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MX•COM, INC. MiXed Signal ICs

DATA BULLETIN

MX633 Call Progress Tone Detector

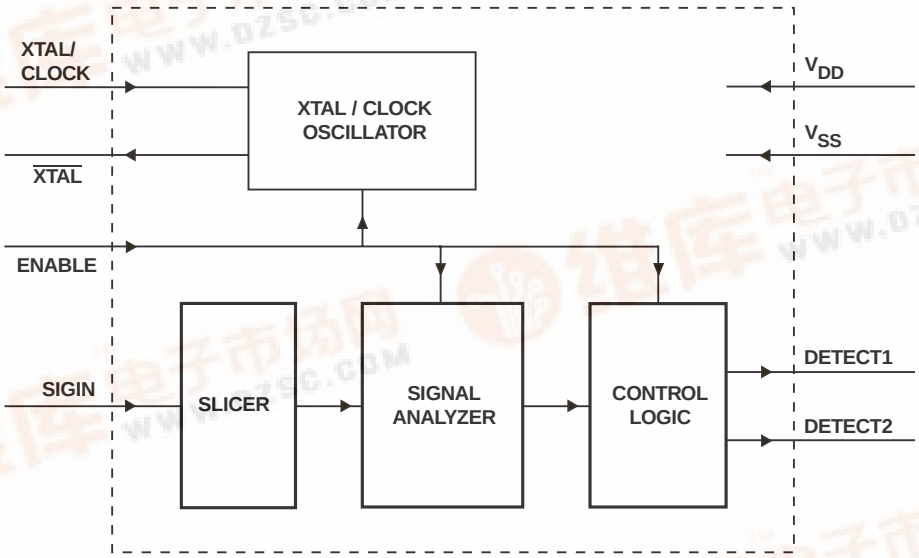
PRELIMINARY INFORMATION

Features

- **Worldwide Tone Compatibility**
- **Single and Dual Tones Detected**
- **U.S. Busy-Detect Output**
- **Voice-Detect Output**
- **Wide Dynamic Range > 40dBm**
- **Low Supply Current (0.3mA/0.5mA)**
- **Low Supply Voltage (3.3V/5.0V)**
- **Standard 3.58MHz Xtal**

Applications

- **Automatic Calling Products**



The MX633 is a low cost, low power device that uses signal processing techniques to detect audible tone signals such as Dial, Ringing, Busy and other conditions found when placing a call throughout the world's telecom systems. Detection of these call progress stages is essential to the proper operation of automatic calling products.

The MX633 adds new features to Call Progress monitoring. It detects and indicates the 'U.S. Busy' tones, reducing the need to measure 'tone cadence' to identify 'U.S. Busy'. It also detects and indicates voice and other signals from Call Progress tones, reducing voice-falsing and adding voice-answer as a connection prompt.

The MX633 may be used with a 3.0V to a 5.5V supply and is available in the following package styles: 8-pin PDIP (MX633P) and 16-pin SOIC (MX633DW).

