FX375 Private Squelch Circuit

Features

- **Tone Operated Private/Clear Switching**
- **CTCSS Tone Encode/Decode**
- **Separate Rx/Tx Speech Paths**
- **Fixed Frequency Speech Inversion**
- **μP Compatible Interface with Serial or Parallel Control Loading**

- **On-Chip Pre- and De-Emphasis Filtering in the Tx Path**
- **38 Programmable Tones + 'NoTone' Facility**
- **Audio Path Filtering (300Hz – 3033Hz)**
- **Low Power 5V CMOS**
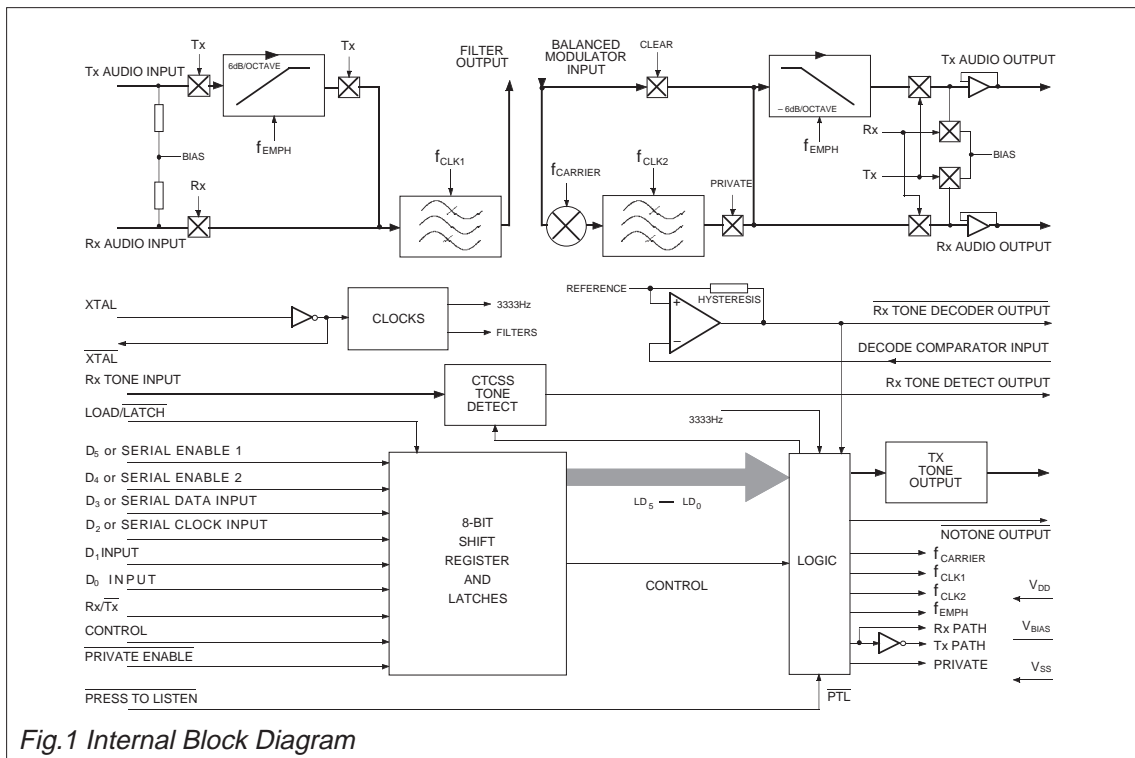
Fig.1 Internal Block Diagram

Brief Description

The FX375 is a Low-Power CMOS LSI microcircuit designed for Tone Operated Voice Privacy in communication systems.

This half-duplex device consists of a Fixed Frequency Voice Band Inverter interfaced with a Continuous Tone Controlled Squelch System (CTCSS) Encoder/ Decoder, whose allocated tone is used for voice privacy and audio squelch operation.

Frequency Inversion is achieved by modulating the input audio with a fixed carrier frequency to exchange the high and low frequencies of the voice band, making the resulting audio output unintelligible to receivers not equipped with a compatible system.

The on-chip CTCSS Dencoder is capable of encoding and decoding any one of 38 sub-audio tones in the range 67.0Hz to 250.3Hz, these Xtal derived tones are selected by a 6-bit binary word that can be loaded to the device in either a serial or parallel format.

The Privacy function is exclusive only to units using the same tone set, other intercepted signals remain "as transmitted."

A 'Press to Listen' facility allows monitoring of the channel prior to transmitting.

This device has separate, switched Rx and Tx voice, and tone audio paths. Voice paths use switched capacitor bandpass filters for the attenuation of sub-audio tones and unwanted modulation products.

6dB/octave pre- and de-emphasis filtering in the Tx path maintains natural sounding audio from this device when embodied in communication transceivers.

The FX375, which is available in DIL and SMT packages, can be simply controlled by switches, or interfaced to a μProcessor.

External requirements are a single 5-volt supply, an external 4.0MHz Xtal or clock input and signal coupling components.

