# Consumer Microcircuits Limited

PRODUCT INFORMATION

# FX326 AUDIO BANDPASS FILTER



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## Features

- 300 – 3000/3400Hz Audio Bandpass Filter
- Low Group Delay Distortion
- On-Chip Uncommitted Amplifier
- Switched Capacitor Filters
- Choice of Xtal/Resonator Frequencies
- Chip Enable Powersave Feature
- Single 5V CMOS Process
- Surface Mounted or DIL Package

## Applications

- Alarm Systems
- Portable Audio Equipments
- Data Signalling—Modems
- PABX and Trunk Equipment
- Cordless Telephones and Intercoms
- Mobile Radio Audio Processing
- Delta Modulation Audio Filtering
- Medical Instrumentation
- Automotive Products

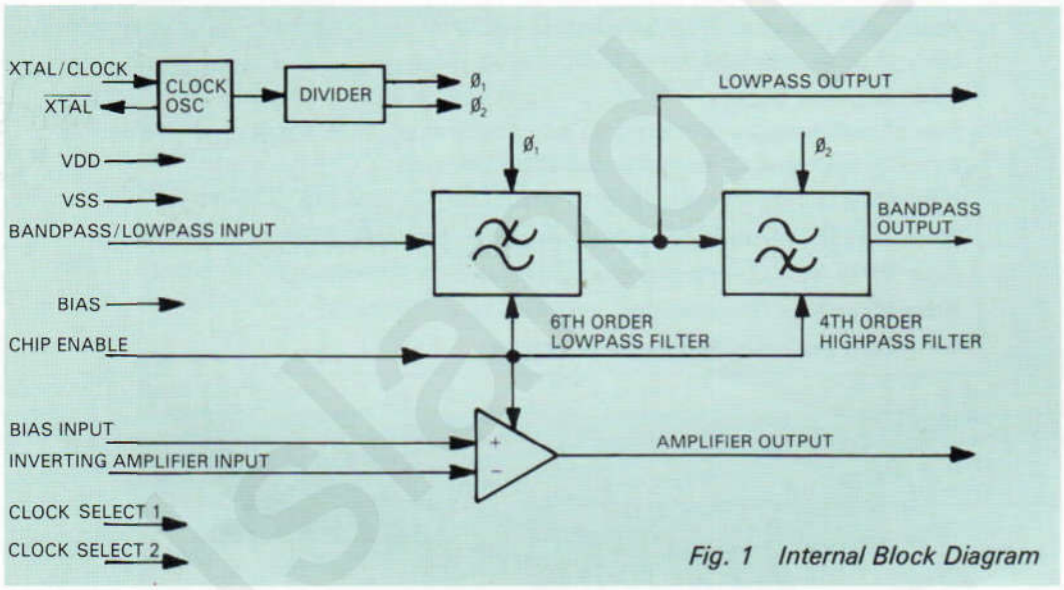



*Fig. 1 Internal Block Diagram*

**FX326**

## Brief Description

The FX326 is a general purpose low power CMOS switched capacitor audio bandpass filter. The filter frequency response is clock related; however, the programmable divider allows for a standard 300 – 3000Hz or 300 – 3400Hz frequency response (see Fig. 3). The device in detail consists of:

(1) a 6th order low group delay distortion lowpass filter
(2) a 4th order highpass filter
(3) an uncommitted amplifier

The two filters are connected in series, thus providing an audio bandpass filter; however, the lowpass filter may be used independently.

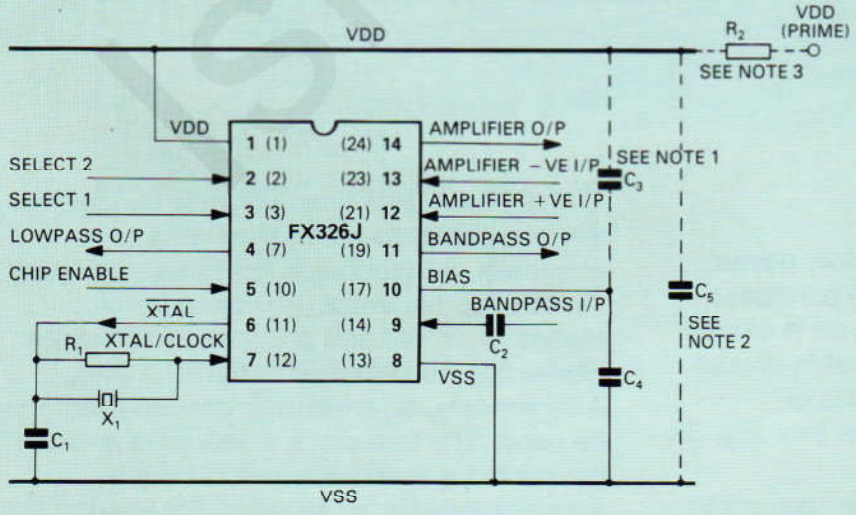
The uncommitted amplifier may be used for any specific application such as pre-emphasis, de-emphasis, buffering, gain, etc. An on-chip oscillator uses an external resonator or xtal and provides all reference clocks for the switched capacitor filters. Alternatively, an externally derived clock may be used. The two clock select lines enable the device to be used with various clock frequencies without significantly altering the filter response. Alternatively, re-programming of the clock select lines, or varying the clock frequency, will shift the filter cutoff frequencies (see Fig. 3). The chip enable input is used to disable the filter and amplifier sections, thus reducing current consumption.