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

1. Block Diagram

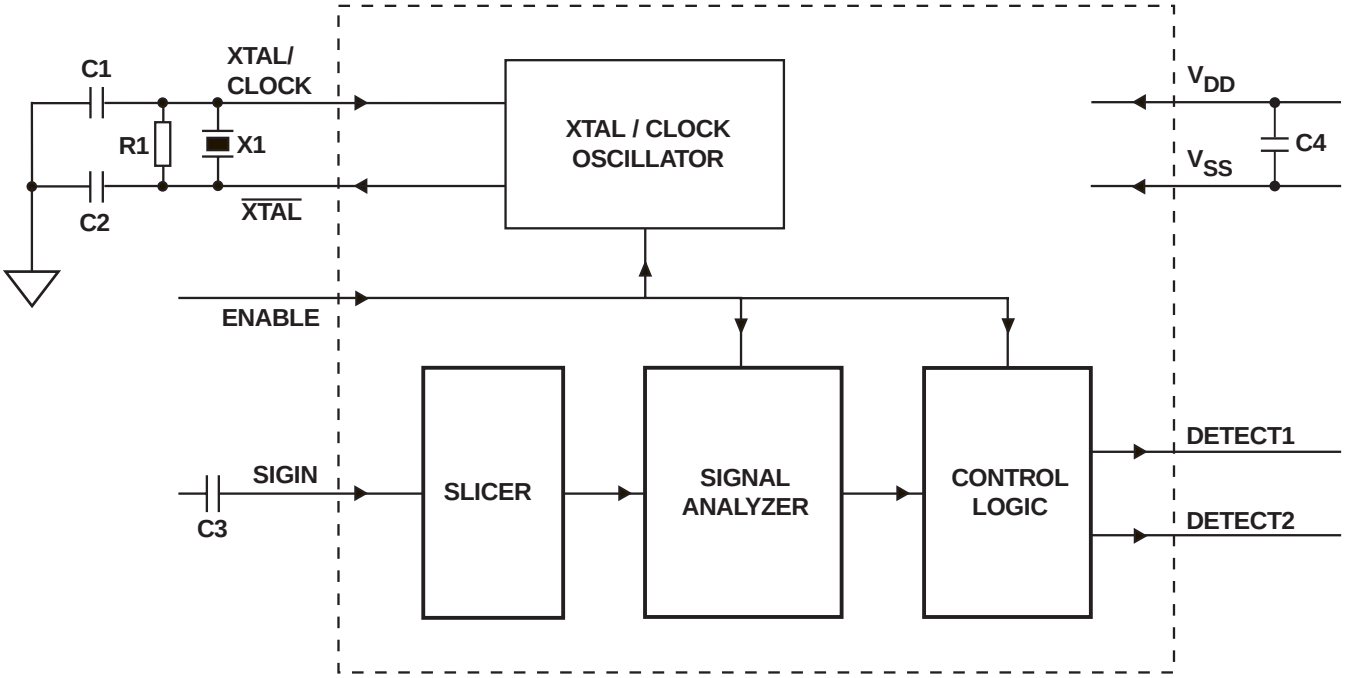


Figure 1: Block Diagram

2. Signal List

Package / Pin No.		Signal	Type	Description
P	DW			
1	2	XTAL/CLOCK	input	Input to the on-chip oscillator, for external Xtal circuit or clock
2	3	$\overline{XTAL}$	output	Output of the on-chip oscillator inverted
3	5	ENABLE	input	A logic 1 applied to this input enables the decoder and detection outputs. A logic 0 pulse of at least 1µs applied to this input resets the decoder circuits and forces both DETECT1 and DETECT2 outputs to a logic 0.
4	7	DETECT1	output	When a Call Progress signal is detected, DETECT1 output state changes 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
7	13	DETECT2	output	Output used in conjunction with DETECT1. When a Call Progress High Band signal is detected and DETECT1 output state is a logic 1, then DETECT2 output state changes to a logic 1. When a Non Call Progress signal is detected and DETECT1 output state is a logic 0, then DETECT2 output state changes to a logic 0.
8	15	V_{DD}	power	Positive supply. This pin should be bypassed to V_{SS} by a capacitor mounted close to the device pins.