Pin Number   Function

FX375J FX375LH	FX375LG FX375LS	Function
1	2	**Xtal/Clock:** The input to the clock oscillator inverter. An external 4MHz Xtal or clock input is to be applied at this pin. See Figure 2.
2	3	**$\overline{\text{Xtal}}$:** The 4MHz output of the clock oscillator inverter. See Figure 2.
3	4	**$\overline{\text{Load}}$/Latch:** This input regulates the operation of the eight input latches : D_0, D_1, D_2, D_3, D_4, D_5, Rx/Tx and Private Enable for both parallel and serial input load modes. Rx/$\overline{\text{Tx}}$ and Private Enable inputs can be used independently in either mode by the use of Load/Latch and Control inputs configured as shown in Table 3, the data format ($D_0 - D_5$), remains as set. This input has an internal 1MΩ pullup resistor.
4	–	**D_5 – (Serial Enable 1) :**
5	5	**D_4 – (Serial Enable 2) :** The Rx/$\overline{\text{Tx}}$ tone programming and function inputs. Programmed as shown in Table 2 these inputs will select the CTCSS tone frequency and parallel or serial loading function. Notone, when set in receive, enables the Rx Audio Output and forces the Rx Tone Decode Output to a logic '0,' in transmit the Tx Tone Output is held at V_{BIAS} (Notone). These inputs each have an internal 1MΩ pullup resistor. If FX375LG or LS package styles are used Pin 5 (Serial Enable 2) should be externally connected to V_{ss}.
6	6	**D_3 – (Serial Data Input) :**
7	7	**D_2 – (Serial Clock Input) :**
8	–	**D_1**
9	–	**D_0**
10	8	**$\overline{\text{Rx Tone Decode Output}}$:** The output of the decode comparator. In Rx a logic '0' indicates 'CTCSS tone decoded' above the internal reference level, or Notone programmed. This action internally enables the Rx audio path and Frequency Inversion function (when applicable) as shown in Table 1. In Tx this output is a logic '1'.
11	9	**Decode Comparator Input :** A logic '1' at this pin, in Rx, is compared internally with a fixed reference level, a more positive input value will produce a logic '0' at the Rx Tone Decode Output. This input should be externally connected to the Rx Tone Detect Output via external integrator components C_7, R_2, R_3, D_1 (see Figure 2).
12	10	**Rx Tone Detect Output :** This output, in Rx, goes to a logic '1' when a valid, programmed CTCSS tone is received at the Rx Tone Input. This input should be externally connected to the Decode Comparator Input via external integrator components C_7, R_2, R_3, D_1 (see Figure 2).
13	–	**$\overline{\text{Notone Output}}$:** Outputs a logic '0' when a " Notone" CTCSS code has been programmed . It can be used to operate squelch circuitry under receive "Notone" conditions.
14	11	**V_{ss} :** Negative supply rail (GND). The FX375LG and LS package styles are configured as a serial-data loading device, Parallel Programing Inputs D_0, D_1 and D_5, and the NOTONE Output pin functions are not available.

Pin Number   Function

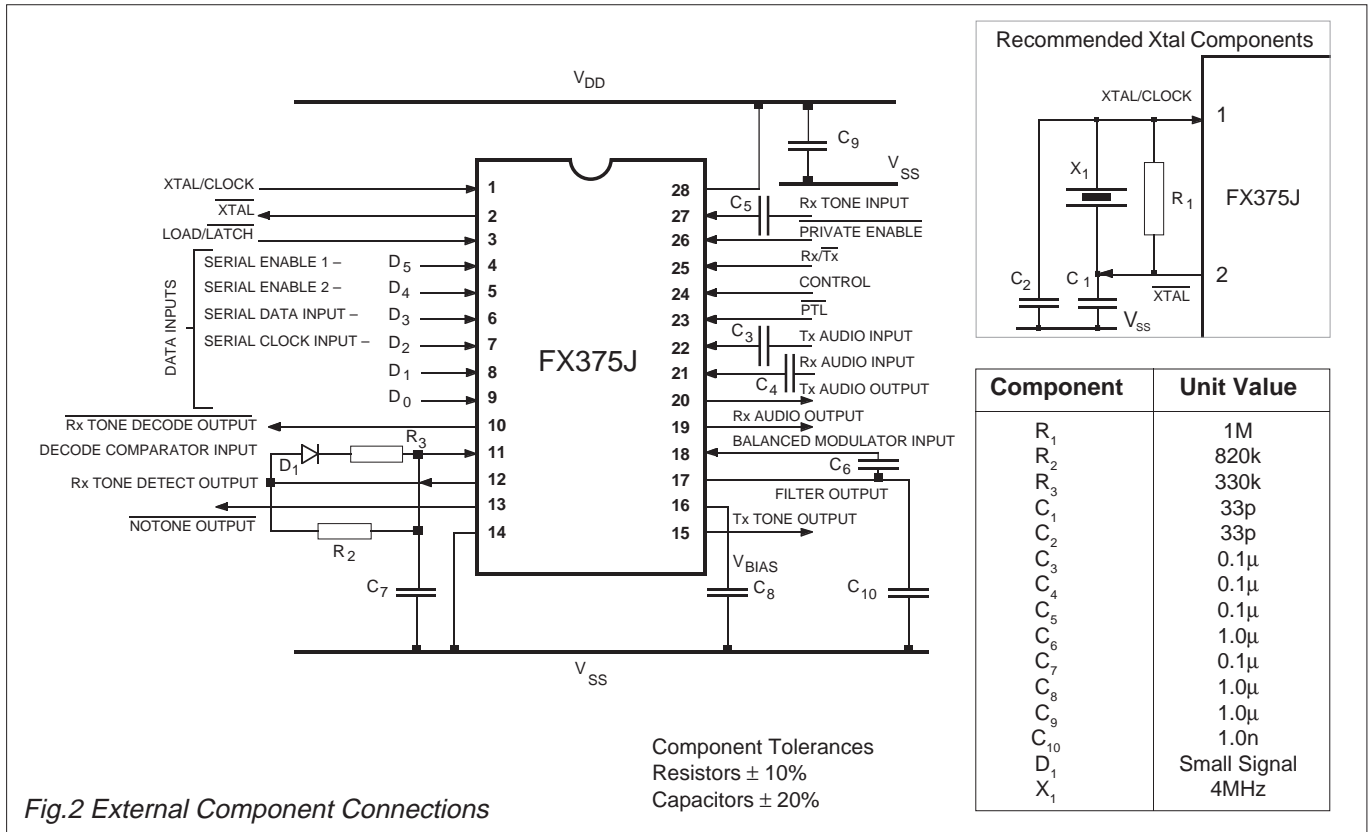| FX375J FX375LH	FX375LG FX375L	
15	12	**Tx Tone Output :** This is the buffered, programmed CTCSS tone sinewave output in Tx. During Rx and Notone operation this output is held at V_{BIAS}. See note "g," page 7 with reference to capacitive load limits of this output.
16	13	**V_{BIAS}:** This bias pin is set internally to $V_{DD}/2$. It must be externally decoupled using a capacitor, C_8, of 1.0µF (minimum) to V_{SS}, see Figure 2.
17	14	**Filter Output :** The Input Audio Bandpass Filter output, this pin must be connected to the Balanced Modulator Input via a capacitor, C_6, and decoupled to V_{SS} by C_{10}, see Figure 2.
18	15	**Balanced Modulator Input :** The input to the Balanced Modulator, this pin must be connected to the Filter Output via a capacitor, C_6, see Figure 2.
19	16	**Rx Audio Output :** Outputs the received audio from a buffered output stage and is held at V_{BIAS} when in Tx.
20	17	**Tx Audio Output :** The output of the audio path in the Tx mode and is held at V_{BIAS} when in Rx.
21	18	**Rx Audio Input :** The Audio input pin for the Rx mode. Input signals should be a.c. coupled via an external capacitor, C_4, see Figure 2.
22	19	**Tx Audio Input :** This is the voice input pin for the Tx mode. Signals should be a.c. coupled via an external capacitor, C_3, see Figure 2.
23	20	**$\overline{PTL}$:** The "Press To Listen" function input, in the receive mode a logic '0' enables the Rx Audio Output directly, overriding tone squelch but not intercepting a private conversation. In the transmit mode a logic '0' reverses the phase of the Tx Tone Output for "squelch tail" reduction (see Table 1), this function, in Tx, should be accurately applied by a timing circuit to ensure correct system operation.
24	21	**Control :** This input, with Load/$\overline{Latch}$, selects the operational mode of Rx/$\overline{Tx}$ and Private Enable functions, see Table 3.
25	22	**Rx/$\overline{Tx}$:** Selects the receive or transmit mode (Rx = '1', Tx = '0') and can be loaded by serial or parallel means, as described in Table 3.
26	23	**$\overline{Private\ Enable}$:** This input selects either Private or Clear modes (Clear = '1', Private = '0'), and can be loaded by serial or parallel means, as described in Table 3. In Rx this input could be taken from the Rx Tone Decode Output. This input has an internal 1MΩ pullup resistor.
27	24	**Rx Tone Input :** The received tone input to the on-chip CTCSS decoder and should be a.c. coupled via capacitor C_5, see Figure 2.
28	1	**V_{DD} :** Positive supply rail. A single +5V power supply is required.