## Pin Number — Function

| FX326J | FX326LV1 | Function |
|---|---|---|
| 1 | 1 | **VDD:** Positive Supply. |
| 2 | 2 | **Select 2:)** Inputs to on chip programmable divider used to select required |
| 3 | 3 | **Select 1:)** operating xtal/clock frequency. Both pins have 1MΩ internal pull down resistors (see Fig. 3). The upper and lower cutoff frequencies are controlled by the clock frequency $\phi$, division ratio n and a design constant. |
| | | The typical lower cutoff frequency $f_L$ is given by: $f_L = \frac{2.5\,\phi}{n}$ where $f_L$ is −3dB frequency in Hz; $\phi$ is clock frequency in kHz; n is set by S1, S2. |
| | | The corresponding upper cutoff frequency $f_H$ is given by $f_H = \frac{34\,\phi}{n}$ |
| | | The relationship between S1, S2 and n is: |

| S1 | S2 | n |
|---|---|---|
| 0 | 0 | 10 |
| 0 | 1 | 6 |
| 1 | 0 | 20 |
| 1 | 1 | 12 |

| | | |
|---|---|---|
| 4 | 7 | **Lowpass O/P:** This is the output of the lowpass filter section and is internally biased to VDD/2. |
| 5 | 10 | **Chip Enable:** Internally pulled to VDD. A logic '0' applied to this input will disable all filters and the uncommitted amplifier. (Powersave). |
| 6 | 11 | **Xtal:** Xtal output. Inverting output of on chip oscillator. |
| 7 | 12 | **Xtal/Clock:** Input to on-chip inverting oscillator. Xtal resonator input or externally derived clock may be applied to this input. |
| 8 | 13 | **VSS:** Negative Supply. |
| 9 | 14 | **Bandpass/Lowpass I/P:** Input to lowpass filter which is connected in series with the Highpass filter to form the Bandpass section. |
| 10 | 17 | **Bias:** VDD/2 Bias pin externally decoupled by $C_4$ (see Fig. 2, Note 1). |
| 11 | 19 | **Bandpass O/P:** Output from Highpass filter, internally biased to VDD/2. |
| 12 | 21 | **Amp I/P (+VE):** Uncommitted amplifier, non-inverting input. |
| 13 | 23 | **Amp I/P (−VE):** Uncommitted amplifier, inverting input. |
| 14 | 24 | **Amp O/P:** Uncommitted amplifier output. |




(FX326LV1 SHOWN IN BRACKETS. NO CONNECTION PINS: 4, 5, 6, 8, 9, 15, 16, 18, 20, 22)

*Fig. 2 External Component Connections*

### Component References

| Component | Unit Value | Tolerance |
|---|---|---|
| $R_1$ | 1M | ± 10% |
| $R_2$ | — | (See note 3) |
| $C_1$ | 33p | ± 20% |
| $C_2$ | 0.1μ | (See note 1) |
| $C_3$ | 0.1μ | (See note 1) |
| $C_4$ | 0.1 μ | (see Note 1) |
| $C_5$ | — | (See notes 2, 3) |
| $X_1$ | Crystal | |

**NOTES:**

1. *Bias may be decoupled to VSS and VDD using $C_3$, $C_4$ when input signals are referenced to the bias pin. For input signals referenced to VSS, decouple Bias to VSS using $C_4$ only.*
2. *Use $C_5$, when input signals are referenced to VSS, to decouple VDD.*
3. *Use $R_2$ to assist decoupling of high frequency power supply noise ($R_2$ $C_5$ typically 300μs)*

# 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 | | −0.3V to 7.0V |
| Input voltage at any pin (ref VSS = OV) | | −0.3V to (VDD + 0.3V) |
| Output sink/source current (total) | | 20mA |
| Operating temperature range: | FX326J | −30°C to + 85°C |
| | FX326LV1 | −30°C to + 70°C |
| Storage temperature range: | FX326J | −55°C to +125°C |
| | FX326LV1 | −40°C to + 85°C |
| Maximum device dissipation | | All versions 100mW |

