_1)	1209	1215.9	+0.57
f_6 (C_2)	1336	1331.7	-0.32
f_7 (C_3)	1477	1471.9	-0.35
f_8 (C_4)	1633	1645	+0.73

TABLE 1 - COMPARISON OF STANDARD VERSUS ACTUAL TONES GENERATED BY TCM5089A USING F = 3.579545 MHz ± .02 % CRYSTAL OSCILLATOR.

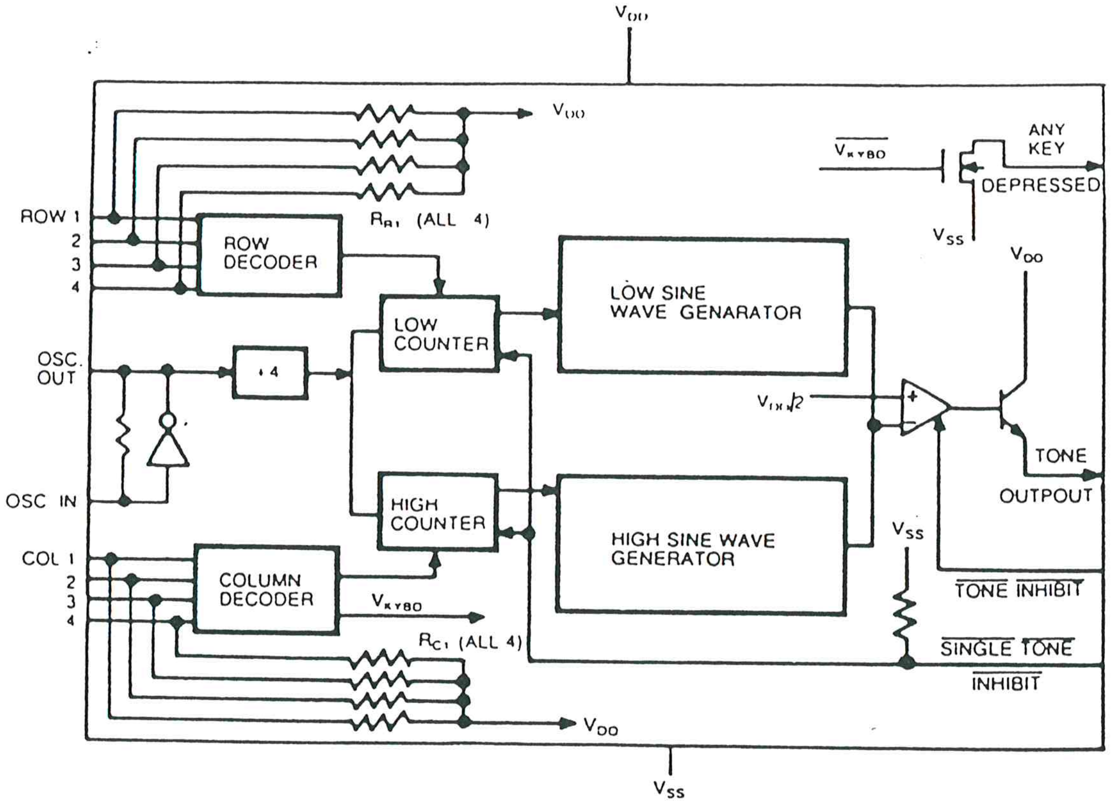


FIGURE 3-BLOCK DIAGRAM OF TCM5089A

oscillator

Oscillation is provided by means of an inexpensive TV crystal and an on-board inverter with sufficient loop-gain. The inverter's input and output are pin 7 and 8 respectively. The crystal frequency is 3.579545 MHz and it does not vary more than ± 0.02 % Any deviation of the crystal would affect the tone output frequency

keyboard interface

The TCM5089A is compatible with keyboards as well as electronic inputs. A keyboard diagram is shown in figures 4 and 5. The electronic inputs are shown in figure 6. The standard CMOS operated off the same supply as TCM5089A or open collector TTL can be used for electronic control. The keyboard inputs are standard CMOS with pull-up resistors to the supply voltage V_{DD}. CMOS circuits are capable of realizing resistance up to 1 kOhms as a valid key closure, therefore, the precious metals used in keyboard switch contacts can be saved

In order to generate a particular column tone, the column is connected to V_{SS} and the $\overline{\text{single tone inhibit}}$ is tied to V_{DD}. No tones will result if more than one column is connected to VSS. When one or more rows are connected to V_{SS}, no tones are generated. In order to generate a particular row tone, the row is connected to V_{SS} along with any two column pins. The generation of dual-tones required connection of a single row and a single column to V_{SS}.