Operational Information

Fig.2 External Component Connections

Recommended Xtal Components

Component	Unit Value
R_1	1M
R_2	820k
R_3	330k
C_1	33p
C_2	33p
C_3	0.1μ
C_4	0.1μ
C_5	0.1μ
C_6	1.0μ
C_7	0.1μ
C_8	1.0μ
C_9	1.0μ
C_{10}	1.0n
D_1	Small Signal
X_1	4MHz

Component Tolerances
Resistors ± 10%
Capacitors ± 20%

Operational Truth Table – Table 1 (below) illustrates the output paths and logic functions of the FX375 Private Squelch Circuit in both Receive and Transmit modes.

Receive Operation – $(Rx/\overline{Tx} = '1')$
In the Rx mode Tx Tone and Tx Audio paths are held at bias.

$D_0 - D_5$	$\overline{Notone}$	Private $\overline{Enable}$	$\overline{PTL}$	Rx Tone Detect	Rx Tone Decode	Receive Signal Path State	Condition
Tone	1	0	1	0	1	bias	X
Tone	1	0	0	0	1	open	Not Inverted
Tone	1	0	X	1	0	open	Inverted
Notone	0	0	X	X	0	open	Not Inverted
Tone	1	1	1	0	1	bias	X
Tone	1	1	0	0	1	open	Not Inverted
Tone	1	1	X	1	0	open	Not Inverted
Notone	0	1	X	X	0	open	Not Inverted

Transmit Operation – $(Rx/\overline{Tx} = '0')$
In the Tx mode the Rx audio path is held at bias and the Rx Tone Detect output at logic '0.'

$D_0 - D_5$	$\overline{Notone}$	Private $\overline{Enable}$	$\overline{PTL}$	Transmitted Tone State	Phase	Transmit Signal Path State	Condition
Tone	1	0	1	active	0°	open	Inverted
Tone	1	0	0	active	180°	open	Inverted
Notone	0	0	X	bias	X	open	Not Inverted
Tone	1	1	1	active	0°	open	Not Inverted
Tone	1	1	0	active	180°	open	Not Inverted
Notone	0	1	X	bias	X	open	Not Inverted

Notes

1. The pre- and de-emphasis circuits remain in the Transmit path during Clear and Private operation.
2. Power remains applied to the CTCSS tone decoder at all times.
3. Carrier Frequency = 3333Hz during Private operation (Tx or Rx).
4. During Clear operation the carrier frequency is turned off to reduce spurious emissions.
5. Under Rx-Notone conditions the Notone output can be used to operate squelch circuitry.
6. The functions in this table are applicable when the device is connected as recommended in Figure 2.

Table 1 Functions and Outputs

Operational Information

The logical inputs ($D_0 - D_5$) are used to programme the FX375 tone frequency ($Rx/\overline{Tx}$) as shown in Table 2 (below). Loading of data is carried out in either serial or parallel formats.

