Consumer Microcircuits Limited
COMMUNICATION SEMICONDUCTORS

CMX673
Call Progress Tone Detector

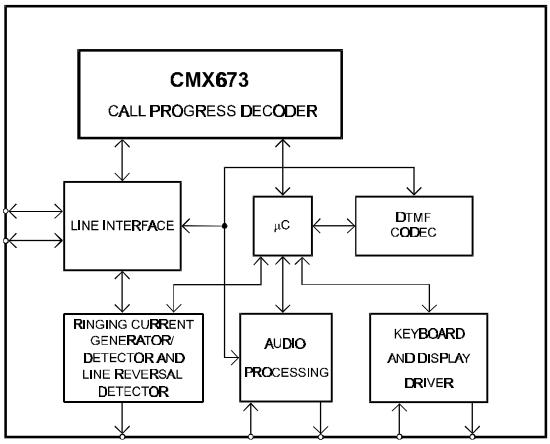
D/673/5 June 2001 Provisional Issue

Features

- **Worldwide Tone Compatibility**
- **Single and Dual Tones Detected**
- **Wide Dynamic Signal Range**
- **Fast Response Time**
- **Low Power Operation 500µA at 3.0V**
- **3.58MHz Xtal/Clock Oscillator**

Applications

- **Worldwide Payphone Systems**
- **Telephone Redialling Systems**
- **Dialling Modems**
- **Banking and Billing Systems**
- **Telecom Test Equipment**
- **Telecom Security Systems**



1.1 Brief Description

The CMX673 is a general purpose call progress tone detector for use in Public Switched Telephone System (PSTN) applications. Call progress detection allows equipment which dials into the PSTN network to monitor the progress of the resulting call. Ringing, Busy, Not available and Answer states can be determined. The CMX673 uses advanced digital signal processing techniques to detect tones in the frequency band 315Hz to 650Hz. The use of DSP techniques allows the CMX673 to distinguish between valid call progress tone signals and line noise or voice, low false detection rates result. This is in contrast to other call progress detection devices which are based on simple filtering techniques. The detection timing of the CMX673 allows it to operate with almost any call progress system. In particular the 'stuttered dial tone' of voice mail messaging systems is supported. The use of digital processing and small geometry CMOS design techniques allows the CMX673 to offer a complete call progress detector which analyses both frequency and amplitude in a single 8 pin package. This, coupled with industry leading performance and substantially lower power supply requirements than comparable devices, demonstrates CML's unique capability in this area. A single 3.58MHz crystal ensures accurate and repeatable performance. With supply requirements between 2.7V and 5.5V the CMX673 can be easily integrated into a wide range of telecom equipments. The CMX673 is pin to pin compatible with the M980 and TSC 75T980 and SSI980. It is available in DIP, TSSOP and SOIC packages. The CMX673 integrated circuit coupled with cadence measurement of the signals detected can identify virtually all call progress tones used worldwide.

