MX·COM, INC. MiXed Signal ICs

DATA BULLETIN

# MX643   Call Progress Tone Detector with Special Information Tones (SIT)

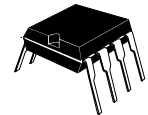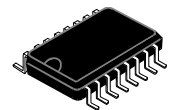- **International Special Information Tone Identification**

- **Worldwide Tone Compatibility**
- **Single and Dual Tone Detected**
- **U.S. Busy-Detect Output**
- **Voice-Detect Output**
- **Wide Dynamic Range > 40dBm**

- **- 40°C to 85°C Operating Temp**
- **Low Supply Current (0.3mA/0.5mA)**
- **Low Supply Voltage (3.3V/5.0V)**
- **Standard 3.58MHz Clock Input**
- **Standard 8-pin DIP Package**
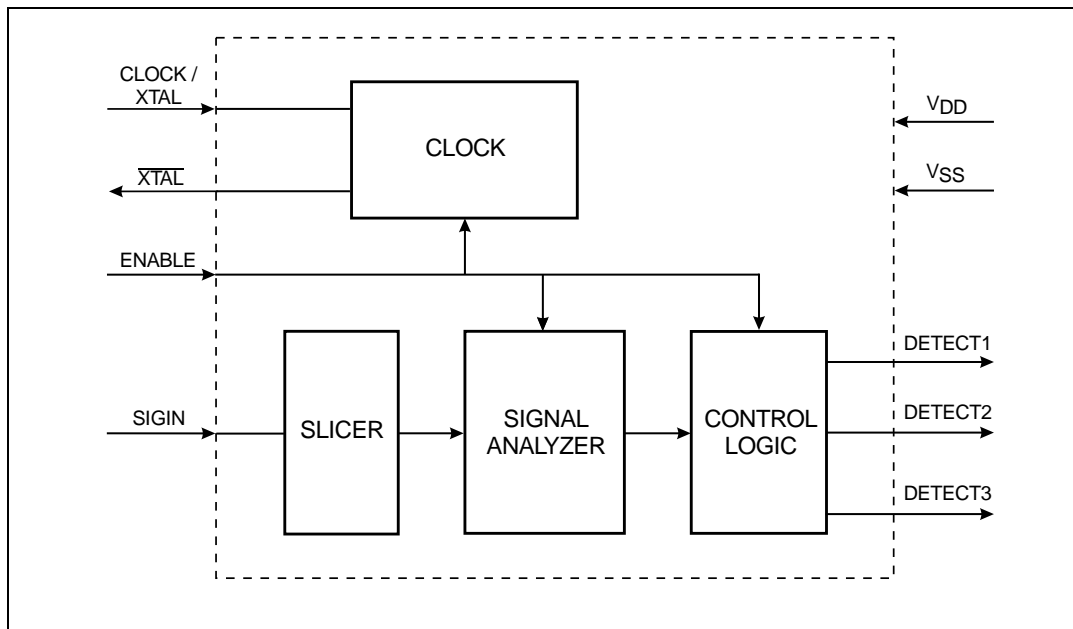
AVAILABLE PACKAGES

**MX643P
8-pin PDIP**

**MX643DW
16-pin SOIC**

The MX643 is a low power, low cost device that uses signal processing techniques to detect audible tone signals such as; Dial, Ring, Busy, Unobtainable, and other conditions found when placing a call throughout the world's telecom systems. The detection of these Call Progress stages is essential to the proper operation and application of automatic calling products.

