

CTCSS ENCODER

Features

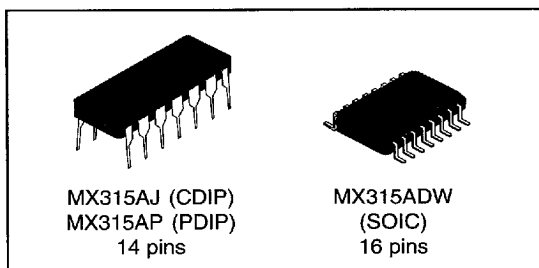
- Field Programmable Tone Encoder
- 40 CTCSS Frequencies
- Crystal-Controlled Frequency Stability
- Low Distortion Sinewave Output
- Few External Components Required
- CMOS Low Power Requirements

Applications

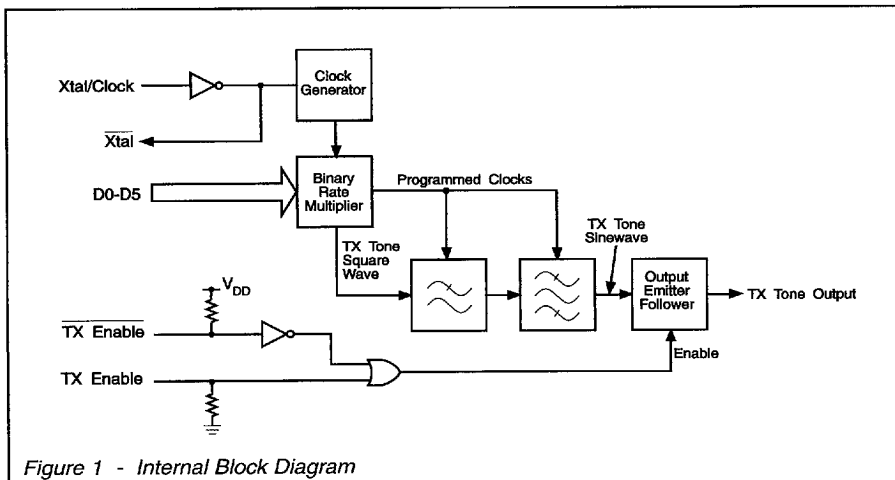
- Mobile Radio Base Stations & Repeater Stations
- Mobile Radios
- Hand-Held Radios
- Industrial Controls
- Intercom Systems
- Door-Entry Systems

Description

The MX315A is a monolithic CMOS tone encoder for sub-audible tone squelch systems. It provides three more frequencies than the earlier MX315: 69.3, 97.4 and 206.5 Hz. The tone frequencies are derived from an input reference frequency. An on-chip inverter is provided to drive an external crystal circuit.



Tone selection is achieved through six programming inputs and two control inputs (which allow either a logic "1" or "0" to enable the device). A low distortion sinewave is generated at the TX Tone Output when the MX315A is enabled. The emitter follower output stage can source 1mW directly into a 600Ω load (0dBm).



Pin Function Chart

Pin		Function
J,P	DW	
1	1	D3 D0-D5 are tone select inputs with internal pull-up resistors. The logic combination at these inputs determines the encoded CTCSS tone. See Table 1.
2	2	D2
3	3	D1 The input sequence is not latched and may be changed at any time. A logic "1" will be programmed if the input is open circuit, allowing the use of SPST switches.
4	4	D0
5	5	D4
6	6	D5
7	7	V_{SS} : Negative Supply Voltage.
8	8	Xtal/Clock In : This is the input to the CMOS inverter. It can be used in conjunction with the Xtal output to form the active element in a crystal oscillator circuit. Alternatively, a logic level 1MHz frequency can be injected at this pin. However, the supply voltage should never be applied without the input clock signal.
9	9	Xtal Output : This is the output of the CMOS inverter. When used as a crystal oscillator, track lengths and loading of this pin should be minimized.
10	10	Internal Connection: Do not use.
	11	N/C
	12	N/C
11	13	TX Tone Output : This is the tone output pin. It includes a low impedance emitter follower stage for sourcing sinusoidal tone. The tone is generated about a DC level of approximately 1/2 V _{DD} . The pin is high impedance when not encoding.
12	14	TX Enable Input : This logic input has an internal pull-up resistor. A logic "0" at this pin enables the MX315A.
13	15	TX Enable Input : This logic input has an internal pull-down resistor. A logic "1" at this pin enables the MX315A.
14	16	V_{DD} : Positive Supply Voltage.

