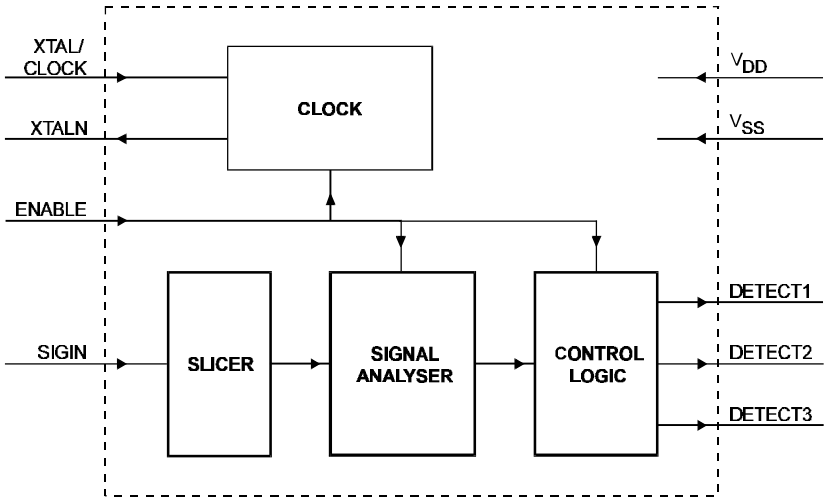
CML Semiconductor Products

Call Progress Tone Detector FX643

D/643/4 March 1996
Provisional Issue

1.0 Features

- **Worldwide Application**
- **Single Tone Decoding**
- **Dual Tone Decoding**
- **US-Busy Tones Identified**
- **Special Information Tones Identified**
- **Voice Detected**
- **Wide Dynamic Signal Range**
- **Low Working Voltage**
- **Standard 3.58MHz Clock Input**
- **Standard 8-pin DIP and 16-pin SOIC Packages**



1.1 Brief Description

The FX643 decodes the audible tone signals provided by Telecom Systems Worldwide to indicate Dial, Ringing, Busy, Unobtainable and other stages of a call attempt. Detection of these signals is essential to applications involving machine dialling or automatic call placement. The FX643 provides the key features needed for intelligent full-function Call Progress monitoring.

In addition to detecting the full range of standard Call Progress tones, the FX643 adds single and dual tone decoding for better cross-system Call Progress monitoring. The FX643 also directly identifies the "US Busy" tones, and the international Special Information Tones, saving the time needed for "cadence verification" under Busy and Unobtainable conditions. The FX643 will also decode and indicate speech, or other Non-Call Progress signals: this reduces voice-falsing of Call Progress tones and adds Voice-Answer as a "connected" prompt.

The FX643 uses new digital signal processing techniques to provide these advantages. It is a low cost, low power product with superior performance. It is available in industry standard 8-pin and 16-pin packages.