The MX643 offers identification of International Special Information Tones (SIT), reducing the time needed for cadence verification under Obtainable conditions. In addition to the SIT feature, single and dual tone decoding are added for better cross-system Call Progress monitoring. The MX643 offers these features in addition to the same performance levels and features of the MX633 Call Progress Tone Detector such as; detection and identification of U.S. Busy tones, thereby reducing the need to measure the tone cadence to identify U.S. Busy. The decoding and indicating of speech, or other Non-Call Progress signals, thus reducing voice-falsing of Call Progress tones and adding Voice-Answer as a connect prompt.
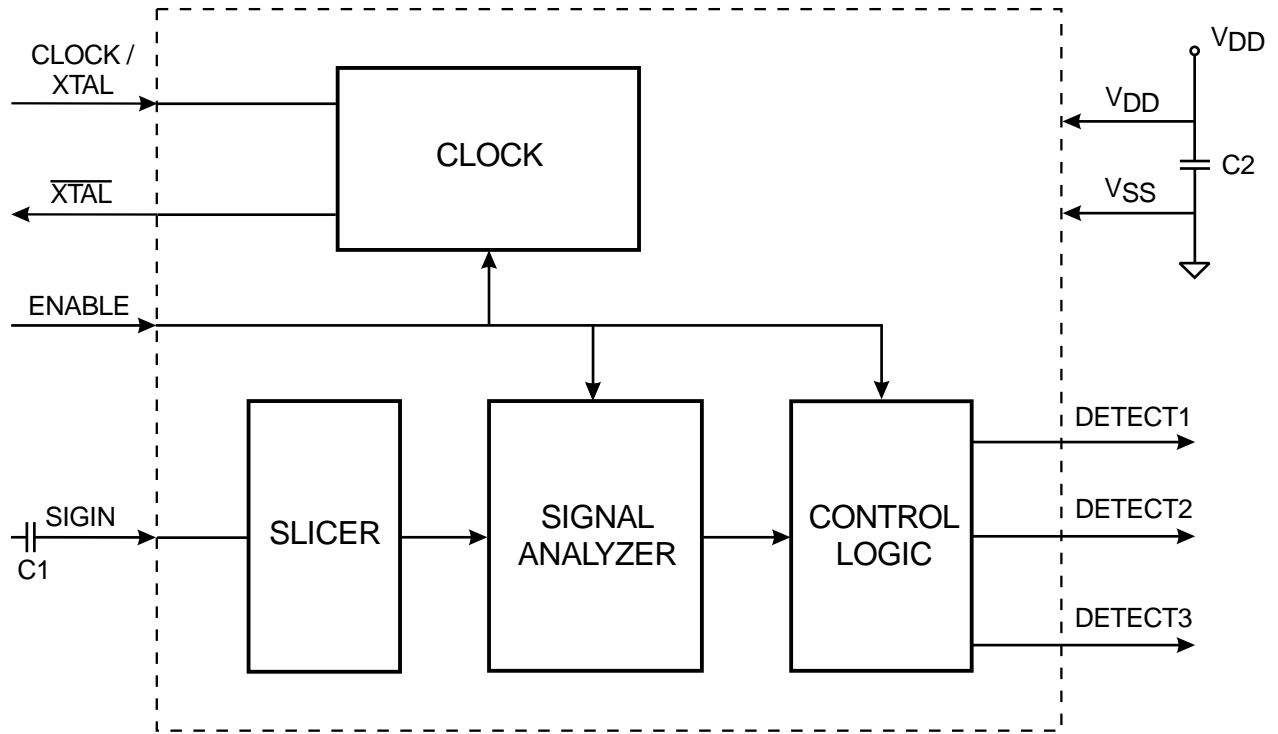
Available in the industry standard 8-pin DIP, the MX643 is also available in a 16-pin SOIC making it pin compatible with the MX633DW (16-pin SOIC).

CONTENTS

MX•COM, Inc. reserves the right to change specifications at any time and without notice.

1. Block Diagram

Note: $\overline{\text{XTAL}}$ used for 16-pin SOIC (MX643DW) only.

Figure 1: Block Diagram

2. Signal List

P-Pin No.	DW-Pin No.	Signal	Type	Description
1	2	CLOCK / XTAL	input	For the MX643P this is the external clock input to the clock divider circuit. For the MX643DW this can be either an external clock input or an external crystal input.
-	3	$\overline{\text{XTAL}}$	output	Output of the on-chip oscillator. Not available on 8-pin DIP..
2	4	DETECT3	output	When a single tone is within the range of the Call Progress Band, Non Call Progress Band, or a Special Information Tone, is detected, this output goes to a logic 1.
3	5	ENABLE	input	A logic 1 applied to this input enables the decoder and detection outputs. A logic 0 applied to this input disables the decoder and forces DETECT1, DETECT2 and DETECT3 to a logic 0.
4	7	DETECT1	output	When a call progress signal is detected, this output goes to a logic 1.
5	10	SIGIN	input	Signal input. Signals to this pin should be ac coupled. The dc bias of this pin is set internally.
6	12	V_{SS}	power	Negative supply. (ground).
7	13	DETECT2	output	This output is used in conjunction with DETECT1. When DETECT1 is at a logic 1, this output goes to a logic 1 if a Call Progress High Band signal is detected. When DETECT1 is at a logic 0, this output goes to a logic 1 if a Non Call Progress signal is detected.
8	15	V_{DD}	power	Positive supply. This pin should be decoupled to V_{SS} by a capacitor.
	1, 6, 8, 9, 11, 14, 16	N/C		Internal connection. Do not make a connection to these pins.