Table 1: Signal List

3. External Components

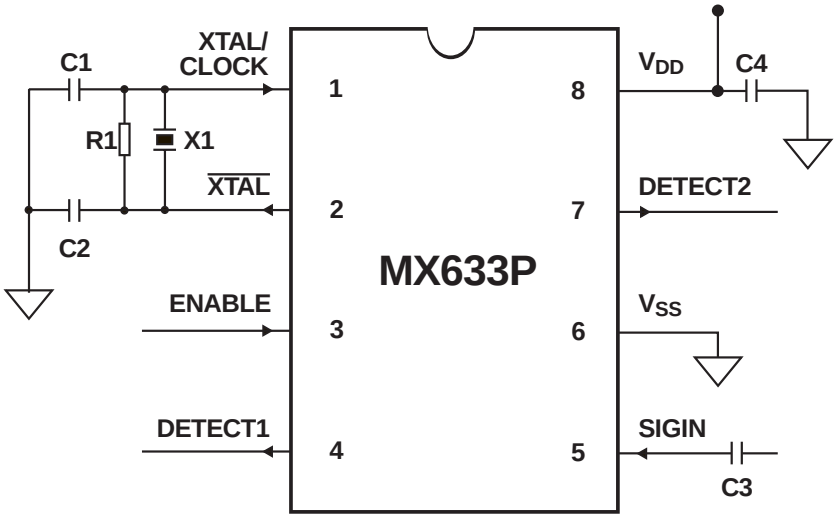


Figure 2: Recommended External Components

R1		1 MΩ	±10%
C1		33pF	±20%
C2		33pF	±20%
C3		560pF at $3.3V_{DD}$ 1nF at $5.0V_{DD}$	±20%
C4		1.0µF	±20%
X1	Note 1	3.579545MHz	refer to sec.5.1

Table 2: Recommended External Components

Notes:

1. For best results, a crystal oscillator design should drive the clock inverter input with signal levels of at least 40% of V_{DD}, peak to peak. Tuning fork crystals generally cannot meet this requirement. To obtain crystal oscillator design assistance, consult your crystal manufacturer.

4. General Description

The following Glossary and Decode Truth Table (found in section 4.4), describe the MX633 decoding features and functions.

4.1 Glossary

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

Call Progress Band: The nominal range 340Hz to 650Hz within which the MX633 will detect Call Progress tones. The detection algorithm requires that the tones have the characteristics typical of Call Progress Tones.

Call Progress Low Band: The nominal range 340Hz to 490Hz. The MX633 will detect single or dual tones falling entirely within this range as Call Progress Low Band tones.

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

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 MX633 will usually interpret this 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.

No Signal: A signal falling outside the nominal range 120Hz to 900Hz 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 MX633 Call Progress Tone Detector uses tone detection methods different from those methods commonly found in other Call Progress Tone Detectors.

Many Call Progress Tone Detectors 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 checked against a level threshold. Any signal of acceptable level in this frequency band is classified as a Call Progress tone, including speech and noise signals. False outputs caused by speech are commonly indicated by such products and background noise may lead to a stuck detect output.

In contrast, the MX633, uses a stochastic signal processing technique. This technique is based on analysis of both the frequency and time domains, with signal amplitude forming a small part in the decision process. This analysis includes checks on whether the signal has a profile that matches international standards for Call Progress tones, speech, noise or other Non-Call-Progress signals. It also checks for U.S. Busy signal tones.

4.3 Block Diagram Description (Reference Figure 1)

4.3.1 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 $V_{DD}/2$.

4.3.2 Signal Analyzer

The frequency range, quality and consistency of the input signal is analyzed by this functional block. To be classified as a call progress signal, the input signal frequencies should lie between 340Hz and 650Hz. The signal to noise ratio must be 16dB or greater and the signal must be consistent over a period of about 140 ms. This decode criteria is continuously monitored and the assessment 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.

4.3.3 Control Logic

This block categorizes the nature of the signal into various decode output states and controls the two output pins. See Table 3.

4.3.4 Xtal/Clock Oscillator

If the on-chip Xtal oscillator is to be used, then external components X1, R1, C1 and C2 are required. If an external clock source is to be used, then it should be connected to the XTAL/CLOCK input pin and the $\overline{\text{XTAL}}$ pin should be left unconnected.