© 1996 Consumer Microcircuits Limited

CONTENTS

Section Page

1.0 Features 1

1.1 Brief Description 1

1.2 Block Diagram 3

1.3 Signal List 4

1.4 External Components 5

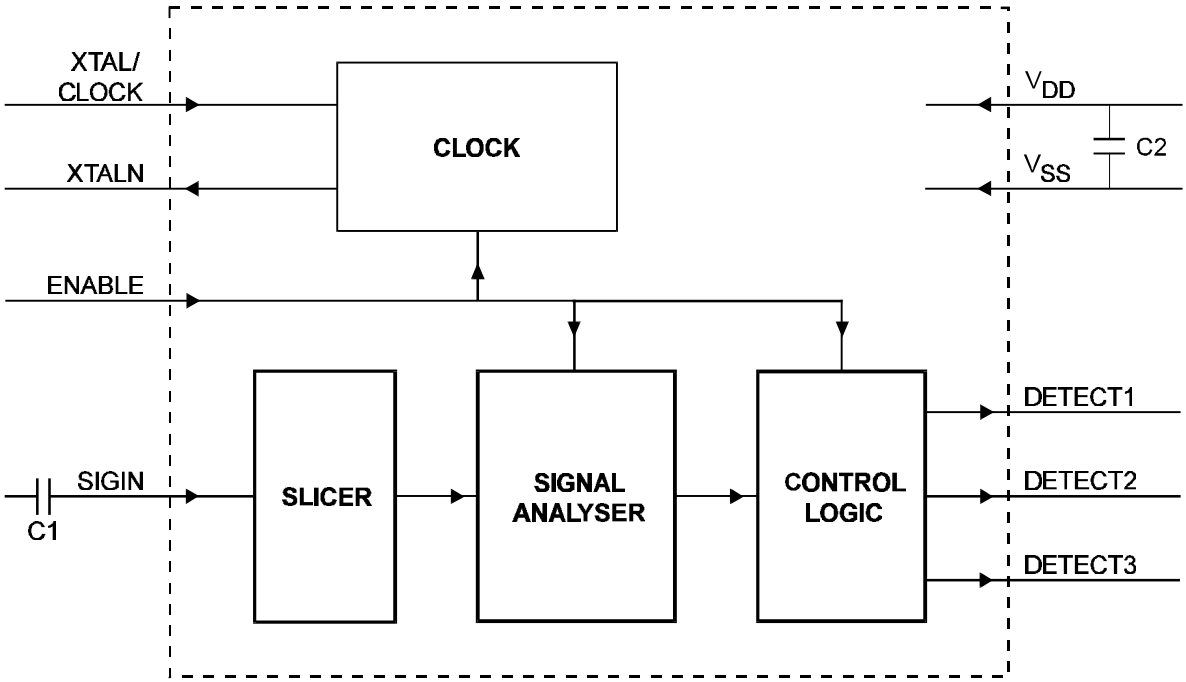
1.5 General Description 6
1.5.1 Overall Function Description 6
1.5.2 Glossary 6
1.5.3 Block Diagram Description 7
1.5.4 Decode Output Truth Table 8

1.6 Application Notes 8
1.6.1 General 8

1.7 Performance Specification 9
1.7.1 Electrical Performance 9
1.7.2 Packaging 14

© 1996 Consumer Microcircuits Limited

1.2 Block Diagram



Note: XTALN for 16-pin SOIC (D4) package only.