3. External Components

C1	1.0nF	±20
C2	1.0μF	±20
For details of CLOCK frequency refer to Sec.6.1		

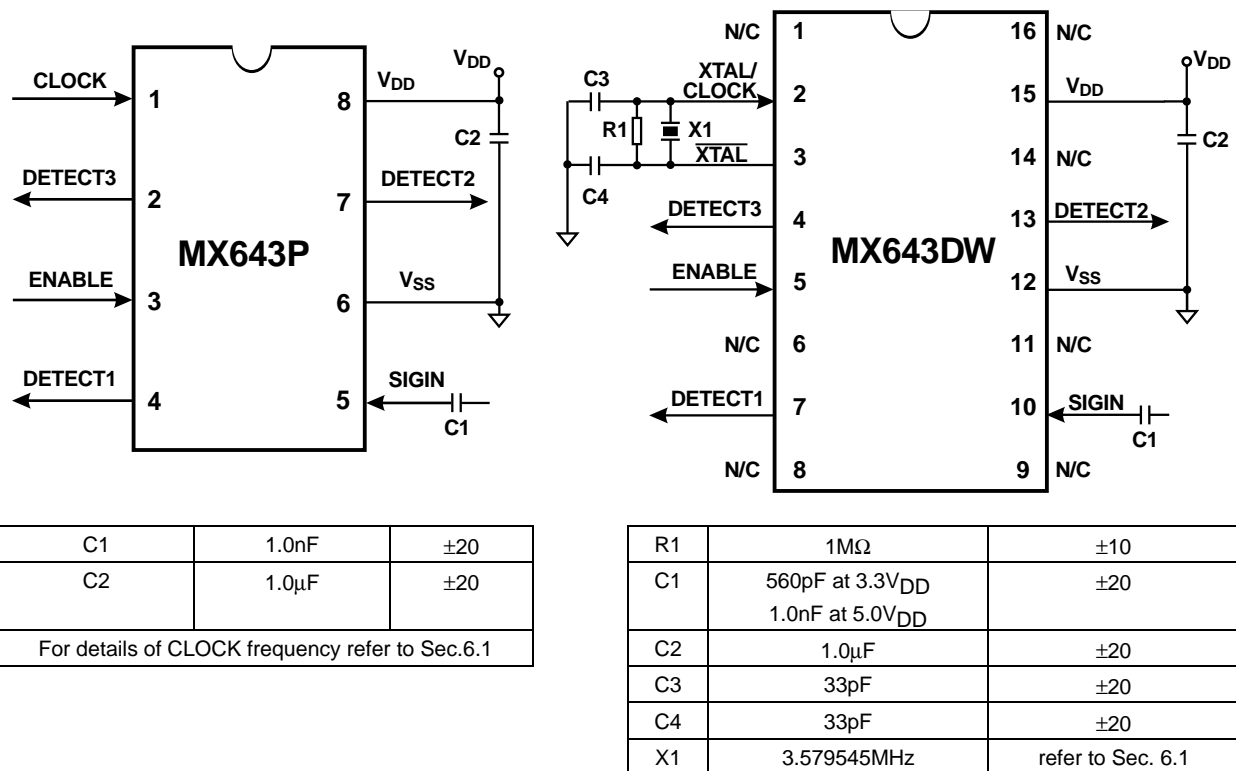| R1	1MΩ	±10
C1	560pF at 3.3V_{DD} 1.0nF at 5.0V_{DD}	±20
C2	1.0μF	±20
C3	33pF	±20
C4	33pF	±20
X1	3.579545MHz	refer to Sec. 6.1

Figure 2: Recommended External Components for Typical Applications

4. General Description

4.1 Glossary

The following glossary and Decode Truth table (found in section 5.1), describe the MX643 decoding features and functions.

Call Progress Tones: The single and dual frequency tones in the range of 350Hz to 620Hz specified widely for Call Progress signaling.

Call Progress Band: The nominal range is 340Hz to 650Hz within which the MX643 will detect Call Progress tones. The detection algorithm requires that the tones have characteristics typical of Call Progress Tones.

Call Progress Low Band: The nominal range is 340Hz to 490Hz. The MX643 will detect single or dual tones falling entirely within this range, as Call Progress Low Band tones.

Call Progress High Band: The nominal range is 600Hz to 650Hz. Single tones in this range, or dual tones having a material frequency component within this range (e.g. 480 + 620Hz), are detected as Call Progress High Band tones.

Special Information Tone: The nominal range is 950Hz or 1400Hz or 1800Hz, with a tolerance of ±50Hz.

Non Call Progress Signal: A signal falling within the nominal range (a) 200Hz to 800Hz, but NOT within the Call Progress Band, or (b) within the nominal range 200Hz to 800Hz, but NOT meeting the DETECTION REQUIREMENTS when the signal falls in the Call Progress Band.

Subject to the duration and other characteristics of such signals, the MX643 will usually interpret these as a Non Call Progress Signal (e.g. speech or other signal activity).

Minimum Input Signal: The minimum signal level for the specified tone decoding performance. The lower level at which absence of an input signal will be registered is not specified.

No Signal: A signal falling outside the nominal range of 120Hz to 900Hz or Special Information Tone or the absence of an input signal. Either will be detected as a No Signal condition.

Nominal: Subject to dynamic tolerances within the signal analysis process. Absolute values are not material or adverse to performance.

4.2 Overall Function Description

The MX643 Call Progress Tone Detector uses different tone detection methods from those commonly found with other Call Progress Tone Detectors.

Many traditional devices use a bandpass filter followed by an energy detector. The filter is usually designed to pass input signals with a frequency between about 300Hz and 700Hz. Each signal amplitude in this range is then checked against a level threshold. Any signal of acceptable level in this frequency band is classed as a Call Progress tone, including speech and noise. False outputs caused by speech are commonly indicated by such products and background noise may lead to a stuck detect output.

In contrast, the MX643 uses a stochastic signal processing technique. This technique is based on analysis of both the frequency and time domains, with signal amplitude forming a minor part in the decision process. This analysis includes, checks on whether the signal has a profile which matches international standards for Call Progress Tones, Special Information Tones, or a profile more likely to match that of speech, noise or other Non-Call Progress signals. Checks are also performed to see if the signal is a single tone, and whether the tones which include frequencies corresponding with the 'U.S. Busy' signals have been detected.