MX315A External Components (See Figure 2)

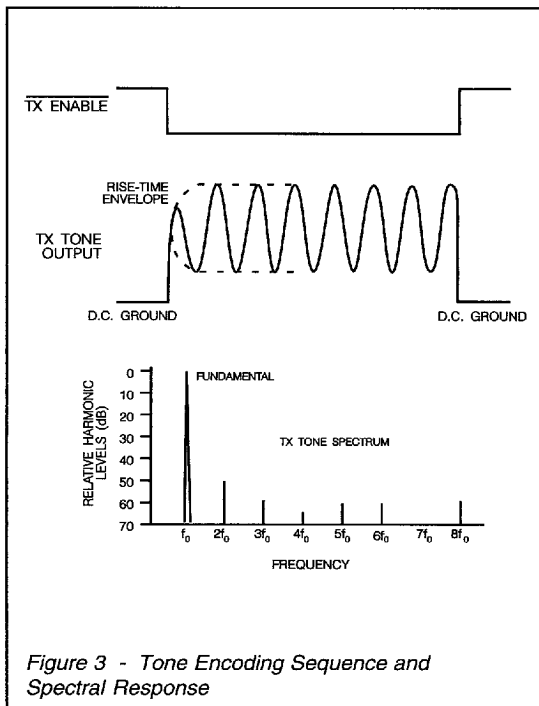
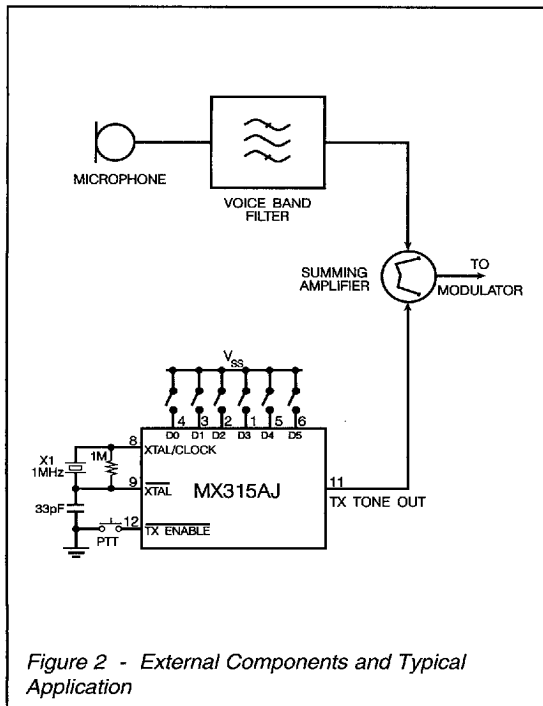
Figure 2 illustrates the required external components:

- The 1M Ω resistor is used to bias the internal CMOS inverter into its linear mode. A tolerance of $\pm 20\%$ is acceptable.
- "X1" is a parallel resonant crystal. A reference frequency of 1 MHz $\pm 0.19\%$ is required to maintain a tone accuracy within 0.5%.

Where two or more circuits are required to use a single oscillator (i.e. repeater applications), the signal at $\overline{\text{Xtal}}$ can be used to drive one additional Xtal/Clock input. Any further circuits can be driven from the buffered Xtal output of the second device.

The program code can be set on the D0-D5 inputs by hardwired logic levels or SPST switches to V_{SS}, as illustrated in Figure 2 (allowing the internal pull-up resistors to program a logic "1").

The MX315A provides both a TX Enable input and a TX Enable input. Either input can be used to enable the tone output, with the unused pin left open circuit (internal resistors establish a valid logic level and prevent damage). Any configuration of PTT switch or TX signal can therefore be interfaced.



Application Notes

The MX315A is dedicated to Continuous Tone-controlled Squelch Systems (CTCSS) in radio applications. However, it can be used wherever encoding of low-frequency tones is required, such as intercoms, door-entry systems and various industrial applications.

The performance of a CTCSS system can be degraded if speech frequencies in the signaling spectrum are not removed prior to transmission. This can be accomplished by filtering the microphone signals to attenuate frequencies below 250 Hz. Figure 2 illustrates the addition of TX Tone Output to the filtered microphone signals prior to modulation. Figure 3 illustrates the TX Tone Output sequence and a typical spectral analysis.

Interfacing and Electromagnetic Capability

The MX315A requires a clock of 1 MHz, which is internally converted to logic level square waves. Consideration should therefore be given to possible interference problems with RF or IF circuitry caused by 1 MHz or its harmonics.