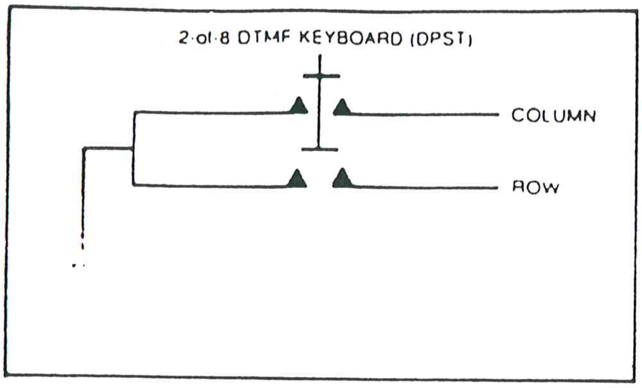


FIGURE 4 - KEYBOARD DIAGRAM

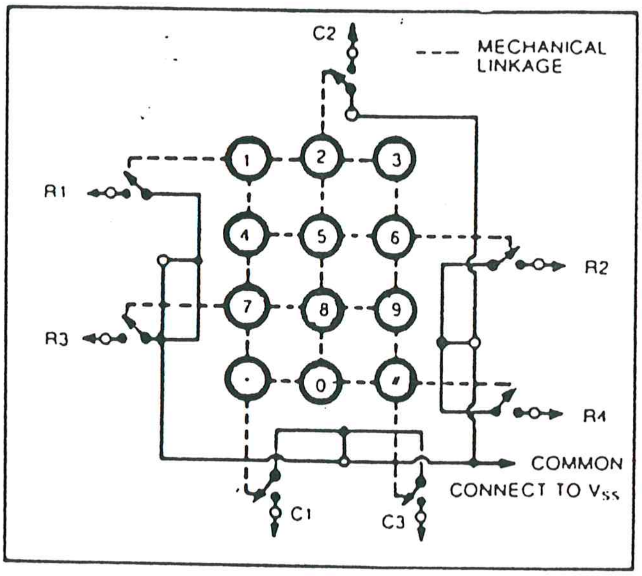


FIGURE 5 - PUSH BUTTON TELEPHONE KEYBOARD

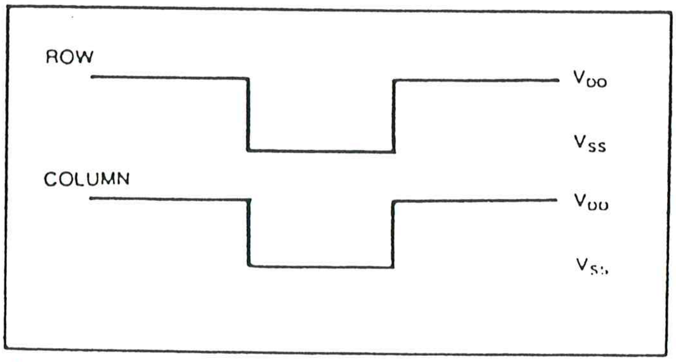


FIGURE 6 - ELECTRONIC INPUTS

output waveforms

Typical stairstep approximation of row and column sinusoidal outputs are shown in figures 7 and 8. On-chip counters as well as D-to-A converters are used to synthesize these sine waveforms whose typical distortion is less than 7 %. The row and colum frequencies are mixed by means of the on-chip operational amplifier. A typical spectral analysis of the resulting dual-tone waveform will indicate that all harmonic and intermodulation distortions will be − 30 dB down when referenced to the strongest column tone fundamental.