5. Block Diagram Description

(Reference Figure 1)

Slicer

The input signal to the slicer is amplified by a self-biased inverting amplifier. The dc bias of this input is internally set at V_{DD}/2.

Signal Analyzer

The frequency range, quality, and consistency of the input signal is analyzed by this function block. To be classified as a Call Progress signal the input signal frequencies should lie between 340Hz and 650Hz. To be classified as a Special Information Tone, the input signal frequency should lie between 900Hz and 1000Hz or 1350Hz and 1450Hz or 1750Hz and 1850Hz. The signal to noise ratio must be 16dB or greater. The signal must be consistent over a period of about 145 ms. These decode criteria are continuously monitored and the assessment is updated every 7 ms, reference Figure 3.

The Signal Analyzer samples the call progress signal at 9.3kHz. Care should be taken to avoid high frequency signals (≥8.4kHz) aliasing into the call progress band.

Control Logic

This block categorizes the nature of the signal into various decoded output states and controls the three output pins. See the Decode Output Truth Table in section 5.1

Clock

An external clock source is to be connected to the CLOCK input pin when using the 8-pin device. If using the on-chip oscillator (16-pin device only) you will need to use the external components shown in Figure 2. If using an external clock source then $\overline{XTAL}$ should be left unconnected.

5.1 Decode Output Truth Table

DETECT3	DETECT2	DETECT1	CONDITIONS
0	0	0	No Signal
1	0	0	Special Information Tone: Will detect 950, 1400 and 1800Hz tones
0	0	1	Call Progress Low Band: Will detect 350+440, 400+450 and 440+480Hz tones, for example
1	0	1	Call Progress Low Band: Will detect single 400, 425, 440, and 450Hz tones, for example
0	1	1	Call Progress High Band: Will detect 480+620Hz tones, for example
1	1	1	Call Progress High Band: Will detect single 600 and 620Hz tones, for example
0	1	0	Non Call Progress signal, e.g. Voice Activity
1	1	0	Will detect a single tone lying outside the Call Progress Band and within the Non Call Progress signal range

Decode Output Truth Table Notes:

DETECT1 responds to the complete range of call progress signals from 340Hz to 650Hz
DETECT2 responds to higher frequency call progress and voice or similar activity
DETECT3 responds to and indicates the presence of a single tone

6. Performance Specification

6.1 Electrical Performance

Absolute Maximum Ratings
Exceeding these maximum ratings can result in damage to the device.

General	Min.	Max.	Units
Supply (V_{DD} - V_{SS})	-0.3	7.0	V
Voltage on any pin to V_{SS}	-0.3	V_{DD} + 0.3	V
Current			
V_{DD}	-30	30	mA
V_{SS}	-30	30	mA
Any other pin	-20	20	mA
P/DW Package			
Total Allowable Power Dissipation at T_{AMB} = 25°C		800	mW
Derating above 25°C		13	mW/°C above 25°C
Storage Temperature	-55	125	°C
Operating Temperature	-40	85	°C

Operating Limits
Correct operation of the device outside these limits is not implied.

	Notes	Min.	Max.	Units
Supply (V_{DD} - V_{SS})		3.0	5.5	V
Xtal Frequency		3.57	3.59	MHz

Operating Characteristics

For the following conditions unless otherwise specified:

Xtal Frequency = 3.579545MHz, S/N = 16 dB, Noise Bandwidth = 5 kHz,
V_{DD} = 3.3V to 5.0V, T_{AMB} = - 40°C to 85°C. 0dB = 775mV_{RMS}.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
Supply Current					
I_{DD} (ENABLE = 1) (V_{DD} = 5.0V)	1		0.5	1.0	mA
I_{DD} (ENABLE = 1) (V_{DD} = 3.3V)	1		0.3	0.7	mA
Enable Input					
Input Logic 1 Level	2	80%			V_{DD}
Input Logic 0 Level	2			20%	V_{DD}
Input Leakage Current (V_{IN} = 0 to V_{DD})	2	-5.0		5.0	µA
Input Capacitance	2		10.0		pF
Detect Output					
Output Logic 1 Level (I_{OH} = 120µA)	3	90%			V_{DD}
Output Logic 0 Level (I_{OL} = 360µA)	3			10%	V_{DD}
AC Parameters					
SIGIN pin					
Input Impedance (at 100Hz)	4		350		k Ω
Input Signal Level	5	-40			dB
Input Signal Dynamic Range	5	40			dB
Signal to Noise Ratio		16			dB
Clock Input					
'High' Pulse Width	6	40			ns
'Low' Pulse Width	6	40			ns
Input Impedance (at 100Hz)		10			MΩ
Gain (input = 1mV_{RMS} at 100Hz)		20			dB

Operating Characteristics Notes:

1. Not including any current drawn from the device pins by external circuitry.
2. ENABLE pin.
3. DETECT1, DETECT2 and DETECT3 pins.
4. Small signal impedance.
5. The input level is not critical as the detector uses a stochastic algorithm.
6. Timing for an external input to the CLOCK pin.