Figure 1 Block Diagram

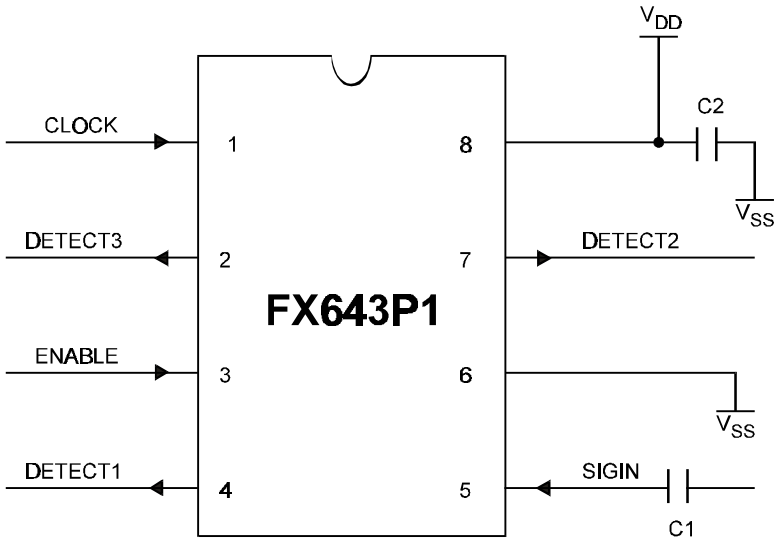
1.3 Signal List

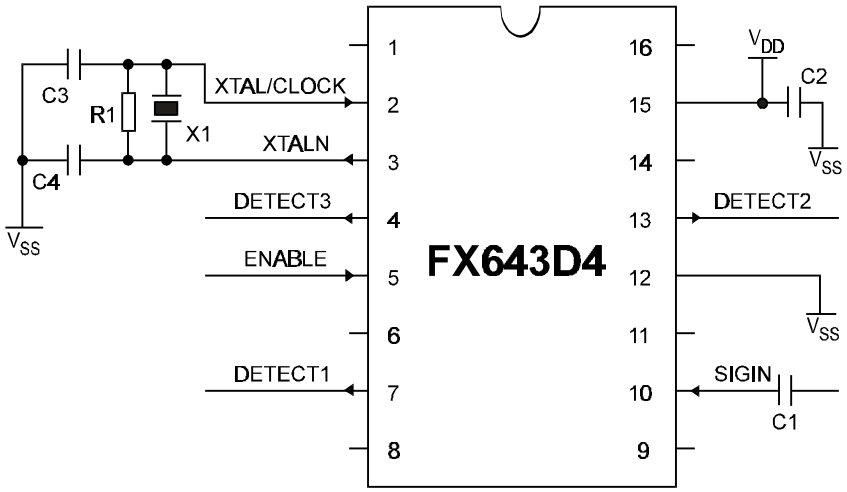
Package D4	Package P1	Signal		Description
Pin No.	**Pin No.**	**Name**	**Type**	
2	1	XTAL/CLOCK	I/P	The external clock input to the clock divider circuit. Also, the input to the on-chip oscillator, for external Xtal circuit (D4 package only).
3	-	XTALN	O/P	The inverted output of the on-chip oscillator (D4 package only).
4	2	DETECT3	O/P	When a single tone within the range of the Call Progress Band or Non Call Progress Band, or a Special Information Tone, is detected, this output goes to a logic "1".
5	3	ENABLE	I/P	A logic "0" pulse of at least 1µs applied to this input resets the decoder circuits and forces DETECT1, DETECT2 and DETECT3 outputs to a logic "0".
7	4	DETECT1	O/P	When a call progress signal is detected, this output goes to a logic "1".
10	5	SIGIN	I/P	Signal input. Signals to this pin should be ac coupled. The dc bias of this pin is set internally.
12	6	V_{SS}	Power	The negative supply rail (ground).
13	7	DETECT2	O/P	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.
15	8	V_{DD}	Power	The positive supply rail. This pin should be decoupled to V_{SS} by a capacitor.
1, 6, 8, 9, 11, 14, 16	-	NC		Internal connection. Do not make any connection to these pins.

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

© 1996 Consumer Microcircuits Limited

1.4 External Components





Typical Values:

C1 1nF ± 20% at 5V, 560pF ± 20% at 3.3V
C2 0.1µF ± 20%
(For details of clock frequency, refer to Section 1.7.1)

C3, C4 33pF ± 20%
R1 1MΩ ± 10%
X1 3.579545MHz
(Refer to Section 1.7.1)

Figure 2 Recommended External Components

© 1996 Consumer Microcircuits Limited

1.5 General Description

1.5.1 Overall Function Description

The FX643 Call Progress Tone Detector uses different tone detection methods from those commonly found with other products.

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, 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 FX643, by contrast, uses a stochastic signal processing technique based on analysis in both the frequency and time domain, 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 or Special Information Tones, or a profile more likely to match that of speech, noise or other non-call-progress signals. It checks on whether the signal is a single tone. It also adds checks on whether tones which include frequencies corresponding with the "US Busy" signals have been detected.

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 FX643.

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 340Hz to 650Hz within which the FX643 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 FX643 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 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 frequencies 950Hz or 1400Hz or 1800Hz.

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 FX643 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.

© 1996 Consumer Microcircuits Limited

No Signal: A signal falling outside the nominal range 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.

1.5.3 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 $\frac{1}{2}V_{DD}$.

Signal Analyser

The frequency range, quality and consistency of the input signal is analysed by this functional block. The signal to noise ratio must be 16dB or greater. The signal must be consistent over a period of about 140 ms. These decode criteria are continuously monitored and the assessment is updated every 7 ms, reference Figure 3.

The analyser samples the call progress signal at 9.3kHz; so care should be taken to avoid high frequency signals (e.g. 18kHz) aliasing into the call progress band.

Control Logic

This block categorises the nature of the signal into various decoded output states and controls the two output pins. See the Decode Output Truth Table in section 1.5.4.