single tone inhibit

Pin 15 is used to inhibit the generation of single tones. This pin is capable of pulling down to V_{SS} supply voltage. The dual or the single tones are generated as described under keyboard Interface when this pin is connected to V_{DD} supply voltage. When this pin is pulled down to V_{SS} or left floating, all chip functions remain unchanged except for the single tone operation which results in no tone at this voltage level.

distortion considerations

The following formula is used to calculate the Total Harmonic Distortion of a single row or a single column.

$$THD = \frac{\sqrt{V^2_{2f} + V^2_{3f} + V^2_{4f} + V^2_{5f} + \ldots + V^2_{nf}}}{V_f} \times 100\ \%$$

Where V_{2f} is the second harmonic of the fundamental frequency waveform and so on.

The dual-tone Total Harmonic Distortion is given by the following formula :

$$THD = \frac{\sqrt{V^2_{2R} + V^2_{3R} + \ldots + V^2_{nR} + V^2_{2C} + \ldots V^2_{nC} + V^2_{IMD}}}{\sqrt{V^2_{FR} + V^2_{FC}}} \times 100\ \%$$

Where V_{FR} and V_{FC} are the row and column fundamental frequency waveforms. V_{2R} and V_{2C}. etc. are the corresponding harmonics.

V^2_{IMD} denotes the total intermodulation distortion

V^2_{IMD} = (V[illegible]$)^2$ + (V[illegible]$)^2$ + … + (V[illegible]$)^2$ + (V[illegible]$)^2$

A relatively simple method of distortion measurement uses a Spectrum Analyzer to relate the harmonics to the fundamental frequency waveform.

The Tone Encoder spectrum indicates the harmonics and intermodulation distortion at least 30dB down relative to the column tone. Another for distortion measurement of the dual-tone waveforms is to compare the total power in the fundamental frequencies with the total power in the varius harmonics plus intermodulation on a Signal Analyser. The TCM5089A provides an output distortion of − 20 dB maximum.

Moreover, when the device is operated between 3 Volts and 3.5 Volts, some clipping occurs at the output waveform causing the distortion in this voltage range to exceed − 20dB maximum.

any key depressed

Pin 10 is used for electronic control of the transmitter and/or the receiver switching as well as other functions. This pin acts like an open-circuit. However, when a keyboard button is pushed, the pin switches to V_{SS}.

The status of the $\overline{\text{tone inhibit}}$ and the $\overline{\text{single tone inhibit}}$ does not affect the output at pin 10.

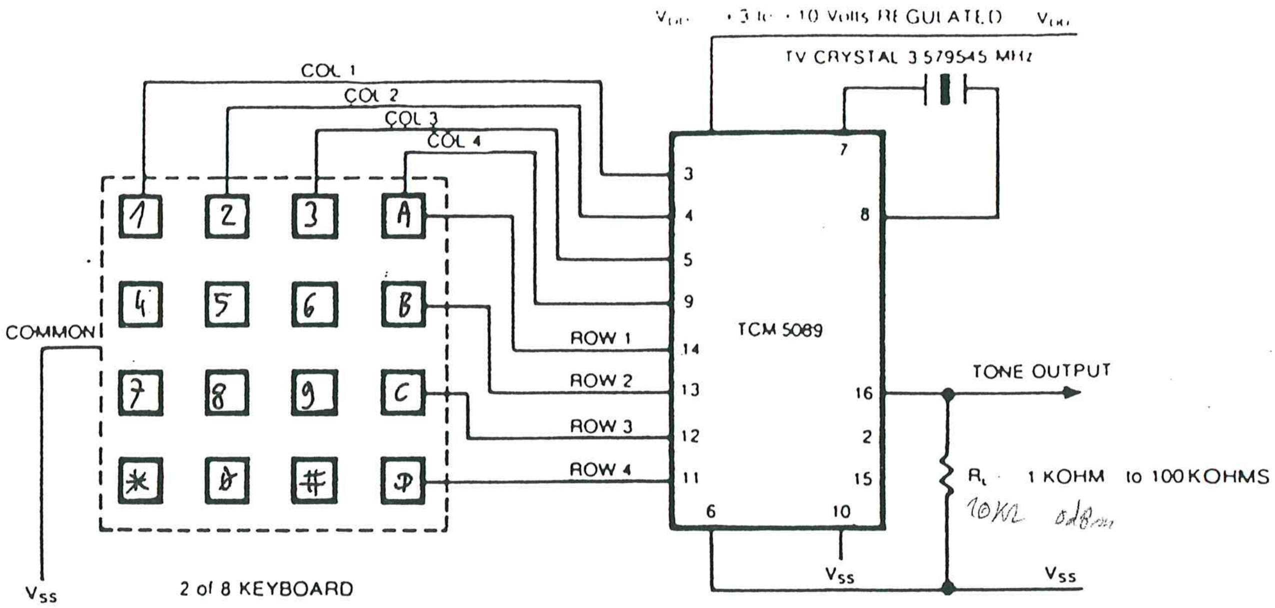
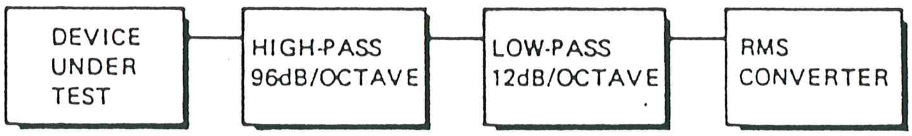