Timing Characteristics

For the following conditions unless otherwise specified:

Xtal Frequency = 3.579545MHz, V_{DD} = 3.3V to 5.0V, T_{AMB} = - 40°C to 85°C, S/N = 20dB.

| Timing (ref. Figures 3, 4, 5 and 6)		Notes	Min.	Typ.	Max.	Units
t_I	Burst Length Ignored	1			70	ms
t_L	Burst Length Detected	1	145			ms
t_{GI}	Call Progress Tone Gap Length Ignored	1, 2			20	ms
t_{GD}	Call Progress Tone Gap Length Detected	1, 2	40			ms
t_{RP}	Call Progress Tone Response Time	1			145	ms
t_{DRP}	Call Progress Tone De-response Time	1			145	ms
t_{GDR}	Gap Detected Recorded	1, 3	6			ms
t_{NG}	Non Call Progress Signal Gap Length Ignored	4			80	ms
t_{NRP}	Non Call Progress Signal Response Time		145			ms
t_{DNRP}	Non Call Progress signal De-response Time				80	ms
t_{CH}	State Change		0			ms
t_V	DETECT1, DETECT2, and DETECT3 Response Time	5			145	ms

Timing Notes:

1. Timings also apply to Special Information Tone.
2. Only applies to bursts of the same frequency.
3. To acknowledge a short tone gap $\geq$ 40 ms, No Signal is indicated for a minimum of 6ms.
4. If the gap > 90 ms, a No Signal state will be decoded.
5. Time between a stable XTAL/CLK and a valid DETECT1, DETECT2, and DETECT3 state when ENABLE is logic high..

Timing Diagrams
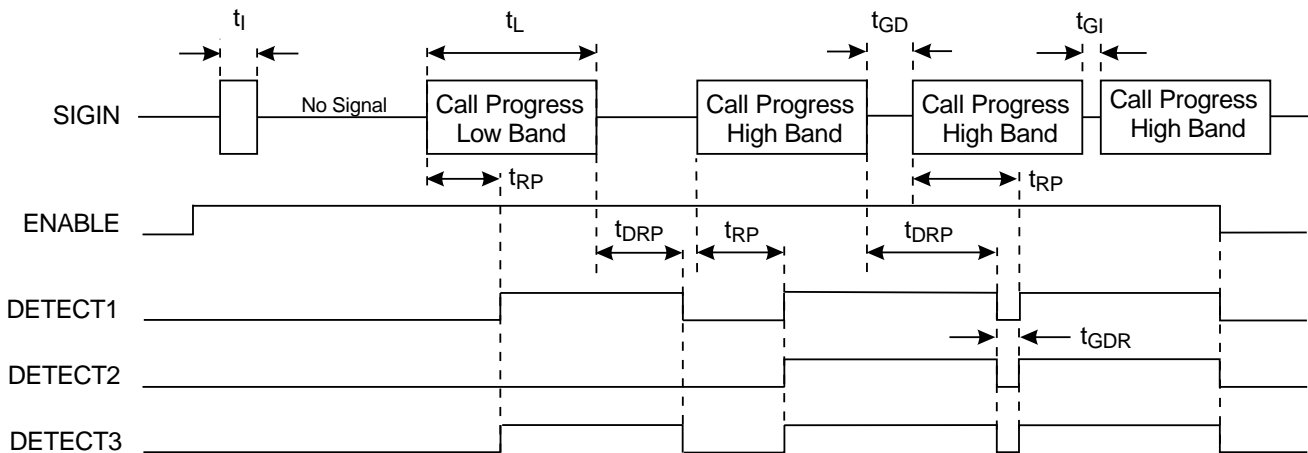
Note: DETECT3 is logic high only when the Call Progress Signal, or the Non Call Progress Signal is a single frequency tone.