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1.2 Block Diagram

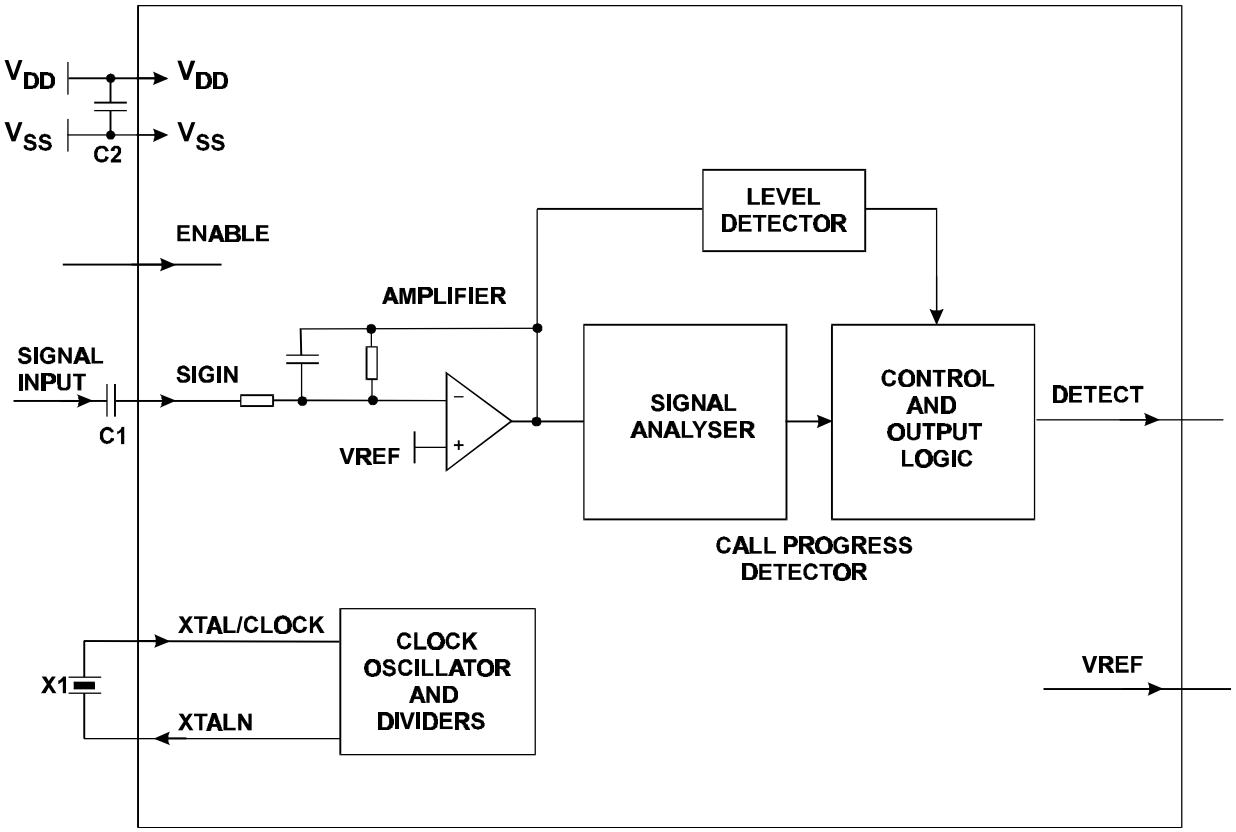


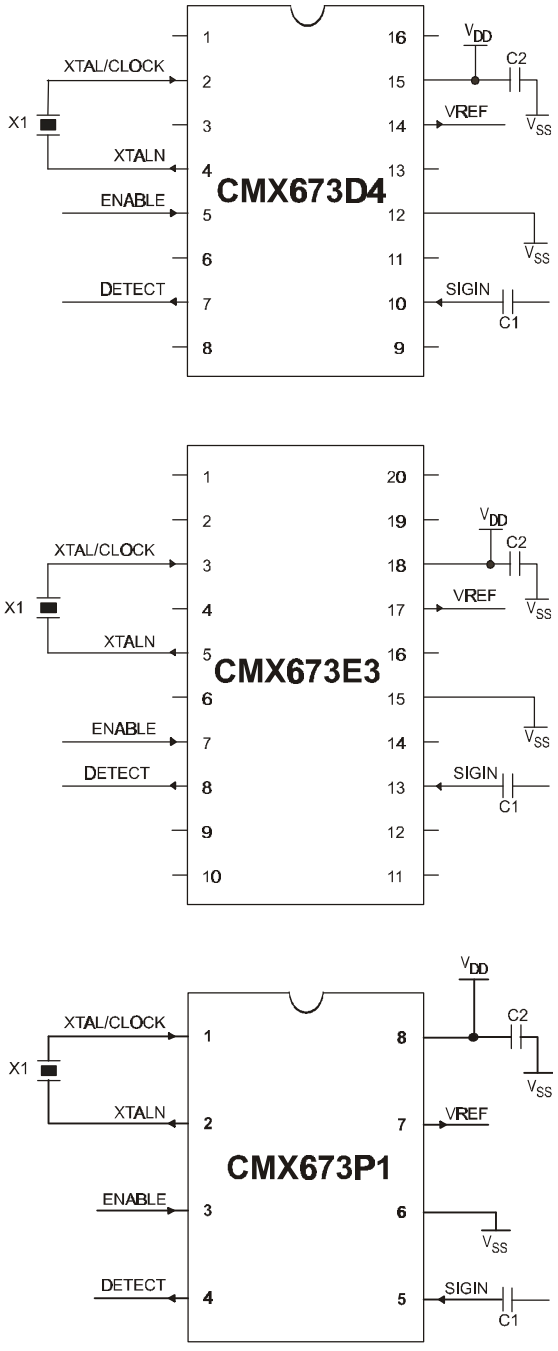
Figure 1 Block Diagram

1.3 Signal List

Package			Signal		Description
D4	**E3**	**P1**			
Pin No.	**Pin No.**	**Pin No.**	**Name**	**Type**	
2	3	1	XTAL/CLOCK	I/P	The input to the on-chip oscillator and external clock input. Components are on chip.
4	5	2	XTALN	O/P	The inverted output of the on-chip oscillator.
5	7	3	ENABLE	I/P	A logic '1' applied to this input enables the DETECT output. A logic '0' will reset DETECT output to a logic '0'.
7	8	4	DETECT	O/P	When a call progress signal is detected, this output goes to a logic '1'.
10	13	5	SIGIN	I/P	Signal input. Signals to this pin should be ac coupled. The dc bias of this pin is set internally.
12	15	6	V_{SS}	Power	The negative supply rail (ground).
14	17	7	VREF	O/P	Internally generated reference voltage, held at $½V_{DD}$.
15	18	8	V_{DD}	Power	The positive supply rail. This pin should be decoupled to V_{SS} by a capacitor.
1, 3, 6, 8, 9, 11, 13, 16	1, 2, 4, 6, 9, 10, 11, 12, 14, 16, 19, 20		NC		Internal Connection. Do not make any connection to these pins.

Notes: I/P = Input
O/P = Output
BI = Bidirectional

1.4 External Components



Typical Values:

C1	0.1µF	± 20%
C2	1µF	± 20%
X1	3.579545MHz (refer to Section 1.7.1)	

Note: C1 is not required if the input is referenced to VREF.

Figure 2 Recommended External Components

1.5 General Description

1.5.1 Overall Function Description

The CMX673 Call Progress Tone Detector uses different tone detection methods from those commonly found with other products.

Many traditional devices from other suppliers 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, and the amplitudes of signals in this range are then checked against a level threshold. Any signal of acceptable level in this frequency band is classed as a Call Progress tone, including signals due to speech and noise. False outputs caused by speech are a common feature with these products, and background noise may lead to a stuck “detect” output.

The CMX673, by contrast, uses a stochastic signal processing technique based on analysis in both the frequency and time domains, with signal amplitude forming part of the decision process. This analysis includes checks on whether the signal has a “profile” which matches international standards for Call Progress tone, or a profile more likely to match that of speech, noise or no signal.

The following Glossary, and the Decode Truth Table in Section 1.5.4 provide a simple explanation of the decoding functions and features offered by the CMX673.

1.5.2 Glossary

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

Call Progress Band: The nominal range 315Hz to 650Hz within which the CMX673 will detect Call Progress tones. The detection algorithm requires that the tones have the characteristics typical of Call Progress Tones.

No Signal: The absence of an input signal or
A signal below 250Hz or
A signal between 750Hz and 10kHz.

Note that signals above 10kHz should be at a level below -38dBm so as to avoid aliasing.