FIGURE 10 - TYPICAL HOOK-UP CONFIGURATION



DISTORTION MEASUREMENT

FREQUENCY TEST

FIGURE 11 - DEVICE TEST CIRCUITS

III – FONCTIONNEMENT
(fig. 2, 3 et 4)

1. Les fréquences générées

Les tableaux de la **figure 3** reprennent les huit fréquences de base générées par le circuit intégré : quatre fréquences (F_1 à F_4) pour les rangées et quatre fréquences (C_1 à C_4) pour les colonnes. Le dernier tableau indique, pour chaque chiffre, la combinaison adoptée par le système DTMF, de deux fréquences de base. On notera que la fréquence la plus élevée et propre à la colonne 4 n'est pas utilisée dans le système de chiffrage DTMF.
Les signaux générés ont une allure sinusoïdale. Les deux fréquences sont additionnées point par point pour former un signal de sortie du type de celui qui est représenté en **figure 6**.

Les valeurs des fréquences de base sont obtenues par des divisions successives d'une fréquence pilote très élevée de plus de 3 MHz. Il en résulte la génération de valeurs numériques finales qui sont légèrement différentes des valeurs standards. Les spécifications définies par la téléphonie imposent une tolérance maximale de ± 1 %. On notera que cette tolérance est largement respectée par le TCM 5089. Les mêmes spécifications limitent à 10 % les distorsions et exigent un niveau sonore de 2,7 ± 3 dB. Le circuit introduit une distorsion inférieure à 7 %.

2. Oscillateur

La fréquence pilote est obtenue à partir d'un quartz monté entre les broches 7 et 8 du circuit intégré. Il s'agit d'un quartz de 3,579 545 MHz, qui est une valeur très courante, utilisée notamment en télévision couleur.
Bien entendu, il est également possible de piloter le circuit intégré à partir d'une base de temps extérieure. Dans ce cas, le signal devra être introduit par l'intermédiaire de la broche n° 7, la broche n° 8 restant inutilisée.

3. Le clavier (fig. 4)

Le TCM 5089 peut être commandé par un clavier téléphonique comportant quatre rangées de trois colonnes, à savoir les chiffres de 0 à 9, l'astérisque (*) et la dièse (#), soit douze touches. Une touche donnée de rang « i » et de colonne « j » doit réaliser, si on la sollicite, un *double contact*, reliant simultanément le rang « i » et la colonne « j » à un commun, lui-même relié au « moins ». La résistance de contact peut aller jusqu'à 1 kΩ. Si on veut utiliser un clavier non motricé et à *contacts simples* com-

2
chéma
interne
lifié du
tégré