Figure 3: Timing Diagram: Call Progress Tone(s)
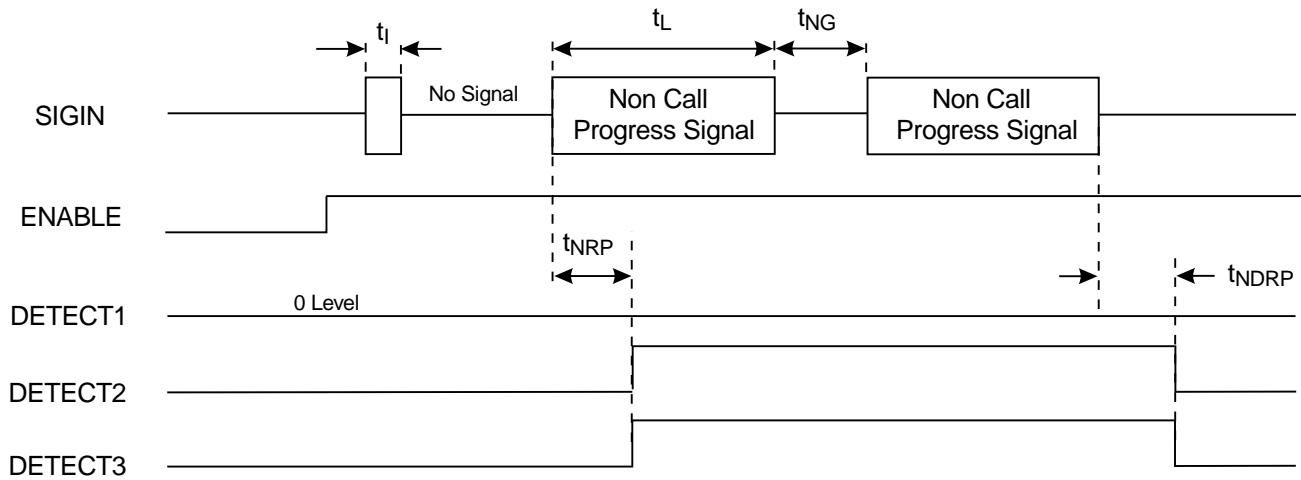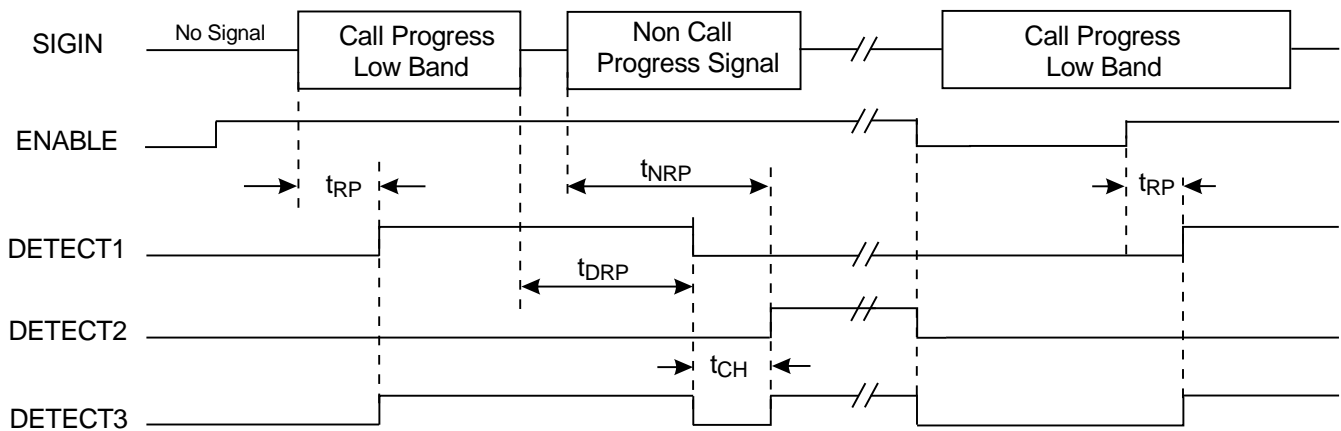
Note: DETECT3 is logic high only when the Call Progress Signal, or the Non Call Progress Signal is a single frequency tone.

Figure 4: Timing Diagram: Non Call Progress Signal

Note: DETECT3 logic high only when the Call Progress signal, or the Non Call Progress signal is a single frequency tone.
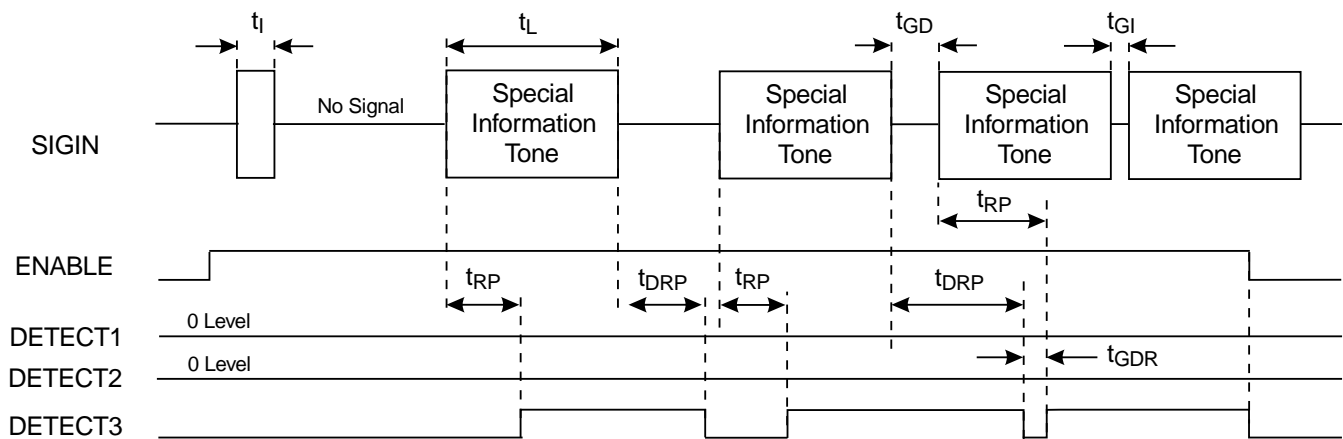
Figure 5: Timing Diagram: Call Progress Tone(s) to Non Call Progress Signal