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

1.5.3 Block Diagram Description

Amplifier
The input signal is amplified by a self-biased inverting amplifier. The dc bias of this input is internally set at $\frac{1}{2}V_{DD}$.

Signal Analyser
The frequency range, quality and consistency of the input signal is analysed by this functional block. To be classified as a call progress signal the input signal frequencies should lie between 315Hz and 650Hz. The signal to noise ratio must be 16dB or greater. The signal must be consistent over a period of about 80ms. These decode criteria are continuously monitored and the assessment is updated every 6ms; reference Figure 4.

Control Logic
This block categorises the nature of the signal into two decoded output states and controls the output pin. See the Decode Output Truth Table in Section 1.5.4.

Level Detector
The level detector operates by measuring the level of the amplified input signal and comparing it with a preset threshold. The level detector output goes to the Control and Output Logic block. The data output is gated with the level detector's output. The data output is valid only if the level detector output is true.

Xtal/Clock Oscillator
If the on-chip Xtal oscillator is to be used, then external component X1 is required. If an external clock source is to be used, then it should be connected to the XTAL/CLOCK input pin and the XTALN pin should be left unconnected.

1.5.4 Decode Output Truth Table

"DETECT"	CONDITIONS
0	No Signal
1	Call Progress Band: Will detect 350+440, 400+450, 440+480 400, 425,440, 450, 480+620, 600 and 620Hz tones

Note that DETECT responds to the whole range of call progress tones from 315Hz to 650Hz.

Table 1 Decode Output Truth Table

1.6 Application Notes

1.6.1 General

On power-up, it will take 80ms to initialise the internal state, this delay should be accounted for before the DETECT output is valid.

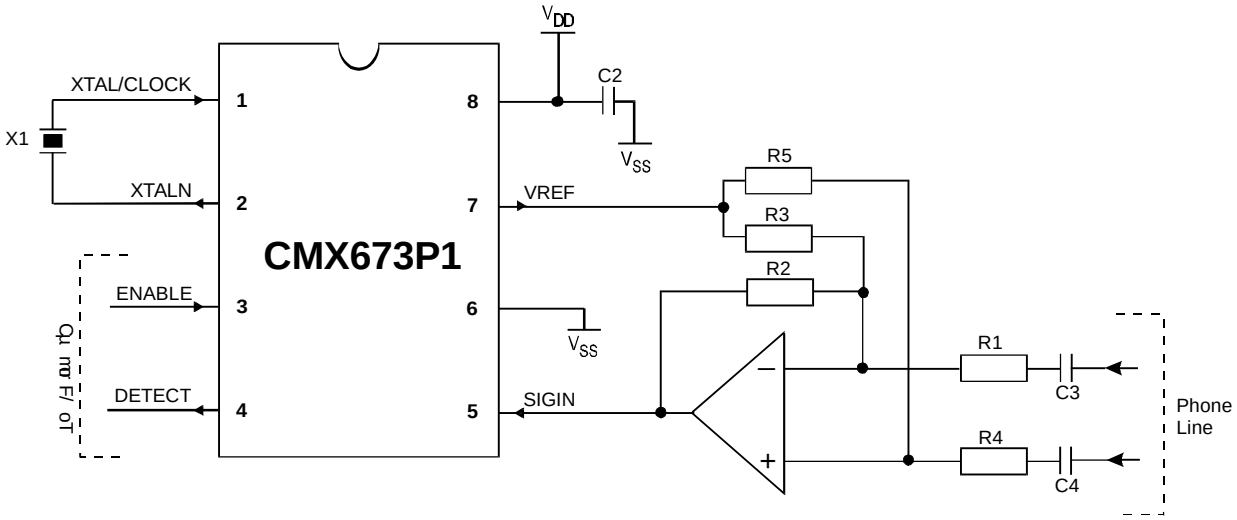


Figure 3 A typical Telephone Line Circuit Application

R1	470kΩ	R5	160kΩ
R2	470kΩ	C3	0.01µF 250V
R3	240kΩ	C4	0.01µF 250V
R4	470kΩ		

Note: 1. Resistors ±1%, Capacitors ±20% unless otherwise stated.
2. A low offset opamp is needed.