4.4 Decode Output Truth Table

DETECT2	DETECT1	CONDITIONS
0	0	No Signal
0	1	Call Progress Low Band: Will detect 350+440, 400+450, 440+480,400, 425, 440, and 450Hz tones
1	1	Call Progress High Band: Will detect 480+620, 600 and 620Hz tones
1	0	Non Call Progress signal, e.g. voice activity

Note:

1. DETECT1 responds to the entire range of call progress tones from 340Hz to 650Hz.

Table 3: Decode Output Truth Table

5. Performance Specification

5.1 Electrical Performance

5.1.1 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
DW / DIP 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

5.1.2 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

5.1.3 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, V_{SS} = 0V, T_{AMB} = 25°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 (from 100Hz to 2kHz at 5.0V)	4		350		kΩ
Input Signal Level	5		– 40		dB
Input Signal Dynamic Range	5	40			dB
Signal to Noise Ratio		16			dB
Xtal/Clock Oscillator					
'High' Input Pulse Width	6	40			ns
'Low' Input 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 and DETECT2 pins.
4. Small signal impedance over the frequency range 100Hz to 2000Hz and at 5.0V
5. The input level is not critical as the detector uses a stochastic algorithm.
6. Timing for an external input to the XTAL/CLOCK pin.

5.1.4 Timing

For the following conditions unless otherwise specified:
Xtal Frequency = 3.579545MHz, V_{DD} = 3.3V to 5.0V, T_{AMB} =25°C, S/N = 20dB

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

Timing Notes:

1. Only applies to bursts of the same frequency.
2. For dual tones in 16dB SNR the Response Time may be longer.
3. To acknowledge a short tone gap ≥ 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 and DETECT2 state when ENABLE is high.

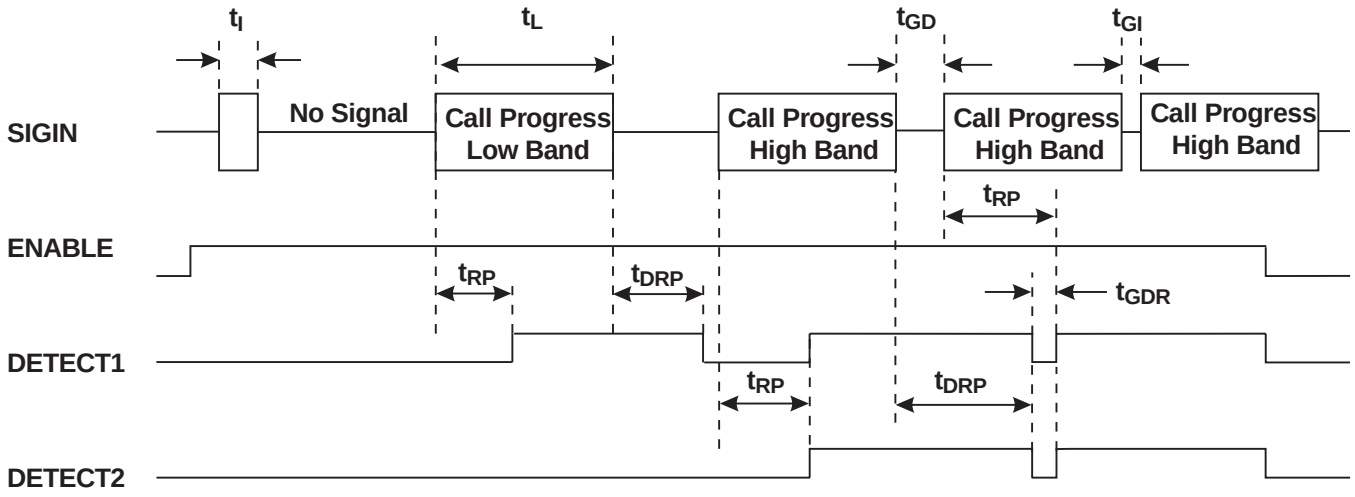


Figure 3: Timing Diagram: Call Progress Tone (s)