Clock

An external clock source is to be connected to the XTAL/CLOCK input pin. Alternatively, the internal oscillator may be used with an external crystal if the 16-pin SOIC (D4) version of the FX643 is used.

© 1996 Consumer Microcircuits Limited

1.5.4 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

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

1.6 Application Notes

1.6.1 General

On power-up, a logic "0" at the ENABLE input may be used to disable and initialise the device.

© 1996 Consumer Microcircuits Limited

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 and D4 Packages	Min.	Max.	Units
Total Allowable Power Dissipation at Tamb = 25°C		800	mW
... Derating		13	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})		3.0	5.5	V
Xtal Frequency		3.57	3.59	MHz

© 1996 Consumer Microcircuits Limited

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, Tamb = - 40°C to +85°C. 0dB = 775mVrms.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
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
AC Parameters					
SIGIN pin					
Input Impedance (at 100Hz)	2		0.35		MΩ
Minimum Input Signal Level	3		-40		dB
Input Signal Dynamic Range	3	40			dB
Signal to Noise Ratio		16			dB
Clock Input					
'High' Pulse Width	4	40			ns
'Low' Pulse Width	4	40			ns
Input Impedance (at 100Hz)		10			MΩ
Gain (I/P = 1mV rms at 100Hz)		20			dB
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 device pins by external circuitry.
2. Small signal impedance over the frequency range 100Hz to 2000Hz and at 5.0V.
3. The input level is not critical as the detector uses a stochastic algorithm.
4. Timing for an external input to the XTAL/CLOCK pin.
5. ENABLE pin.
6. DETECT1, DETECT2 and DETECT3 pins.

© 1996 Consumer Microcircuits Limited

1.7.1 **Electrical Performance** (continued)

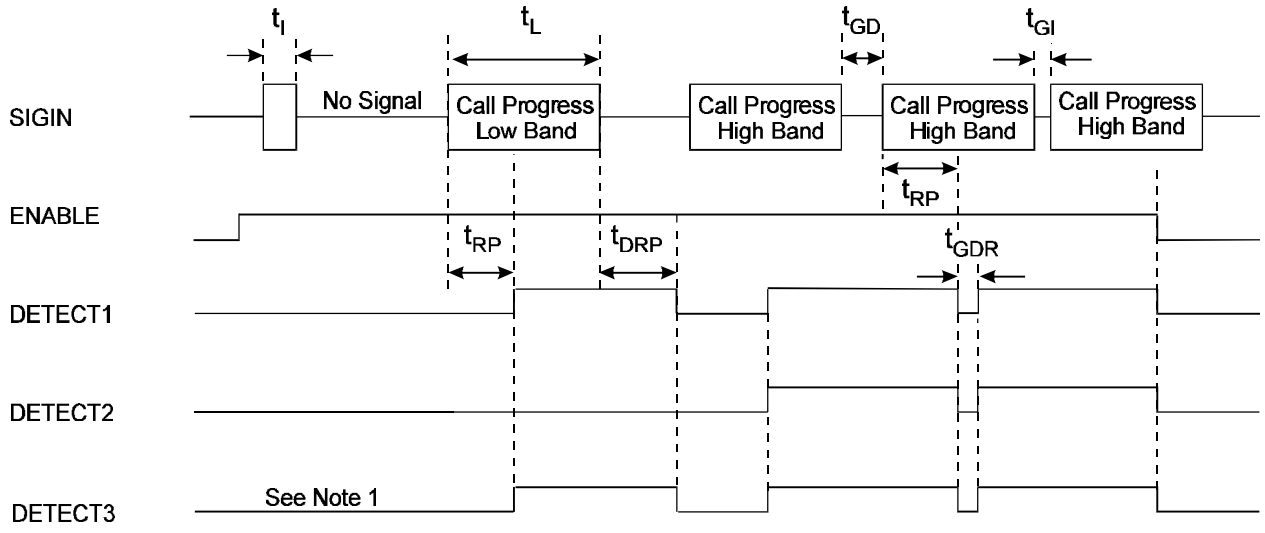
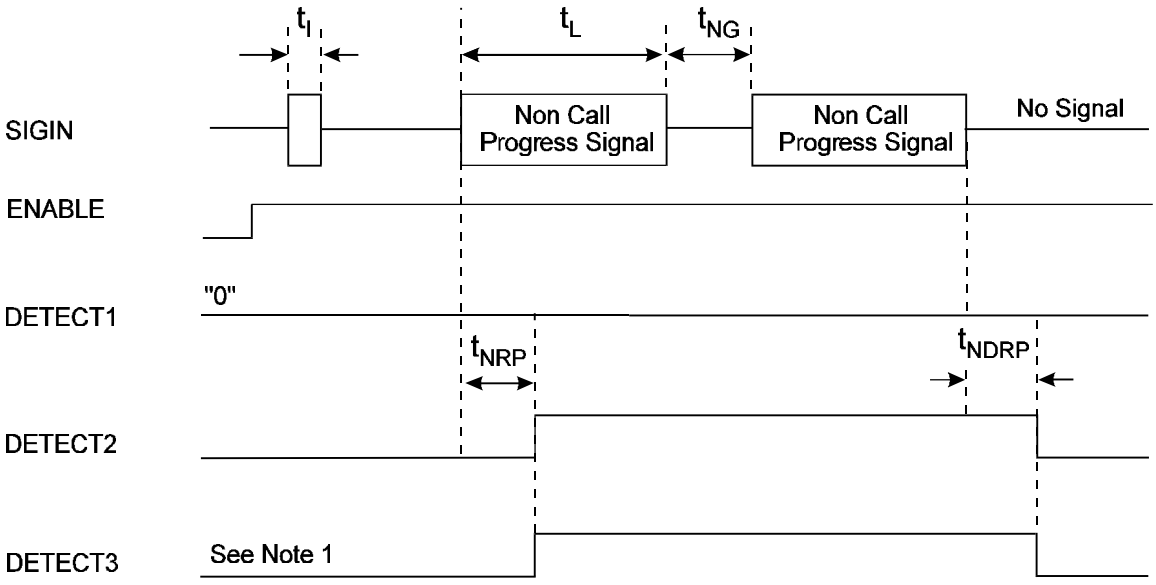