An alternative set of component values can be used:

R1	499kΩ	R5	49.9kΩ
R2	499kΩ	C3	0.001µF 300V
R3	54.9kΩ	C4	0.001µF 300V
R4	499kΩ		

Note: 3. Resistors ±1%, Capacitors ±2% unless otherwise stated.
4. A higher value of C3 and C4 will reduce the level sensitivity tolerance at around -38dBm.

1.7 Performance Specification

1.7.1 Electrical Performance

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

	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 into or out of V_{DD} and V_{SS} pins	-30	+30	mA
Current into or out of any other pin	-20	+20	mA

P1 Package	**Min.**	**Max.**	**Units**
Total Allowable Power Dissipation at Tamb = 25°C		800	mW
... Derating		13.0	mW/°C
Storage Temperature	-55	+125	°C
Operating Temperature	-40	+85	°C

E3 Package	**Min.**	**Max.**	**Units**
Total Allowable Power Dissipation at Tamb = 25°C		300	mW
... Derating		5.0	mW/°C
Storage Temperature	-55	+125	°C
Operating Temperature	-40	+85	°C

D4 Package	**Min.**	**Max.**	**Units**
Total Allowable Power Dissipation at Tamb = 25°C		800	mW
... Derating		13.0	mW/°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})	2.7	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 = 16dB, Noise Bandwidth = 5kHz,
V_{DD} = 3.0V to 5.0V, Tamb = -40°C to +85°C. 0dB = 775mVrms.

		Notes	Min.	Typ.	Max.	Units
DC Parameters						
I_{DD} (ENABLE = '1')	(V_{DD} = 5.0V)	1		1.0	1.5	mA
I_{DD} (ENABLE = '1')	(V_{DD} = 3.0V)	1		0.5	1.0	mA
AC Parameters						
SIGIN pin						
Input Impedance		2		0.1		MΩ
Minimum Input Signal Level				-38.0		dB
Input Signal Dynamic Range			40.0			dB
Signal to Noise Ratio			16.0			
Xtal/Clock Input						
'High' Pulse Width		3	100			ns
'Low' Pulse Width		3	100			ns
Gain (I/P = 1mVrms at 100Hz)			20.0			dB
Level Detector						
Must Detect Signal Level		4	-38.0			dB
Must Not Detect Signal Level		4			-50.0	dB
Call Progress Band		7				
Must Detect Range			315		650	Hz
Must Not Detect Range			750		250	Hz
Logic Interface						
Input Logic "1" Level		5	80%			V_{DD}
Input logic "0" level		5			20%	V_{DD}
Input leakage current (Vin = 0 to V_{DD})		5	-5.0		+5.0	µA
Input Capacitance		5		10.0		pF
Output logic "1" level (I_{OH} = 120µA)		6	90%			V_{DD}
Output logic "0" level (I_{OL} = 360µA)		6			10%	V_{DD}

Notes:
1. Not including any current drawn from the detector pins by external circuitry.
2. Small signal impedance over the frequency range 100Hz to 2000Hz and at V_{DD} = 5.0V.
3. Timing for an external input to the XTAL/CLOCK pin.
4. Input signal level at V_{DD} = 5.0V, scale signal for different V_{DD}.
5. ENABLE pin.
6. DETECT pin.
7. Nominal values which are subject to dynamic tolerances within the signal analysis process, as a result of using stochastic signal processing techniques.

