



# CML Semiconductor Products

PRODUCT INFORMATION

## FX002 Signal to Noise Enhancer

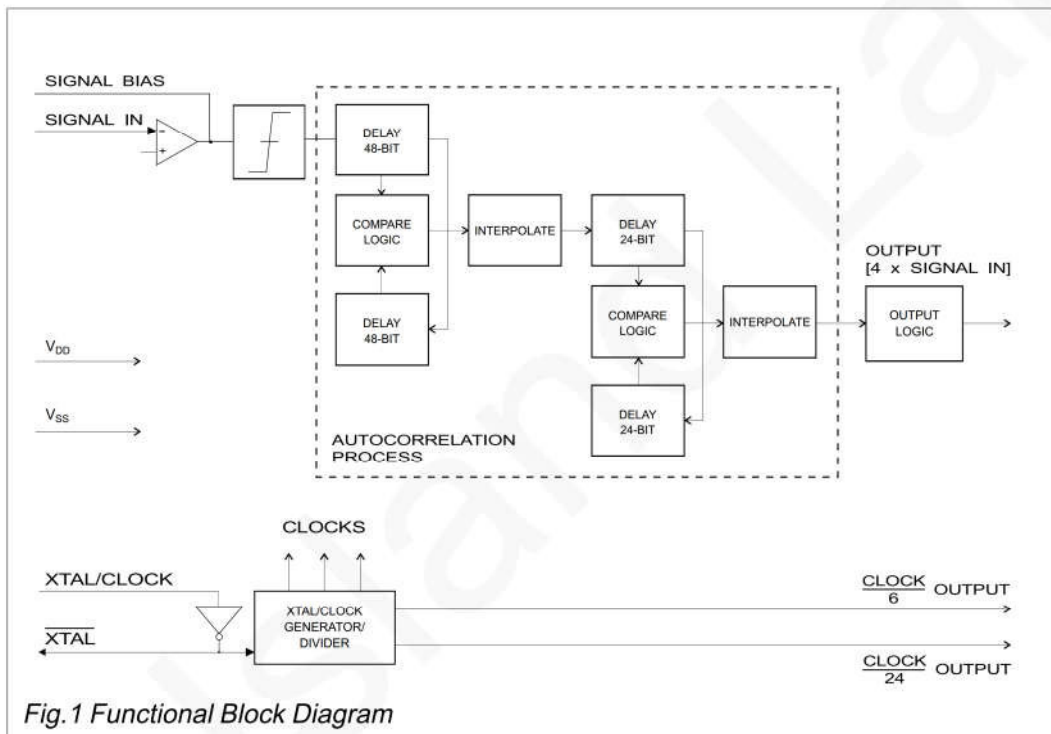
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### Features

- Up to 8.5dB Signal-to-Noise Improvement
- Input Frequency Range: 17Hz to 13kHz [Sub-Audio and Audio Frequencies]
- Low-Voltage Operation: 2.5 Volts
- 10mVrms Minimum Signal Input
- Digital Output Signal ( $f_{IN} \times 4$ )
- 'Divided-Down' Clock Outputs

### Applications

- Radio Communications and Paging Systems
- Tone Detection
- Sonar Detection and Analysis
- Slow Data-Rate Communications
- Medical Equipment
- Interference Investigation



Island Labs

# FX002

### Brief Description

The FX002 is a single-chip device to extract single periodic signals from very high random-noise environments.

Using patented autocorrelation techniques the FX002 will enhance the input signal's signal-to-noise ratio by as much as 8.5dB and provide a digital output signal centred at four times (x4) the input frequency.

The amplitude of non-periodic components of the signal is substantially reduced. The patented autocorrelator compares the incoming signal to itself; the more elements of the waveform that are seen as periodic, the higher the energy at the microcircuit output.

The FX002 cascades two autocorrelators, each one improving the signal-to-noise ratio.

With a random noise input the output will swing rail-to-rail at random (peak-limited). The input/output signal delay is fixed by the choice of clock frequency and the length of the internal register. The FX002 will operate at supply voltages of between 2.5 volts and 5.5 volts and with Xtal/clock frequencies from 20kHz to 2.5MHz. Using various Xtal/clock inputs the device can be set to accept input signal frequencies, in bands, from 17.0Hz to 13.0kHz.