A decoupling capacitor can be used to reduce ripple on the power supply. This will reduce the level of superimposed noise on the supply caused by internal switching transients (particularly at 1 MHz and f_0).

Nominal Frequency (Hz)	MX315A Freq. (Hz)	Δf_o (%)	Programming Inputs						Hex
			D5	D4	D3	D2	D1	D0	
67.0	67.06	+10	1	1	1	1	1	1	3F
69.3	69.37	+10	1	1	1	0	0	1	39
71.9	71.84	-08	0	1	1	1	1	1	1F
74.4	74.33	-10	1	1	1	1	1	0	3E
77.0	76.99	-02	0	0	1	1	1	1	0F
79.7	79.65	-06	1	1	1	1	0	1	3D
82.5	82.50	0.0	0	1	1	1	1	0	1E
85.4	85.34	-0.7	1	1	1	1	0	0	3C
88.5	88.62	+14	0	0	1	1	1	0	0E
91.5	91.38	-13	1	1	1	0	1	1	3B
94.8	94.88	+08	0	1	1	1	0	1	1D
97.4	97.46	+06	1	1	1	0	1	0	3A
100.0	99.87	-13	0	0	1	1	0	1	0D
103.5	103.39	-11	0	1	1	1	0	0	1C
107.2	107.17	-03	0	0	1	1	0	0	0C
110.9	110.85	-04	0	1	1	0	1	1	1B
114.8	114.80	0.0	0	0	1	0	1	1	0B
118.8	118.60	-17	0	1	1	0	1	0	1A
123.0	123.12	+10	0	0	1	0	1	0	0A
127.3	127.50	+16	0	1	1	0	0	1	19
131.8	131.67	-10	0	0	1	0	0	1	09
136.5	136.69	+14	0	1	1	0	0	0	18
141.3	141.48	+13	0	0	1	0	0	0	08
146.2	145.96	-16	0	1	0	1	1	1	17
151.4	151.45	+03	0	0	0	1	1	1	07
156.7	156.59	-07	0	1	0	1	1	0	16
162.2	162.10	-06	0	0	0	1	1	0	06
167.9	168.01	+07	0	1	0	1	0	1	15
173.8	173.43	-21	0	0	0	1	0	1	05
179.9	180.21	+17	0	1	0	1	0	0	14
186.2	186.46	+14	0	0	0	1	0	0	04
192.8	193.16	+19	0	1	0	0	1	1	13
203.5	202.88	-31	0	0	0	0	1	1	03
206.5	206.78	+14	1	1	1	0	0	0	38
210.7	210.84	+07	0	1	0	0	1	0	12
218.1	217.96	-07	0	0	0	0	1	0	02
225.7	225.58	-05	0	1	0	0	0	1	11
233.6	233.75	+07	0	0	0	0	0	1	01
241.8	242.54	+31	0	1	0	0	0	0	10
250.3	250.06	+10	0	0	0	0	0	0	00
Test	4032	0.0	1	1	0	0	1	1	33 (or any invalid address)

Table 1 - CTCSS Tone Programming

Specifications

Absolute Maximum Ratings

Exceeding the maximum rating can result in device damage. Operation of the device outside the operating limits is not suggested.

Supply Voltage	-0.3V to 7.0 V
Device Dissipation @ 85°C	100mW
Operating Temperature	-30°C to +85°C
Storage Temperature	-55°C to +125°C

Operating Limits

All devices were measured under the following conditions unless otherwise noted.

$V_{DD} = 5V$
$T_{AMB} = 25^{\circ}C$
Clock = 1MHz

Characteristics	See Note	Min.	Typ.	Max.	Unit
Supply Voltage (V_{DD})		4.5	5.0	5.5	V
Supply Current (operating)		-	1.5	4.5	mA
Input Impedance	1	-	500	-	k Ω
Input Impedance	2	-	10	-	M Ω
Logic Input "1"		3.5	-	-	V
Logic Input "0"		-	-	1.5	V
TX Output EMF	3	550	775	-	mVrms
TX Risettime		-	1	-	ms
TX Tone Output Load Current		-	-	5	mA
TX Distortion	3	-	2	5	%
Variation in Output Level Between Tones	3	-	0.1	-	dB

Notes:

1. Refers to D0, D1, D2, D3, D4, D5, TX Enable and TX Enable inputs.
2. Refers to Xtal/Clock input.
3. Any program tone and $R_L = 600$, $C_L = 15pF$. THD measurements are taken in the 0-6 kHz bandwidth.