Figure 3 Timing Diagram: Call Progress Tone(s)



Note 1: DETECT3 is "1" only when the Call Progress Signal, or a Non Call Progress Signal, is a single frequency tone.

Figure 4 Timing Diagram: Non Call Progress Signal

1.7.1 Electrical Performance (continued)

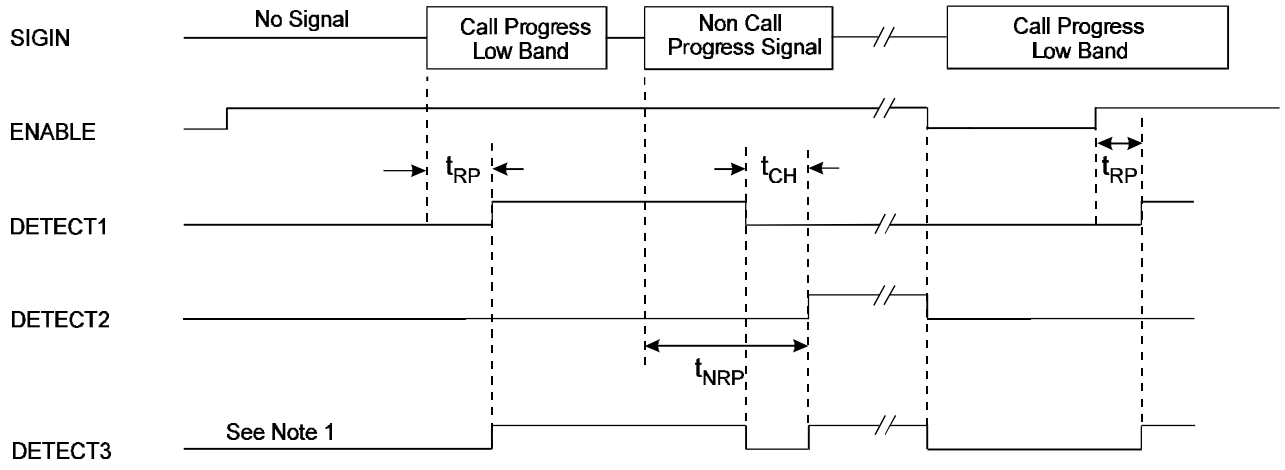
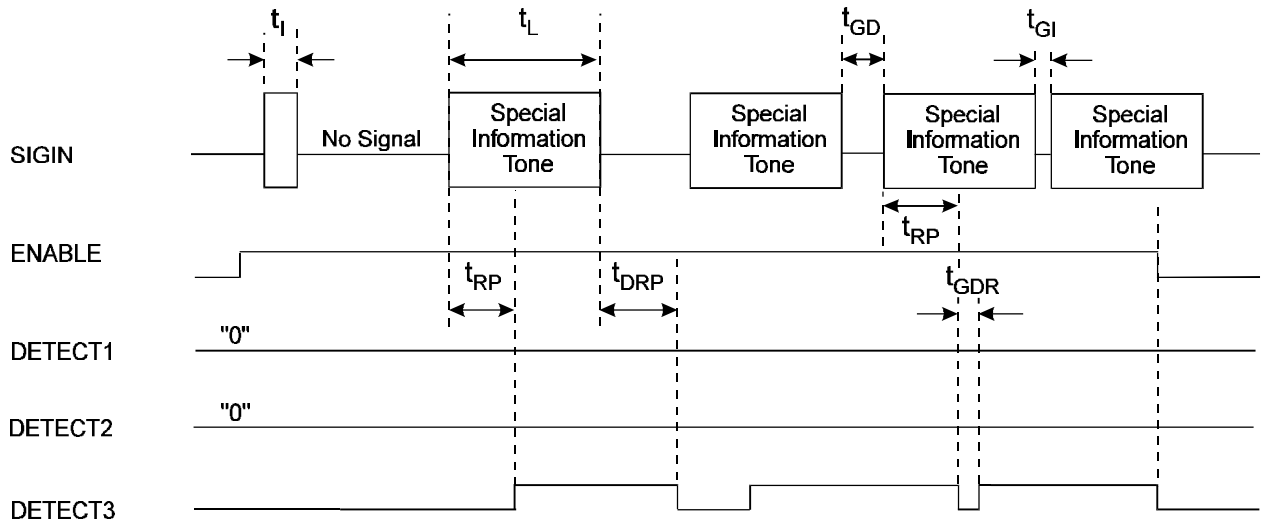


Figure 5 Timing Diagram: Call Progress Tone(s) to Non Call Progress Signal



Note 1: DETECT3 is "1" only when the Call Progress Signal, or a Non Call Progress Signal, is a single frequency tone.

Figure 6 Timing Diagram: Special Information Tones

For the following conditions unless otherwise specified:

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

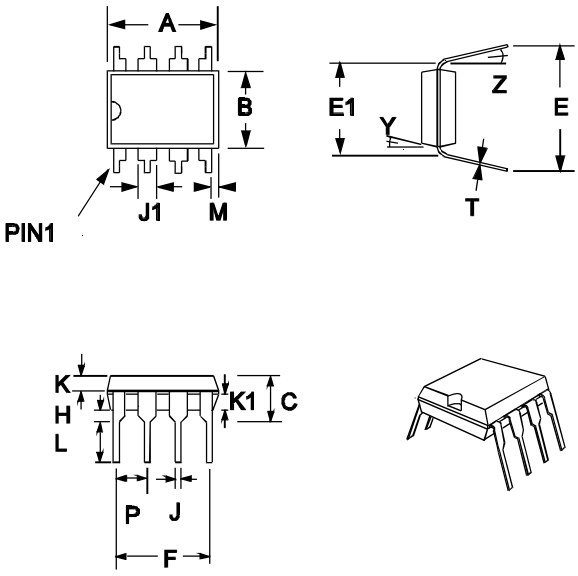
		Notes	Min.	Typ.	Max.	Units
Signal Timings (ref. Figures 3, 4, 5 and 6)						
t_I	Burst Length Ignored	10			70	ms
t_L	Burst Length Detected	10	145			ms
t_{GI}	Call Progress Tone Gap Length Ignored	7,10,11			20	ms
t_{GD}	Call Progress Tone Gap Length Detected	7,10	40			ms
t_{RP}	Call Progress Tone Response Time	10			145	ms
t_{DRP}	Call Progress Tone De-response Time	10			145	ms
t_{GDR}	Gap Detected Recorded	8,10	6			ms
t_{NG}	Non Call Progress Signal Gap Length Ignored	9		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