Two uncommitted clock outputs are available to supply 'divided-down' Xtal/clock frequencies for use in external and peripheral functions.

This low-power signal processing device is available in 16-pin cerdip dual-in-line (DIL) and plastic small outline (S.O.I.C.) surface mount packages.

## Pin Number

## Function

| FX002DW              | FX002J                      |   |                     |                             |     |       |     |     |     |     |
|----------------------|-----------------------------|---|---------------------|-----------------------------|-----|-------|-----|-----|-----|-----|
| 1                    | 1                           | <b>Signal In:</b> The inverting input to the analogue amplifier/comparator. Used with the Signal Bias pin; external coupling components are required (see Figure 2).  |                     |                             |     |       |     |     |     |     |
| 3                    | 3                           | <b>Signal Bias:</b> The output of the analogue amplifier/comparator. Do not load this pin with peripheral circuitry; there is no drive capacity for off-chip signalling. The feedback resistor should be not less than 200kΩ. See Figure 2.   |                     |                             |     |       |     |     |     |     |
| 4                    | 4                           | <b>V<sub>DD</sub>:</b> Positive supply rail. A single, stable power supply is required. Note that this device has two V <sub>DD</sub> pins; this input is positioned to prevent cross-talk, either or both may be connected to the host circuit's supply line. Do not attempt to draw current from either V <sub>DD</sub> pin.  |                     |                             |     |       |     |     |     |     |
| 5                    | 5                           | <b>Clock/24:</b> A squarewave output clock signal at the rate of $f_{Xtal/clock}/24$ ; provided for peripheral and test purposes.   |                     |                             |     |       |     |     |     |     |
| 6                    | 6                           | <b>Xtal:</b> The output of the on-chip clock oscillator inverter.   |                     |                             |     |       |     |     |     |     |
| 8                    | 7                           | <b>Xtal/Clock:</b> The input to the on-chip clock oscillator inverter; this may be a Xtal, resonator or clock pulse input. The selection of this frequency will affect the operational input signal bandwidth (and output frequency) of this device; refer to Table 2. Note that the choice of V <sub>DD</sub> will determine the maximum Xtal/clock frequency and hence the maximum useable signal input frequency. Operation of any CML microcircuit without an active Xtal or clock input may cause device damage. A clock pulse input is fed directly into this pin; Xtal/clock components are not required.<br>Table 1 provides a guide to maximum usable Xtal/clock frequencies at pre-determined V <sub>DD</sub> values. |                     |                             |     |       |     |     |     |     |
|                      |                             | <table border="1"> <thead> <tr> <th>V<sub>DD</sub> (V)</th> <th>Max. Xtal/Clock Freq. (MHz)</th> </tr> </thead> <tbody> <tr> <td>2.5</td> <td>0.625</td> </tr> <tr> <td>3.0</td> <td>1.0</td> </tr> <tr> <td>5.0</td> <td>2.5</td> </tr> </tbody> </table> <p style="text-align: right;"><i>Table 1</i></p>   | V <sub>DD</sub> (V) | Max. Xtal/Clock Freq. (MHz) | 2.5 | 0.625 | 3.0 | 1.0 | 5.0 | 2.5 |
| V <sub>DD</sub> (V)  | Max. Xtal/Clock Freq. (MHz) |   |                     |                             |     |       |     |     |     |     |
| 2.5                  | 0.625                       |   |                     |                             |     |       |     |     |     |     |
| 3.0                  | 1.0                         |   |                     |                             |     |       |     |     |     |     |
| 5.0                  | 2.5                         |   |                     |                             |     |       |     |     |     |     |
| 9                    | 9                           | <b>V<sub>SS</sub>:</b> Negative supply rail (GND).  |                     |                             |     |       |     |     |     |     |
| 11                   | 11                          | <b>Clock/6:</b> A squarewave output clock signal at the rate of $f_{Xtal/clock}/6$ ; provided for peripheral and test purposes.   |                     |                             |     |       |     |     |     |     |
| 13                   | 13                          | <b>Output:</b> ( $f_{OUT} = 4 \times f_{SIGNAL IN}$ ). The auto-correlated output signal at four times (x 4) the input signal (see Figure 4).<br>There is a time delay between input and output signals (see Specifications).   |                     |                             |     |       |     |     |     |     |
| 16                   | 16                          | <b>V<sub>DD</sub>:</b> Positive supply rail. A single, stable power supply is required.<br>Note that this device has two V <sub>DD</sub> pins; either or both may be connected to the host circuit's supply line. Do not attempt to draw current from either V <sub>DD</sub> pin.<br>The choice of V <sub>DD</sub> will determine the maximum Xtal/clock frequency and hence the maximum useable signal input frequency (see Figure 3).   |                     |                             |     |       |     |     |     |     |
| 2, 7, 10, 12, 14, 15 | 2, 8, 10, 12, 14, 15        | No internal connection. Leave open-circuit.   |                     |                             |     |       |     |     |     |     |