Nominal Frequency (Hz)	FX375 Frequency (Hz)	Δfo (%)	Tone Data Programme Inputs					
			D_0	D_1	D_2	D_3	D_4	D_5
67.0	67.05	+ 0.07	1	1	1	1	1	1
71.9	71.9	0	1	1	1	1	1	0
74.4	74.35	- 0.07	0	1	1	1	1	1
77.0	76.96	- 0.5	1	1	1	1	0	0
79.7	79.77	+ 0.09	1	0	1	1	1	1
82.5	82.59	+ 0.1	0	1	1	1	1	0
85.4	85.38	- 0.2	0	0	1	1	1	1
88.5	88.61	+ 0.13	0	1	1	1	0	0
91.5	91.58	+ 0.09	1	1	0	1	1	1
94.8	94.76	- 0.04	1	0	1	1	1	0
97.4	97.29	- 0.11	0	1	0	1	1	1
100.0	99.96	- 0.04	1	0	1	1	0	0
103.5	103.43	- 0.07	0	0	1	1	1	0
107.2	107.15	- 0.05	0	0	1	1	0	0
110.9	110.77	- 0.12	1	1	0	1	1	0
114.8	114.64	- 0.14	1	1	0	1	0	0
118.8	118.8	0	0	1	0	1	1	0
123.0	122.8	- 0.17	0	1	0	1	0	0
127.3	127.08	- 0.17	1	0	0	1	1	0
131.8	131.67	- 0.10	1	0	0	1	0	0
136.5	136.61	+ 0.08	0	0	0	1	1	0
141.3	141.32	+ 0.02	0	0	0	1	0	0
146.2	146.37	+ 0.12	1	1	1	0	1	0
151.4	151.09	- 0.2	1	1	1	0	0	0
156.7	156.88	+ 0.11	0	1	1	0	1	0
162.2	162.31	+ 0.07	0	1	1	0	0	0
167.9	168.14	+ 0.14	1	0	1	0	1	0
173.8	173.48	- 0.19	1	0	1	0	0	0
179.9	180.5	+ 0.14	0	0	1	0	1	0
186.2	186.29	+ 0.05	0	0	1	0	0	0
192.8	192.86	+ 0.03	1	1	0	0	1	0
203.5	203.65	+ 0.07	1	1	0	0	0	0
210.7	210.17	- 0.25	0	1	0	0	1	0
218.1	218.58	+ 0.22	0	1	0	0	0	0
225.7	226.12	+ 0.18	1	0	0	0	1	0
233.6	234.19	+ 0.25	1	0	0	0	0	0
241.8	241.08	- 0.30	0	0	0	0	1	0
250.3	250.28	- 0.01	0	0	0	0	0	0
	Serial Input Mode		X	X	Clk	Data	0	1
	Notone		0	0	0	0	1	1

Table 2 Tone Programming

Load/$\overline{Latch}$ and Control Functions – The Load/$\overline{Latch}$ function regulates the loading of the FX375 tone frequency ($D_0 - D_5$, Table 2) in either the serial or parallel modes. The Control input enables the flexible use of the $Rx/\overline{Tx}$ and $\overline{Private\ Enable}$ functions, its use is illustrated in Table 3.

Load Configuration	Load/$\overline{Latch}$ *Logic*	*and*	Control *Logic*	Loading mode of :-	
				$D_0 - D_5$	$Rx/\overline{Tx}$, $\overline{Private\ Enable}$
Parallel	1		0	Transparent	Transparent
Parallel	0		0	Latched	Latched
Parallel	1		1	Transparent	Transparent
Parallel	0		1	Latched	Transparent
Serial	0		1	Load data in	Transparent
Serial	0 – 1 – 0		0	Latch data in	Latched

Notes

Glossary –	Transparent	Data at the device inputs acts directly.
	Latched	In this position data and/or functions are latched in.

'0 – 1 – 0' is a strobe pulse as shown in figures 3 and 4 (Timing).

Table 3 Load/$\overline{Latch}$ and Control Functions

5

Timing Information ......

Control instructions are input to the FX375 by serial (figure 3) or parallel (figure 4) means, using Data Inputs and Load/Latch as shown in the diagrams below.