Notes:

7. Only applies to bursts of the same frequency.
8. To acknowledge a short tone gap ≥ 40 ms, No Signal is indicated for a minimum of 6ms.
9. If the gap > 90 ms, a No Signal state will be decoded.
10. Timings also apply to Special Information Tone.
11. Special Information Tone Gap Length Ignored is 15ms maximum.

© 1996 Consumer Microcircuits Limited

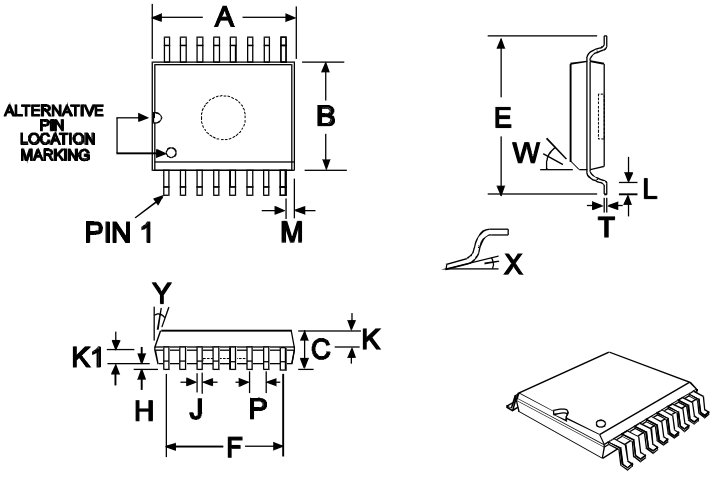
1.7.2 Packaging



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)		0.187 (4.75)
E	0.300 (7.62)		0.370 (9.40).
E1	0.290 (7.37)		0.320 (8.13)
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 : All dimensions in inches (mm.)
Angles in degrees

Figure 7 P1 Mechanical Outline: *Order as part no. FX643P1*



DIM.	MIN.	TYP.	MAX.
A	0.395 (10.03)		0.413 (10.49)
B	0.291 (7.39)		0.299 (7.59)
C	0.093 (2.36)		0.105 (2.67)
E	0.394 (10.01)		0.419 (10.64)
F		0.366 (9.29)	
H	0.004 (0.10)		0.012 (0.30)
J	0.013 (0.33)		0.019 (0.48)
K		0.041 (1.04)	
K1		0.041 (1.04)	
L	0.016 (0.41)		0.050 (1.27)
M	0.021 (0.53)		0.031 (0.79)
P		0.050 (1.27)	
T	0.009 (0.23)		0.012 (0.30)
W		45°	
X	0°		8°
Y		7°	

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

Figure 8 D4 Mechanical Outline: *Order as part no. FX643D4*

Handling precautions: This product includes input protection, however, precautions should be taken to prevent device damage from electro-static discharge. CML does not assume any responsibility for the use of any circuitry described. No IPR or circuit patent licences are implied. CML reserves the right at any time without notice to change the said circuitry and this product specification. CML has a policy of testing every product shipped using calibrated test equipment to ensure compliance with this product specification. Specific testing of all circuit parameters is not necessarily performed.

CONSUMER MICROCIRCUITS LIMITED
1 WHEATON ROAD **Telephone: +44 1376 513833**
WITHAM - ESSEX CM8 3TD - ENGLAND **Telefax: +44 1376 518247**