# Application Information

## External Components

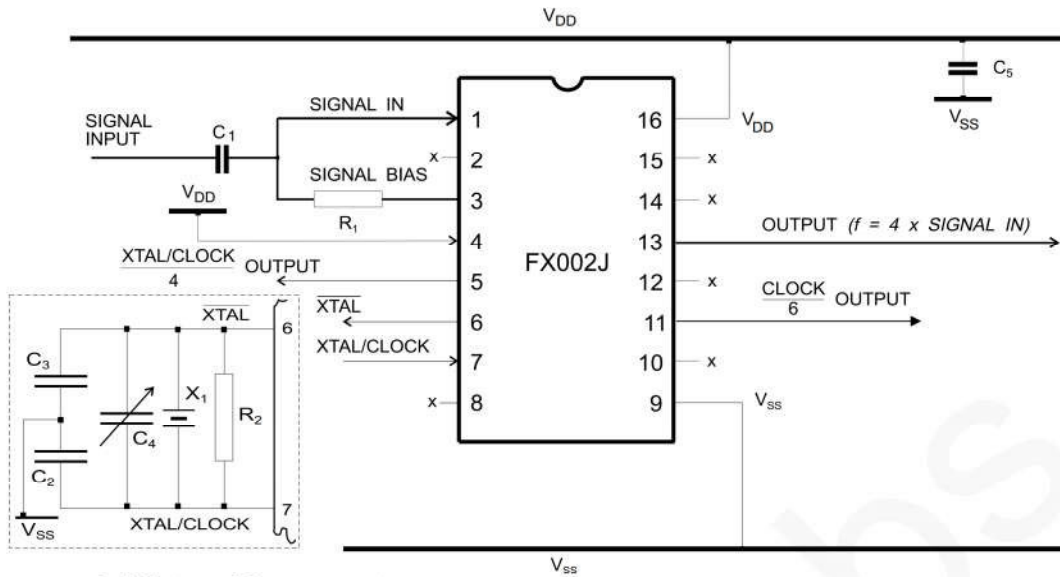


Fig.2 Recommended External Components

| Xtal/Clock Freq. (kHz) | Input Freq. (Hz) |       | BW (Hz) |
|------------------------|------------------|-------|---------|
|                        | Min              | Max   |         |
| 20                     | 17               | 105   | 88      |
| 100                    | 88               | 526   | 443     |
| 200                    | 166              | 1052  | 886     |
| 300                    | 250              | 1579  | 1329    |
| 400                    | 333              | 2105  | 1772    |
| 500                    | 416              | 2632  | 2216    |
| 560                    | 467              | 2947  | 2480    |
| 600                    | 500              | 3158  | 2658    |
| 700                    | 583              | 3684  | 3101    |
| 800                    | 667              | 4210  | 3543    |
| 900                    | 750              | 4737  | 3987    |
| 1000                   | 833              | 5263  | 4430    |
| 2000                   | 1667             | 10526 | 8859    |
| 2500                   | 2083             | 13157 | 11074   |