Fig.3 Serial Load Timing
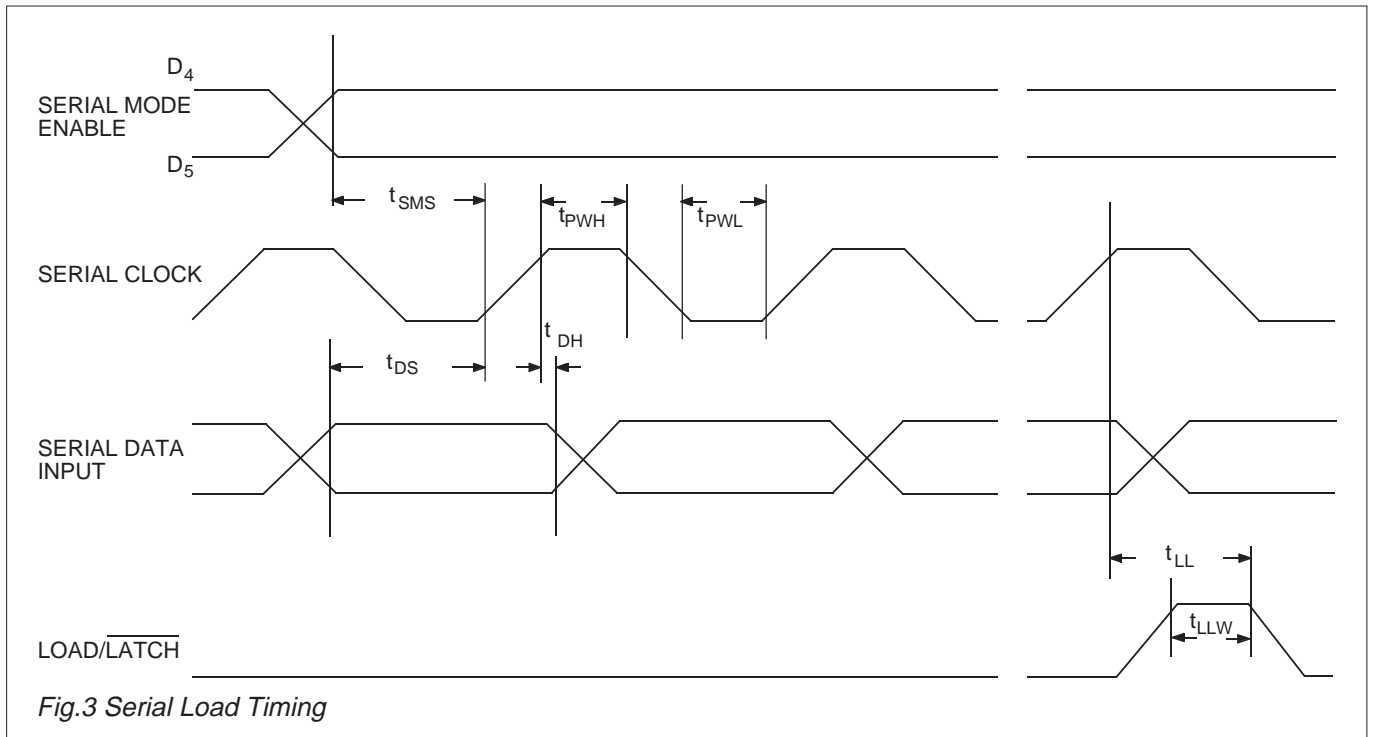
		Min.	Typ.	Max.	Unit
Serial	Figure 3				
Serial Mode Enable Set Up Time – (t_{SMS})		250	–	–	ns
Clock 'High' Pulse Width – (t_{pWH})		250	–	–	ns
Clock 'Low' Pulse Width – (t_{pWL})		250	–	–	ns
Data Set Up Time – (t_{DS})		150	–	–	ns
Data Hold Time – (t_{DH})		50	–	–	ns
Load/Latch Set Up Time – (t_{LL})		250	–	–	ns
Load/Latch Pulse Width – (t_{LLW})		150	–	–	ns
Parallel	Figure 4				
Data Valid Time – (t_{VP})		200	–	–	ns
Load Time – (t_L)		150	–	–	ns
Fall Time – (t_F)		–	–	50	ns
Data Hold Time – (t_H)		50	–	–	ns

Serial Loading Sequence : With Load/Latch at logic '0' serial data is loaded in the sequence :-
D_5, D_4, D_3, D_2, D_1, D_0, Rx/Tx, Private Enable. When these 8 bits have been clocked in on the rising clock edge, data is latched by strobing the Load/Latch input – " 0 – 1 – 0 " (Figure 3).

Table 4 Timing

Fig.4 Parallel Load Timing
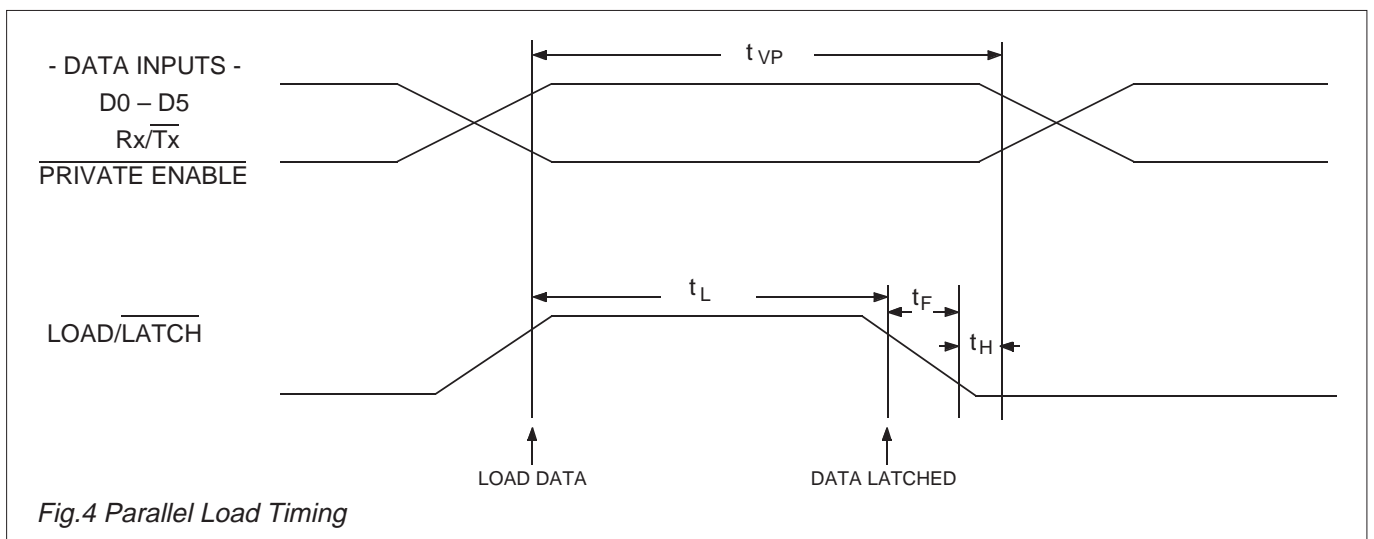
Specification

Absolute Maximum Ratings

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

Supply voltage	- 0.3 to 7.0V
Input voltage at any pin (ref V_{SS} = 0V)	- 0.3 to (V_{DD} + 0.3V)
Sink/source current (supply pins)	+/- 30mA
(other pins)	+/- 20mA
Total device dissipation @ T_{AMB} 25°C	800mW Max.
Derating	10mW/°C
Operating temperature range: **FX375J**	- 30°C to + 85°C (ceramic)
FX375LG/LS	- 30°C to + 70°C (plastic)
Storage temperature range: **FX375J**	- 55°C to + 125°C (ceramic)
FX375LG/LS	- 40°C to + 85°C (plastic)

Operating Limits

All device characteristics are measured under the following conditions unless otherwise specified:

V_{DD} = 5.0V, T_{AMB} = 25°C, Xtal/Clock f_0 = 4.0 MHz, Audio level 0dB ref: = 300mV rms.