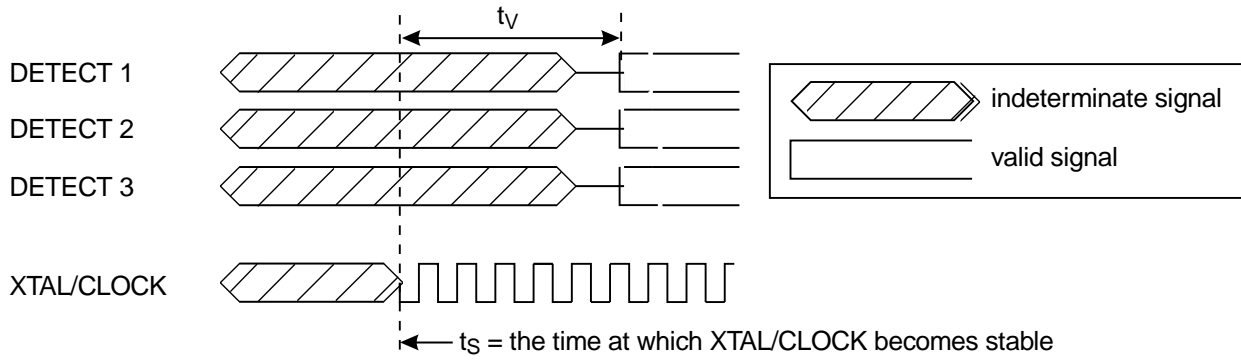**Figure 6: Timing Diagram: Special Information Tones**

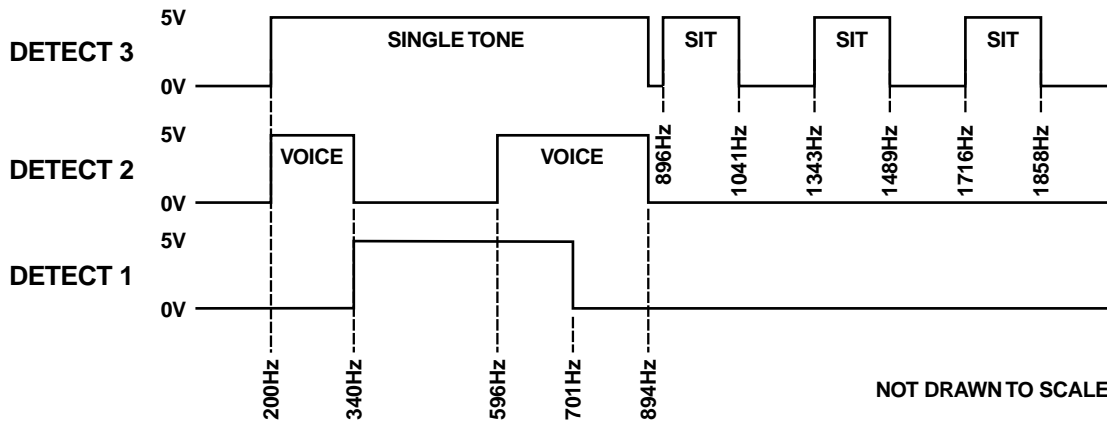**Figure 7: Timing Diagram: DETECT1, DETECT2, and DETECT3 Response time when ENABLE is high**

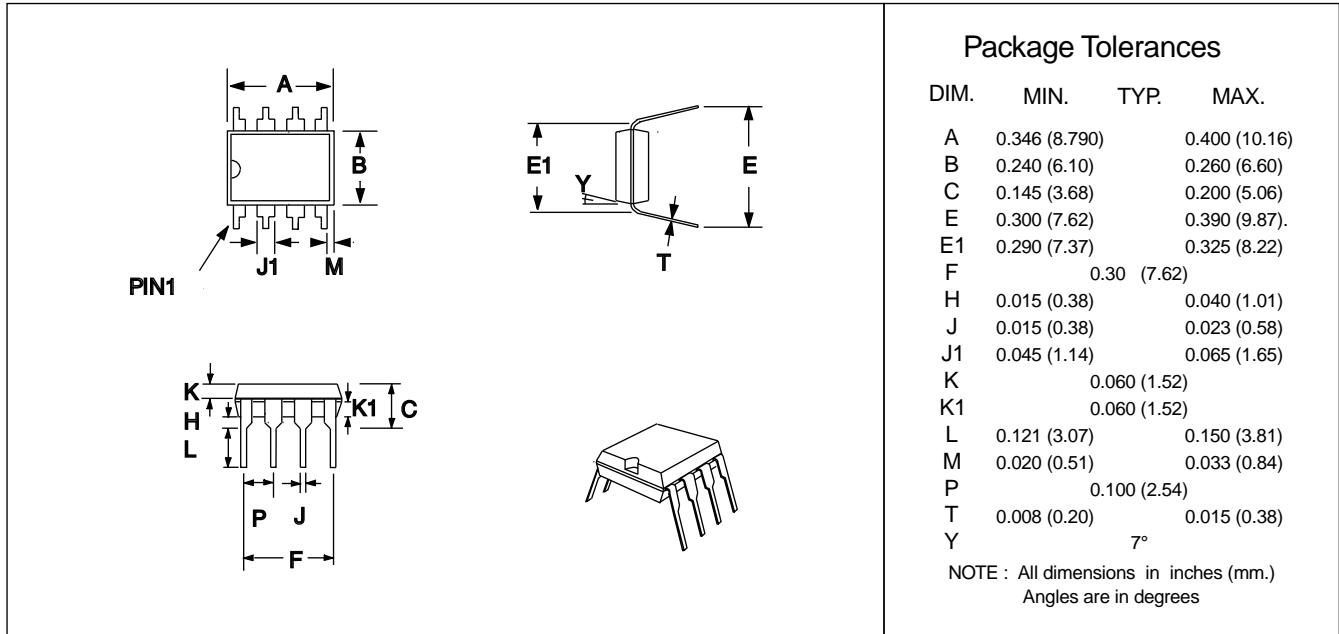**Figure 8: MX643 Frequency Sweep Results**