Table 2 Input Signal Ranges vs Xtal/Clock Frequency

| Component   | Value for $V_{DD} = 5.0V$ |
|-------------|---------------------------|
| $R_1$       | 2.2M $\Omega$             |
| $R_2$       | 1.0M $\Omega$             |
| $C_1$       | 0.01 $\mu F$              |
| $C_2$       | 47.0pF -see below         |
| $C_3$       | 47.0pF -see below         |
| $C_4$       | 5 - 65pF -see below       |
| $C_5$       | 1.0 $\mu F$               |
| $X_1$       | 560kHz resonator          |
| $X_1$ range | 20kHz to 2.5MHz           |

Table 3 Recommended External Components

### Xtal/Clock Components

$C_4$  is suggested for frequency setting when using a resonator; when a Xtal is used  $C_4$  is omitted. Values of capacitors  $C_2$  and  $C_3$  should be reduced for higher Xtal frequencies and/or lower supply voltages ( $V_{DD}$ ).

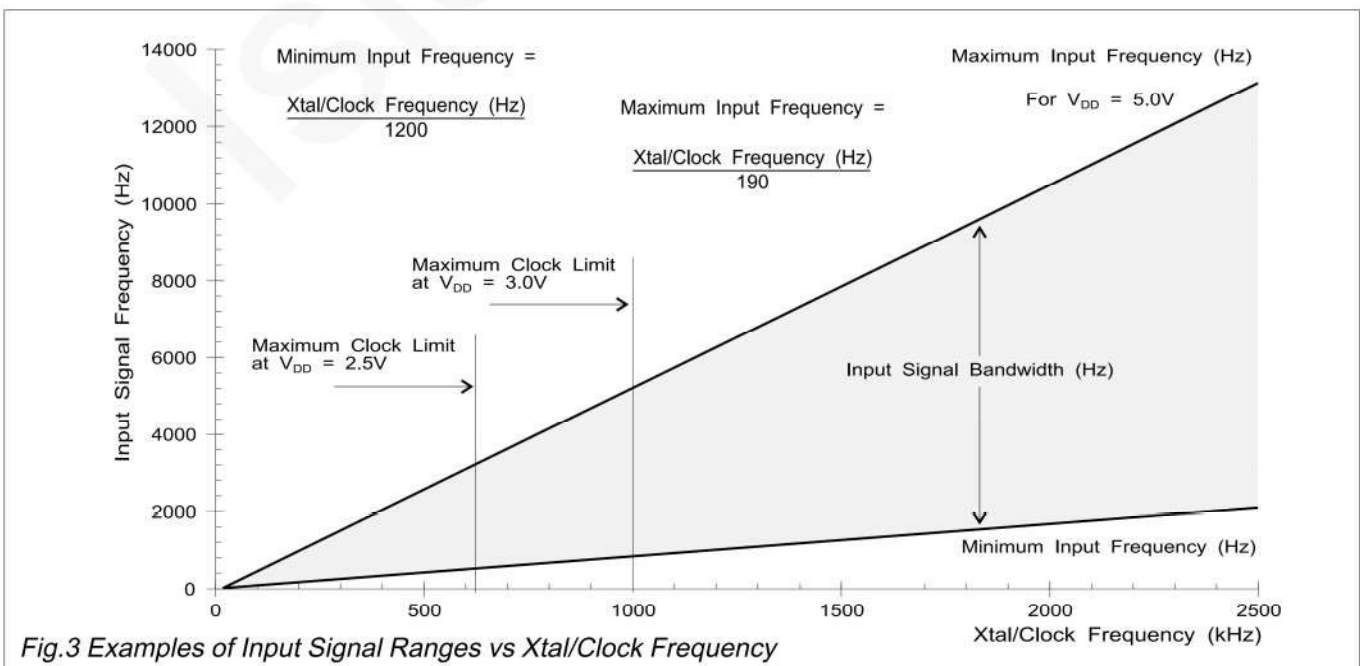
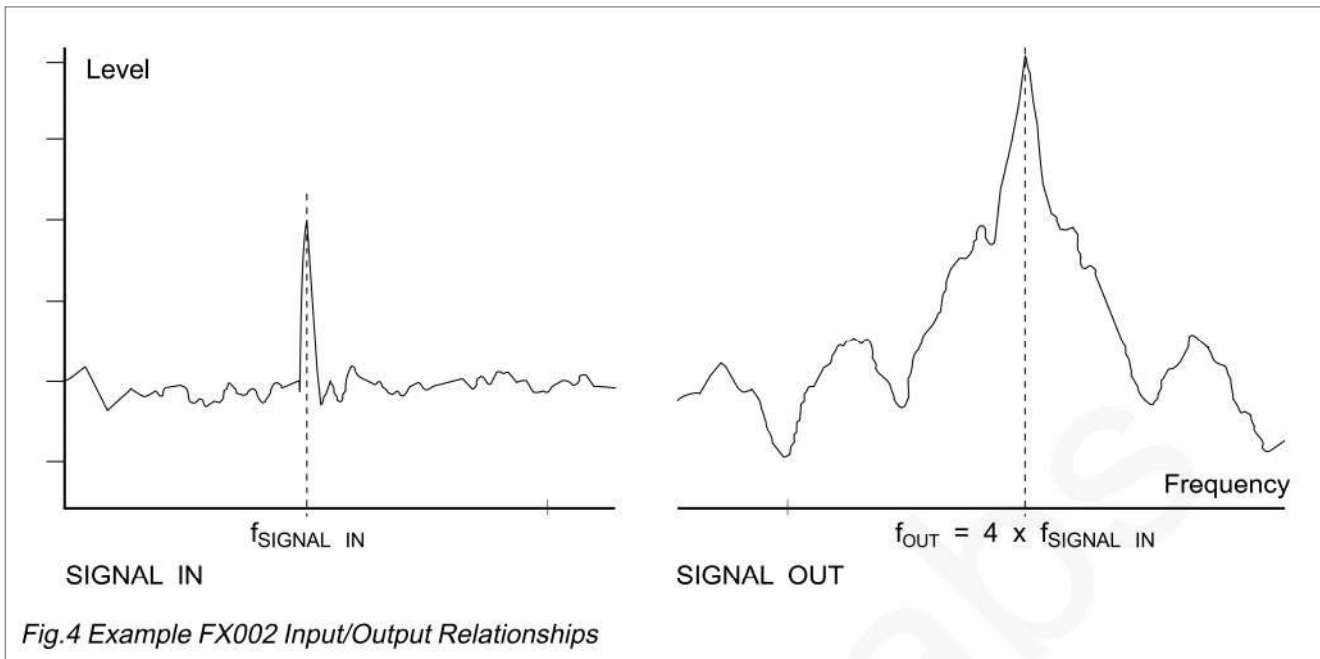