Composite input signal = 0dB, 1kHz tone in −12dB (6kHz band limited) gaussian white noise with a −20dB CTCSS tone.

Characteristics	See Note	Min.	Typ.	Max.	Unit
Static Values					
Supply Voltage		4.5	5.0	5.5	V
Supply Current :					
Rx /Tx (Operating)		–	8.0	–	mA
Rx standby (No Decode)		–	2.8	–	mA
Rx only (Decoding)		–	5.0	–	mA
Analogue Input Impedance		–	0.5	–	MΩ
Analogue Output Impedance		–	0.5	–	kΩ
Tone Input Impedance		–	1.0	–	MΩ
Digital Input Impedance		–	1.0	–	MΩ
Input Logic '1'		3.5	–	–	V
Input Logic '0'		–	–	1.5	V
Output Logic '1' (I = 0.1mA)		4.0	–	–	V
Output Logic '0' (I = 0.1mA)		–	–	1.0	V
Dynamic Values					
Maximum Input Level		–	+ 10.5	–	dB
Decoder					
Tone Input Signal Level	1,4	- 20	–	–	dB
Response Time	1,4,6	–	–	250	ms
De-response Time	1,4,6	–	–	250	ms
Selectivity	4	± 0.5	–	± 3.0	%fo
Encoder					
Tone Output Level (relative 775mVrms)		- 3.0	0	+ 3.0	dB
Tone Frequency Accuracy		- 0.3	–	+ 0.3	%fo
Tone Harmonic Distortion		–	2.0	5.0	%
Tone Output Load Current	2	–	–	5.0	mA
Output Level Variation between Tones		–	0.1	–	dB
Rise Time (to 90% nominal level)					
(fo >100Hz)	5	–	15	–	ms
(fo <100Hz)	5	–	45	–	ms

Specification

Characteristics	See Note	Min.	Typ.	Max.	Unit
Rx Clear					
Total Harmonic Distortion	3	–	2	5	%
Output Noise Level	7	–	- 43	–	dB
Passband Gain (300Hz – 3033Hz)		–	0	–	dB
Passband Ripple (300Hz – 3033Hz)	3	–	–	3	dB
Audio Stopband Attenuation					
($f$in > 3333Hz)		–	20	–	dB
($f$in > 3633Hz)		–	45	–	dB
($f$in < 250Hz)		–	42	–	dB
Rx Invert					
Carrier Frequency		–	3333	–	Hz
Total Harmonic Distortion	3,8	–	4	10	%
Baseband Breakthrough		–	- 40	–	dB
Carrier Breakthrough		–	- 40	–	dB
Output Noise Level	7	–	- 37	–	dB
Passband Ripple (300Hz – 3033Hz)	8	–	–	5	dB
Audio Stopband Attenuation					
($f$in > 3333Hz)		–	50	–	dB
($f$in > 3633Hz)		–	60	–	dB
($f$in < 250Hz)		–	60	–	dB
Tx Clear					
Total Harmonic Distortion	3	–	3	5	%
Output Noise Level	7	–	- 43	–	dB
Passband Gain (300Hz – 3033Hz)	3	–	0	–	dB
Passband Ripple (300Hz – 3033Hz)	3	–	–	4	dB
Audio Stopband Attenuation					
($f$in > 3333Hz)		–	20	–	dB
($f$in > 3633Hz)		–	45	–	dB
($f$in < 250Hz)		–	42	–	dB
Pre- and De-emphasis		–	–	6	dB/octave
Tx Invert					
Carrier Frequency		–	3333	–	Hz
Total Harmonic Distortion	3,8	–	4	10	%
Baseband Breakthrough		–	- 40	–	dB
Carrier Breakthrough		–	- 40	–	dB
Output Noise Level	7	–	- 37	–	dB
Passband Ripple (300Hz – 3033Hz)	3,8	–	–	5	dB
Audio Stopband Attenuation					
($f$in > 3333Hz)	8	–	50	–	dB
($f$in > 3633Hz)	8	–	60	–	dB
($f$in < 250Hz)	8	–	60	–	dB
Pre- and De-emphasis		–	–	6	dB/octave

Notes
1. These values are obtained using the external integrator components as detailed in Figure 2.
2. An Emitter Follower output.
3. With an input signal of 1kHz @ 0dB.
4. Under Composite Signal test conditions.
5. Any programmed tone with RL = 600, CL = 15pF. Including any response to a phase reversal instruction.
6. fo > 100Hz, (for 100Hz > fo > 67Hz : t = [100/fo (Hz)] x 250ms).
7. Input a.c. short circuit, audio path enabled, measured in a 30kHz bandwidth.
8. Due to frequency inversion, this figures reflects the difference from the expected ideal response.

Private Squelch Circuit ...... Application Notes

The FX375 Private Squelch Circuit utilizes Audio Frequency Inversion and Continuous Tone Controlled Squelch System (CTCSS) techniques to provide secure voice communication on a common radio channel.

Clear/Private Switching is controlled by the logic state of the Private Enable input. Table 1 shows that, in the receive condition the signal path will only be inverted when the programmed CTCSS tone is received. Although other logic actions will enable the receive path, privacy of the conversation is maintained at all times.