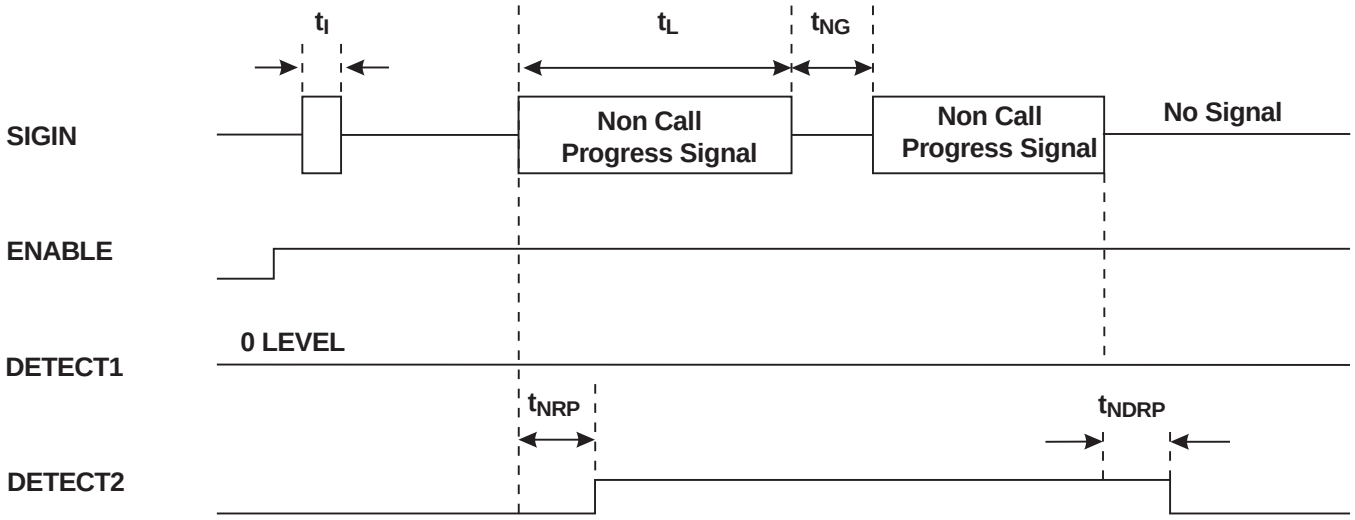


Figure 4 : Timing Diagram: Non Call Progress Signal

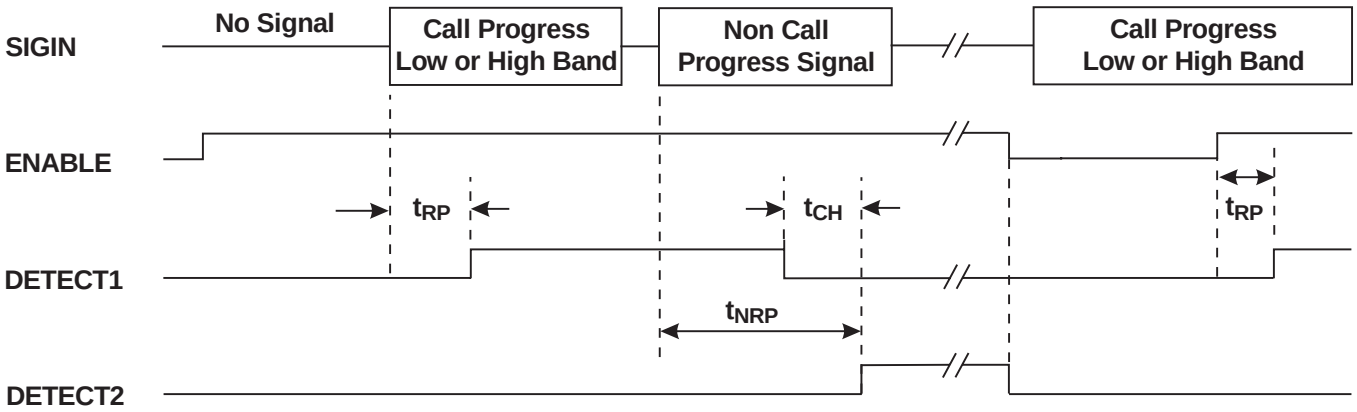


Figure 5 : Timing Diagram: Call Progress Tone (s) to Non Call Progress Signal

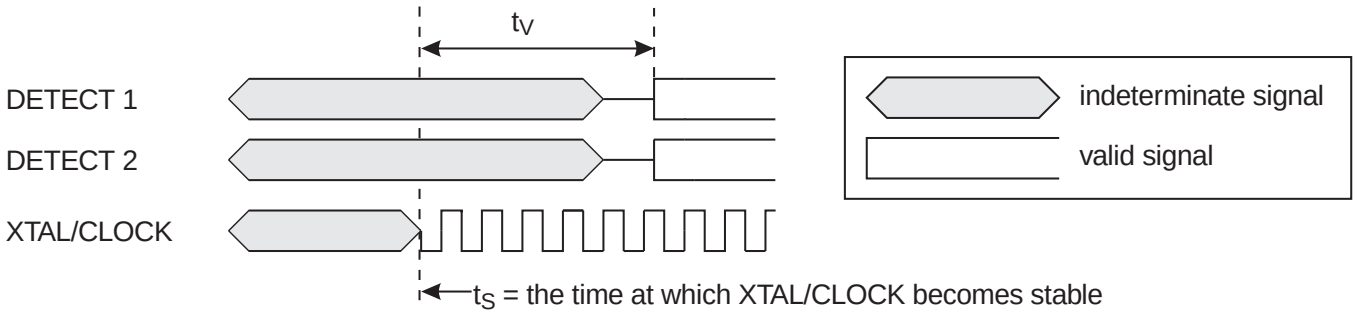
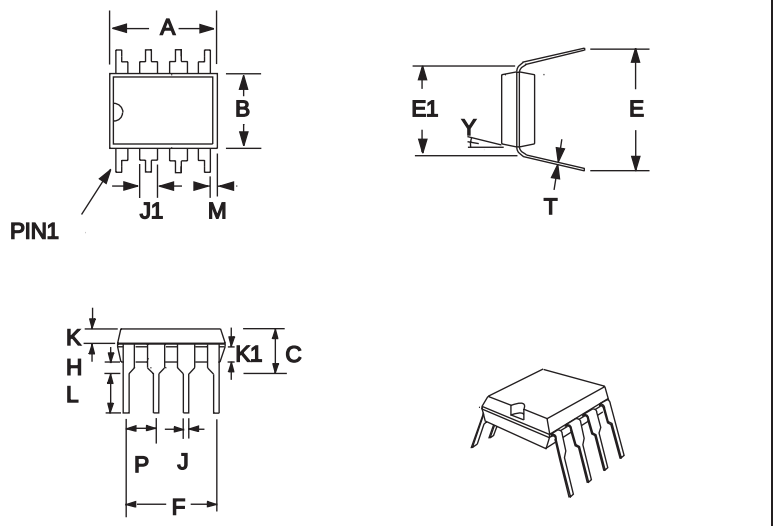


Figure 6: Timing Diagram: DETECT 1 and DETECT 2 Response Time when ENABLE is high

5.2 Packaging

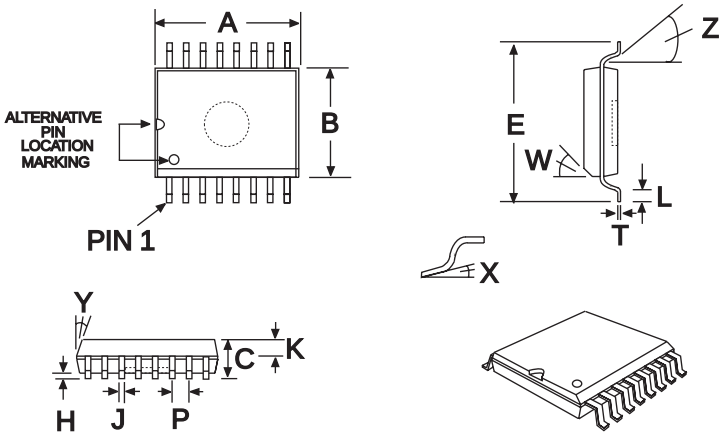


Package Tolerances

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 7 : 8-pin PDIP Mechanical Outline: *Order as part no. MX633P*



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 8 : 16-pin SOIC Mechanical Outline: *Order as part no. MX633DW*