Fig.3 Examples of Input Signal Ranges vs Xtal/Clock Frequency

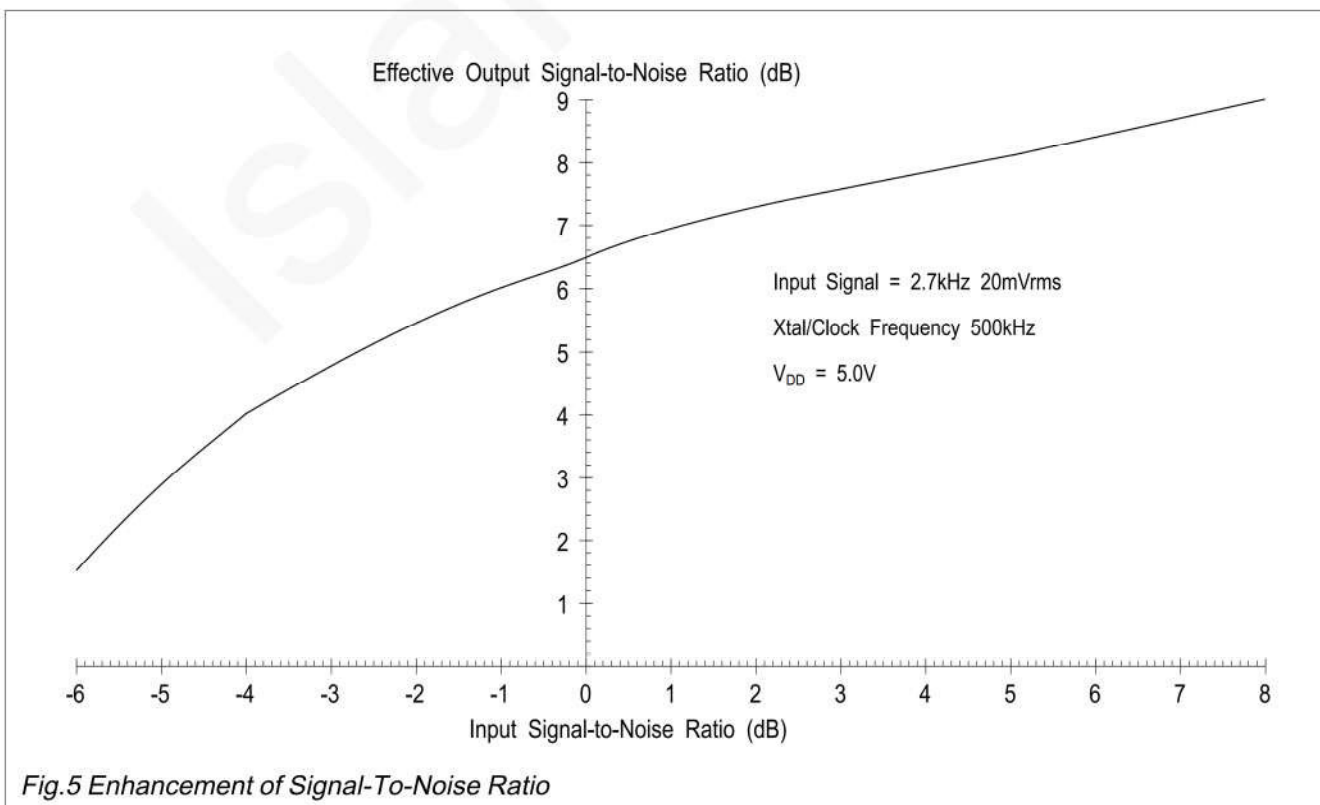


## Application Information .....



The diagrams in Figure 4 are example spectrums of the input and output signal conditions of the FX002. Note that the frequency of the output signal is four times (x4) that of the input signal.

The graph shown in Figure 5 illustrates the signal-to-noise enhancement that can be obtained, under varying input conditions, from the FX002.



## 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 @ $T_{AMB} = 25^{\circ}C$ | 800mW Max.                          |
| Derating   | 10mW/ $^{\circ}C$                   |
| Operating temperature range: <b>FX002DW</b>        | -40 $^{\circ}C$ to +85 $^{\circ}C$  |
| <b>FX002J</b>                                      | -40 $^{\circ}C$ to +85 $^{\circ}C$  |
| Storage temperature range: <b>FX002DW</b>          | -40 $^{\circ}C$ to +85 $^{\circ}C$  |
| <b>FX002J</b>                                      | -55 $^{\circ}C$ to +125 $^{\circ}C$ |

### Operating Limits

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

|                             | Remarks             | Min.  | Max.  | Unit        |
|-----------------------------|---------------------|-------|-------|-------------|
| Supply Voltage ( $V_{DD}$ ) | Note 1              | 2.5   | 5.5   | V           |
| Operating Temperature       |                     | -40.0 | +85.0 | $^{\circ}C$ |
| Xtal/Clock Frequency        | ( $V_{DD} = 2.5V$ ) | 20.0  | 625   | kHz         |
|                             | ( $V_{DD} = 5.0V$ ) | 0.02  | 2.5   | MHz         |

### Operating Characteristics

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

$V_{DD} = 5.0V$ ,  $T_{AMB} = 25^{\circ}C$ . Xtal/Clock Frequency = 560kHz. Input Test Signal = 1.0kHz at 200mVrms.