Pre- and De-emphasis (6dB/octave) filters are included on-chip in the transmit path, so that the use of this device will produce natural sounding audio (clear or private modes) when installed in modern radio communication transceivers, with or without existing audio processing circuitry. The recommended layout is shown in block form below.

Figure 5 shows the recommended positioning of the
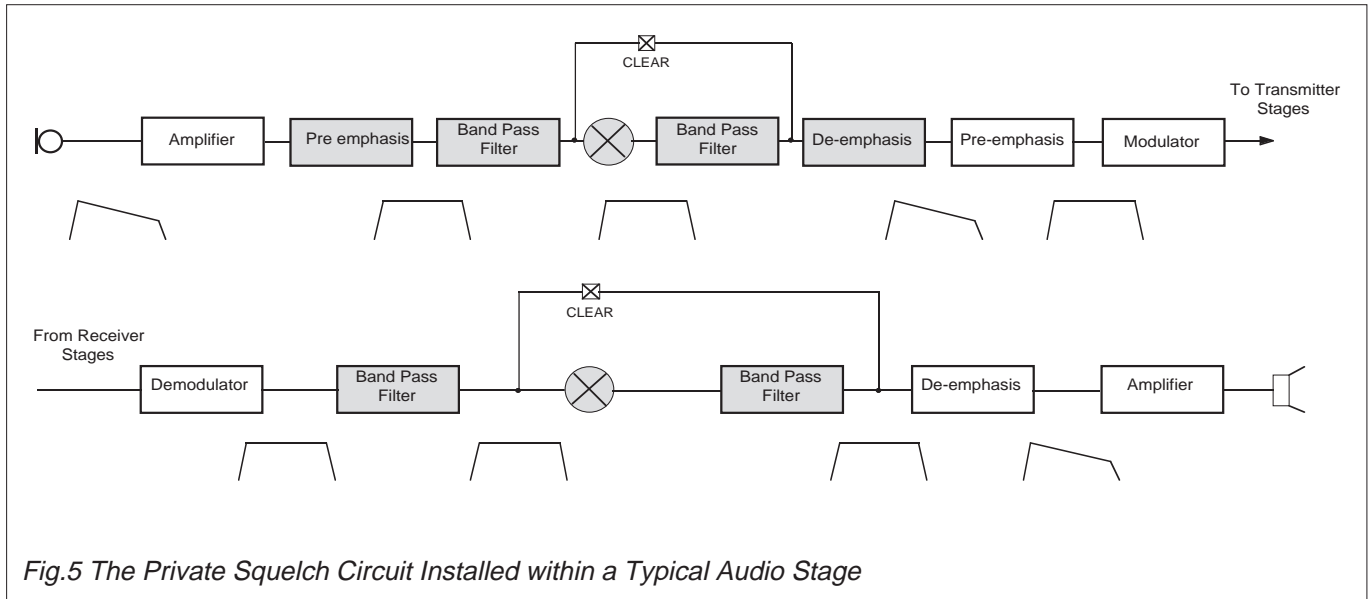
Fig.5 The Private Squelch Circuit Installed within a Typical Audio Stage

FX375 (shaded areas) when installed within the audio stages of a typical transceiver system. The accompanying waveform diagrams indicate the relative "voice band amplitudes" at each stage of the receive or transmit process.

Installation Recommendations – Care should be taken on the design and layout of the printed circuit board taking into consideration the points noted below.

(a) All external components (as recommended in Figure 2) should be kept close to the package.

(b) Tracks should be kept short, particularly the Audio and V_{BIAS} inputs.

(c) Xtal/clock and digital tracks should be kept well away from analogue inputs and outputs.

(d) Inputs and outputs should be screened wherever possible.

(e) A "ground plane" connected to V_{SS} will assist in eliminating external pick-up on input and output pins.

(f) It is recommended that the power supply rails have less than 1mV rms of noise allowed.

(g) Tx Tone Output loading – Large capacitive loads could cause this pin to oscillate. If capacitive loads in excess of 100pF are unavoidable, a resistor of 1kΩ or greater put in series with the load should minimise this effect.