Electrical Performance (continued)

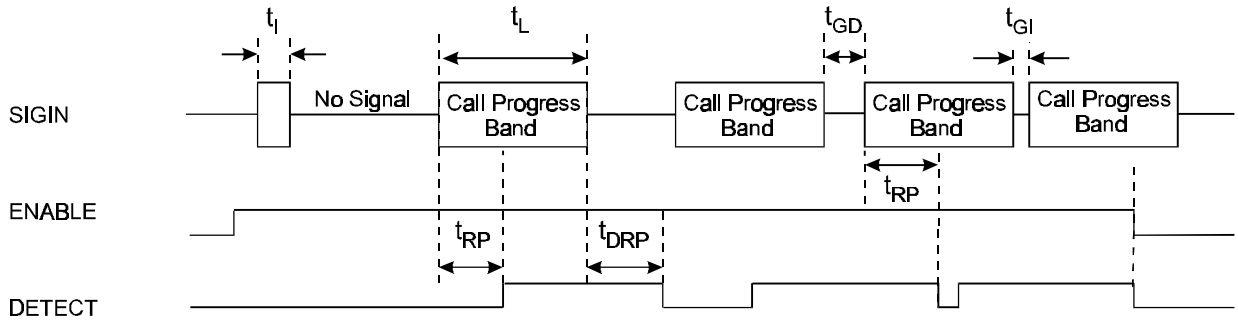


Figure 4 µC Parallel Interface Timings

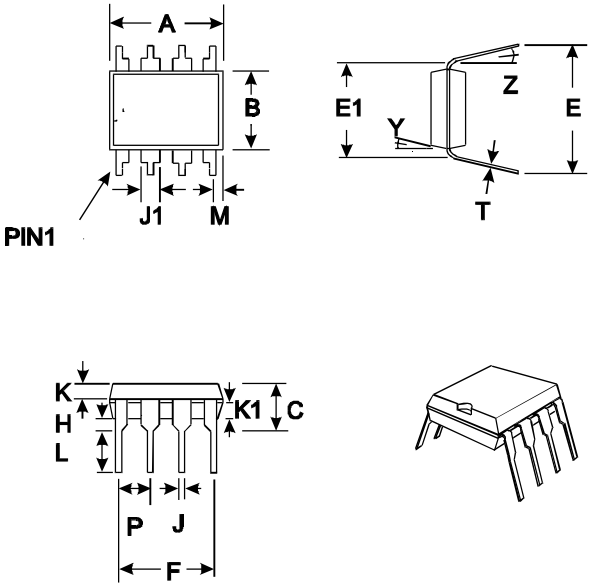
For the following conditions unless otherwise specified:

Xtal Frequency = 3.579545MHz, V_{DD} = 3.0V to 5.0V, Tamb = -40°C to +85°C, S/N = 20dB.

		Notes	Min.	Typ.	Max.	Units
Signal Timings (ref. Figures 3, 4 and 5)						
t_I	Burst Length Ignored				40.0	ms
t_L	Burst Length Detected		80.0			ms
t_{GI}	Call Progress Tone Gap Length Ignored	8			20.0	ms
t_{GD}	Call Progress Tone Gap Length Detected	8	40.0			ms
t_{RP}	Call Progress Tone Response Time	9			80.0	ms
t_{DRP}	Call Progress Tone De-Response Time	9			80.0	ms

Notes: 8. Only applies to bursts of the same frequency.
9. Measured with 350+440Hz tone pair.