| Characteristics                              | See Note | Min.   | Typ. | Max.  | Unit       |
|--|----------|--------|------|-------|------------|
| <b>Static Values</b>                         |          |        |      |       |            |
| Supply Current ( $I_{DD}$ )                  |          | -      | 1.0  | 2.5   | mA         |
|  | 2        | -      | 4.0  | -     | mA         |
| Output Logic '1'                             |          | 80%    | -    | -     | $V_{DD}$   |
| Output Logic '0'                             |          | -      | -    | 20%   | $V_{DD}$   |
| Digital Output Impedance                     |          | -      | 4.0  | 10.0  | $k\Omega$  |
| <b>Dynamic Values</b>                        |          |        |      |       |            |
| Signal Input Levels                          | 3        | 10.0   | 20.0 | 1000  | mVrms      |
| Analogue (Input) Amplifier Gain              | 4        | 20.0   | -    | -     | dB         |
|  | 5        | 9.0    | -    | -     | dB         |
|  | 6        | 10.0   | -    | -     | dB         |
| Recommended Input Signal Mark-to-Space Ratio |          | 35.0   | -    | -     | %          |
| Freq. In/Freq. Out Ratio                     |          | 4.0    | -    | 4.0   |            |
| Maximum Xtal/Clock Frequency                 | 1        | 2.5    | -    | -     | MHz        |
| Minimum Xtal/Clock Frequency                 |          | -      | -    | 20.0  | kHz        |
| Frequency Input Range (Xtal/Clock = 560kHz)  |          | 500    | -    | 3000  | Hz         |
| (Table 2)                                    | 7        | 1/1200 | -    | 1/190 | Xtal/Clock |
| Input to Output Delay                        | 8        | -      | 1.4  | -     | ms         |
| Output Resolution                            |          | -      | 1/6  | -     | Xtal/Clock |

### Notes

1. Maximum Xtal/clock frequency allowed varies with applied supply voltage ( $V_{DD}$ ).
2.  $I_{DD}$  requirement for Xtal/clock frequency of 2.24MHz.
3. Signal input level required to provide a constant autocorrelated output.
4. Measured with a 6.0kHz sinewave at the signal input.
5. Measured with  $V_{DD} = 2.5$  volts.
6. Measured with a 12kHz input signal.
7. Recommended input signal frequency range to correlation circuits.
8. Input (Signal In) to output (Output) time with a 2.24MHz Xtal/clock input.

## Package Outlines

The FX002 is available in the package styles outlined below. Mechanical package diagrams and specifications are detailed in Section 10 of this document.

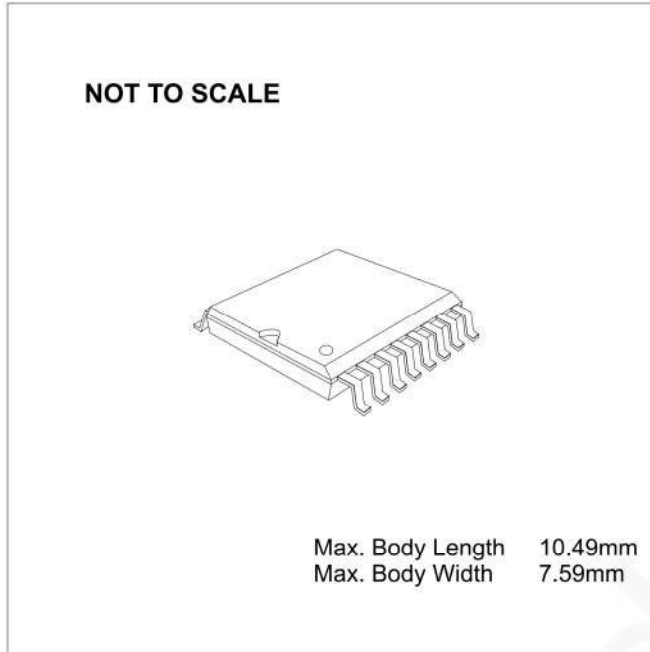
Pin 1 identification marking is shown on the relevant diagram and pins on all package styles number anti-clockwise when viewed from the top.

## Handling Precautions

The FX002 is a CMOS LSI circuit which includes input protection. However precautions should be taken to prevent static discharges which may cause damage.

**FX002DW** 16-pin plastic S.O.I.C. (D4)

**FX002J** 16-pin cerdip DIL (J2)



## Ordering Information

**FX002DW** 16-pin plastic S.O.I.C. (D4)

**FX002J** 16-pin cerdip DIL (J2)