Package Outlines

The FX375 is available in the package styles outlined below. Mechanical package diagrams and specifications are detailed in Section 10 of this document.
Pin 1 identification marking is shown on the relevant diagram and pins on all package styles number anti-clockwise when viewed from the top.
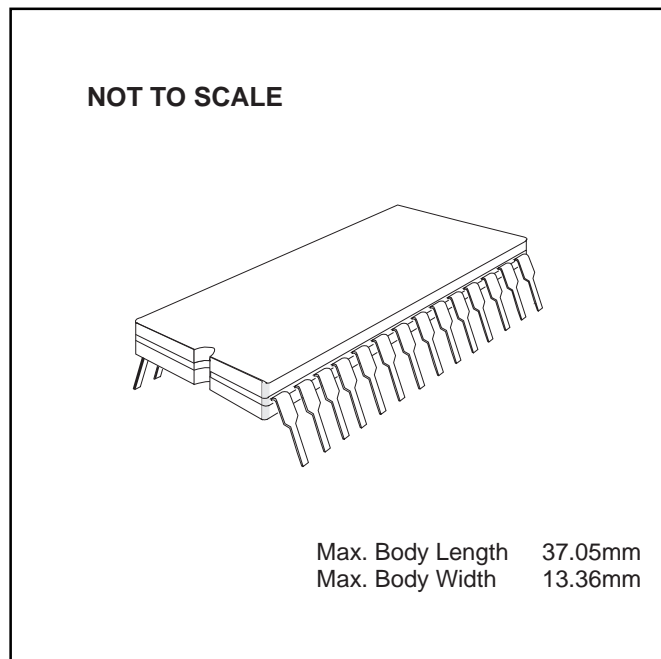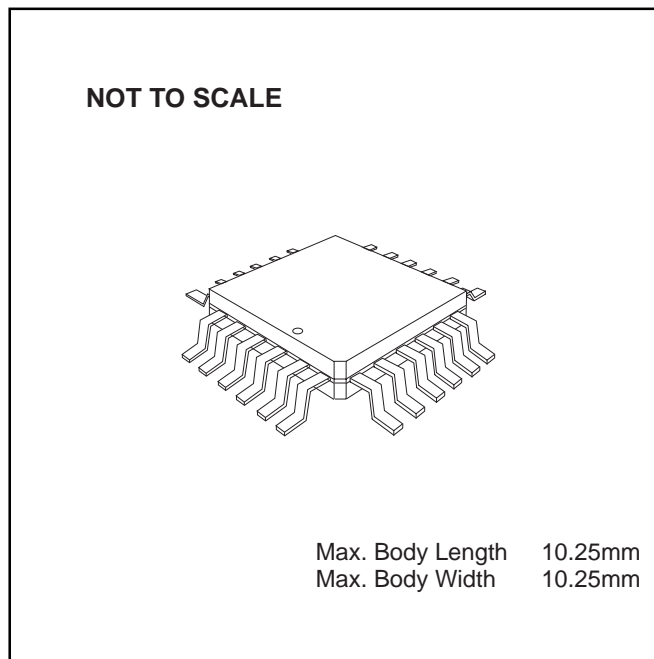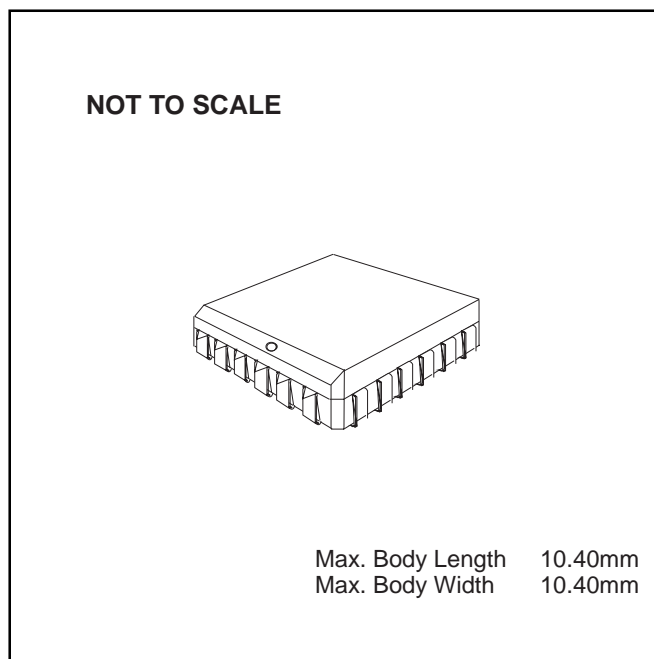
Handling Precautions

The FX375 is a CMOS LSI circuit which includes input protection. However precautions should be taken to prevent static discharges which may cause damage.

FX375J   28-pin cerdip DIL   (J5)

NOT TO SCALE

Max. Body Length	37.05mm
Max. Body Width	13.36mm

FX375LG   24-pin quad plastic encapsulated bent and cropped   (L1)

NOT TO SCALE

Max. Body Length	10.25mm
Max. Body Width	10.25mm

FX375LS   24-lead plastic leaded chip carrier   (L2)

NOT TO SCALE

Max. Body Length	10.40mm
Max. Body Width	10.40mm

Ordering Information

FX375J   28-pin cerdip DIL   (J5)

FX375LG   24-pin encapsulated bent and cropped   (L1)

FX375LS   24-lead plastic leaded chip carrier   (L2)

CML Microcircuits
COMMUNICATION SEMICONDUCTORS

CML Product Data

In the process of creating a more global image, the three standard product semiconductor companies of CML Microsystems Plc *(Consumer Microcircuits Limited (UK), MX-COM, Inc (USA) and CML Microcircuits (Singapore) Pte Ltd)* have undergone name changes and, whilst maintaining their separate new names *(CML Microcircuits (UK) Ltd, CML Microcircuits (USA) Inc and CML Microcircuits (Singapore) Pte Ltd)*, now operate under the single title **CML Microcircuits**.

These companies are all 100% owned operating companies of the CML Microsystems Plc Group and these changes are purely changes of name and do not change any underlying legal entities and hence will have no effect on any agreements or contacts currently in force.

CML Microcircuits Product Prefix Codes

Until the latter part of 1996, the differentiator between products manufactured and sold from MXCOM, Inc. and Consumer Microcircuits Limited were denoted by the prefixes MX and FX respectively. These products use the same silicon etc. and today still carry the same prefixes. In the latter part of 1996, both companies adopted the common prefix: CMX.

This notification is relevant product information to which it is attached.

Company contact information is as below:

CML Microcircuits (UK) Ltd
COMMUNICATION SEMICONDUCTORS

Oval Park, Langford, Maldon,
Essex, CM9 6WG, England
Tel: +44 (0)1621 875500
Fax: +44 (0)1621 875600
uk.sales@cmlmicro.com
www.cmlmicro.com

CML Microcircuits (USA) Inc.
COMMUNICATION SEMICONDUCTORS

4800 Bethania Station Road,
Winston-Salem, NC 27105, USA
Tel: +1 336 744 5050,
          0800 638 5577
Fax: +1 336 744 5054
us.sales@cmlmicro.com
www.cmlmicro.com

CML Microcircuits (Singapore) Pte Ltd
COMMUNICATION SEMICONDUCTORS

No 2 Kallang Pudding Road, 09-05/
06 Mactech Industrial Building,
Singapore 349307
Tel: +65 7450426
Fax: +65 7452917
sg.sales@cmlmicro.com
www.cmlmicro.com