1.7.2 Packaging



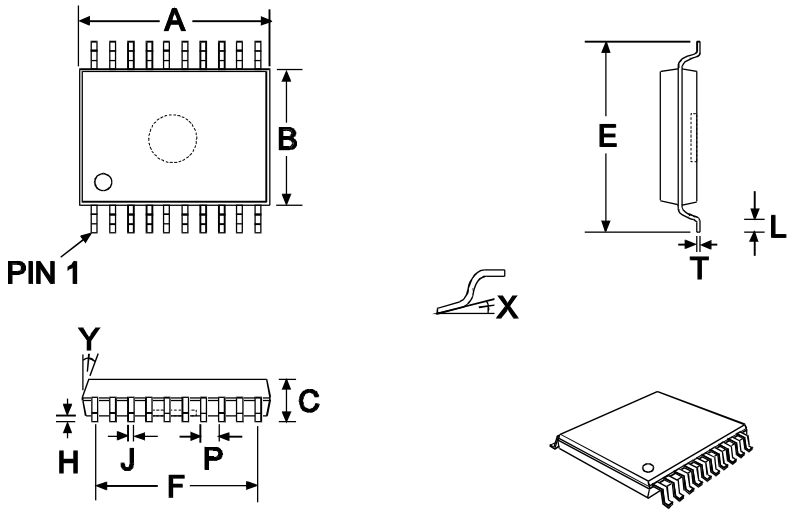
DIM.	MIN.	TYP.	MAX.
* A	0.346 (8.790)		0.400 (10.16)
* B	0.240 (6.10)		0.260 (6.60)
C	0.145 (3.68)		0.200 (5.08)
E	0.300 (7.62)		0.390 (9.91).
E1	0.290 (7.37)		0.325 (8.25)
F		0.30 (7.62)	
H		0.030 (0.76)	
J	0.015 (0.38)		0.023 (0.58)
J1	0.045 (1.14)		0.065 (1.65)
K		0.062 (1.58)	
K1		0.062 (1.58)	
L	0.121 (3.07)		0.150 (3.81)
M		0.029 (0.74)	
P		0.100 (2.54)	
T	0.008 (0.20)		0.015 (0.38)
Y		7°	
Z		5°	

NOTE :

* A & B are reference datum's and do not include mold deflash or protrusions.

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

Figure 5 P1 Mechanical Outline: *Order as part no. CMX673P1*



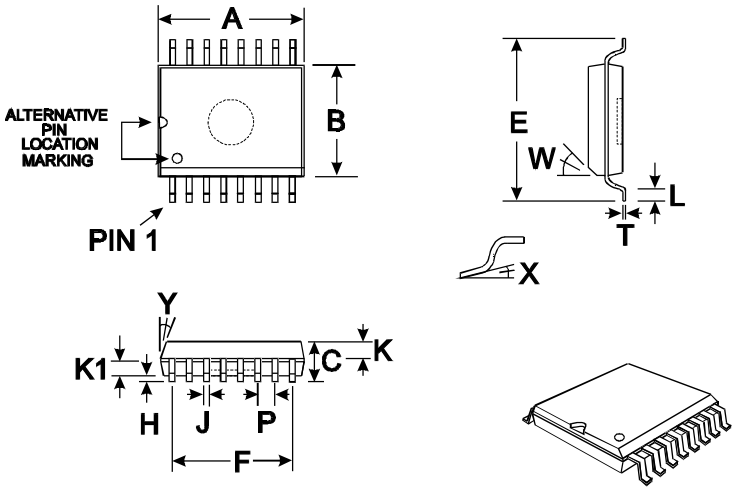
DIM.	MIN.	TYP.	MAX.
* A	0.252 (6.40)		0.260 (6.60)
* B	0.169 (4.30)		0.177 (4.50)
C	--------		0.047 (1.20)
E	0.248 (6.30)		0.256 (6.50)
F		0.230 (5.85)	
H	0.002 (0.05)		0.006 (0.15)
J	0.007 (0.17)		0.012 (0.30)
L	0.020 (0.50)		0.030 (0.75)
P		0.026 (0.65)	
T	0.003 (0.08)		0.008 (0.20)
X	0°		7°
Y		12°	

NOTE :

* A & B are reference data and do not include mold deflash or protrusions.

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

Figure 6 E3 Mechanical Outline: *Order as part no. CMX673E3*



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)
F		0.350 (8.89)	
H	0.003 (0.08)		0.020 (0.51)
J	0.013 (0.33)		0.020 (0.51)
K		0.041 (1.04)	
K1		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		7°	

NOTE :

* A & B are reference datum's and do not include mold deflash or protrusions.

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

Figure 7 D4 Mechanical Outline: *Order as part no. CMX673D4*

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