6.2 Packaging

Package Tolerances

DIM.	MIN.	TYP.	MAX.
A	0.346 (8.790)		0.400 (10.16)
B	0.240 (6.10)		0.260 (6.60)
C	0.145 (3.68)		0.200 (5.06)
E	0.300 (7.62)		0.390 (9.87).
E1	0.290 (7.37)		0.325 (8.22)
F		0.30 (7.62)	
H	0.015 (0.38)		0.040 (1.01)
J	0.015 (0.38)		0.023 (0.58)
J1	0.045 (1.14)		0.065 (1.65)
K		0.060 (1.52)	
K1		0.060 (1.52)	
L	0.121 (3.07)		0.150 (3.81)
M	0.020 (0.51)		0.033 (0.84)
P		0.100 (2.54)	
T	0.008 (0.20)		0.015 (0.38)
Y		7°	

NOTE : All dimensions in inches (mm.)
Angles are in degrees

Figure 9: 8-pin PDIP Mechanical Outline: *Order as part no. MX643P*

Package Tolerances

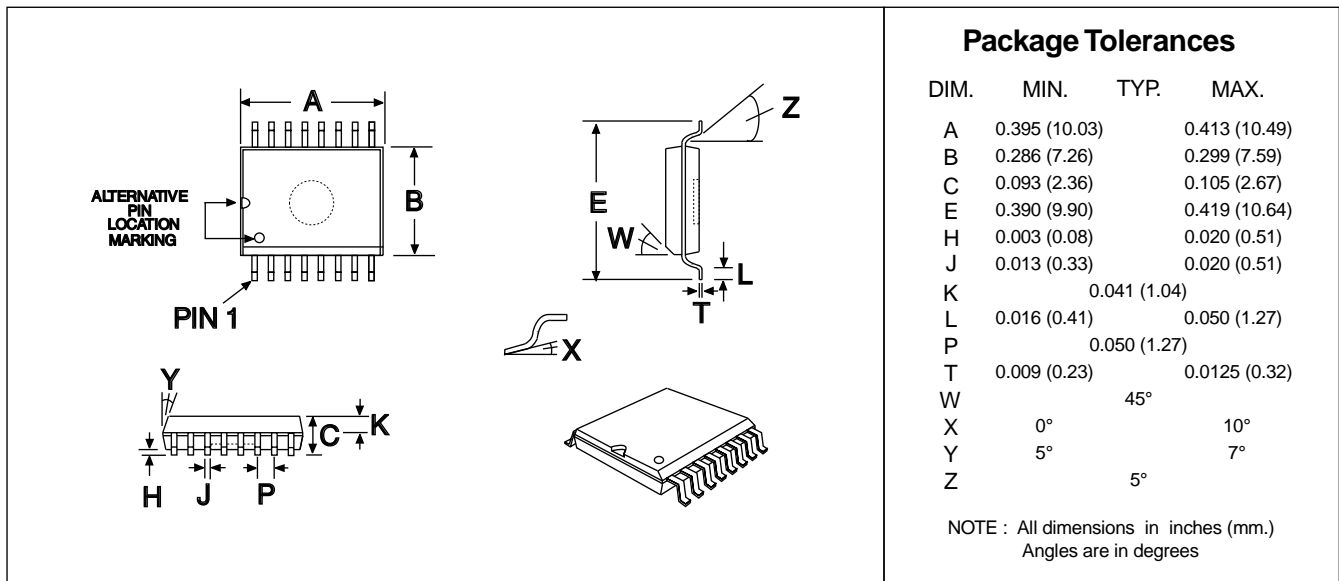| DIM.	MIN.	TYP.	MAX.
A	0.395 (10.03)		0.413 (10.49)
B	0.286 (7.26)		0.299 (7.59)
C	0.093 (2.36)		0.105 (2.67)
E	0.390 (9.90)		0.419 (10.64)
H	0.003 (0.08)		0.020 (0.51)
J	0.013 (0.33)		0.020 (0.51)
K		0.041 (1.04)	
L	0.016 (0.41)		0.050 (1.27)
P		0.050 (1.27)	
T	0.009 (0.23)		0.0125 (0.32)
W		45°	
X	0°		10°
Y	5°		7°
Z		5°	

NOTE : All dimensions in inches (mm.)
Angles are in degrees

Figure 10: 16-pin SOIC Mechanical Outline: *Order as part no. MX643DW*