## Operating Limits

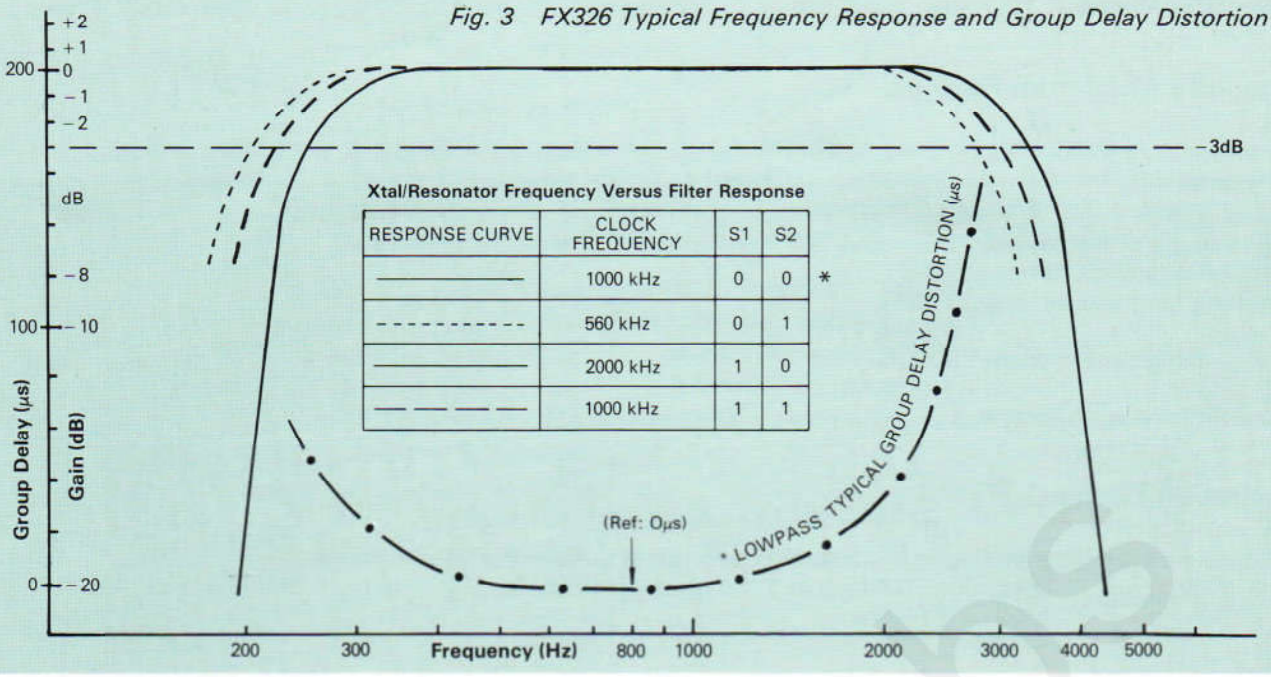
All characteristics measured using the following parameters unless otherwise specified:
VDD = 5V, $T_{amb}$ = 25°C, $\phi$ = 1MHz, (pin 2 and pin 3 open circuit), $\Delta f_{\phi}$ = 0, $f_{in}$ = 1kHz, 100 mV rms.

| Characteristics | See Note | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Static Characteristics** | | | | | |
| Supply voltage | | 4.5 | 5 | 5.5 | V |
| Supply current (Enabled) | | — | 3.5 | — | mA |
| Supply current (Disabled) | | — | 1 | 2 | mA |
| Input impedance (Filters & Amplifier) | | 100 | — | — | kΩ |
| Output impedance (Filters) | | — | 3 | — | kΩ |
| Output impedance (Amplifier open loop) | | — | 800 | — | Ω |
| Output impedance (Amplifier closed loop) | | — | 6 | — | Ω |
| Input logic '1' | | 3.5 | — | — | V |
| Input logic '0' | | — | — | 1.5 | V |
| On-chip crystal oscillator: R in | | 10 | — | — | MΩ |
| R out | | 5 | — | 15 | kΩ |
| Inverter gain | | 10 | — | 20 | dB |
| Gain Bandwidth Product | | 3 | — | — | MHz |
| Crystal/Resonator Frequency | 1 | | 1 | | MHz |
| **Dynamic Characteristics** | | | | | |
| Passband Ripple (400 — 2800Hz) | | — | — | 2 | dB |
| Cutoff Frequency LP (−3dB) | | — | 3400 | — | Hz |
| HP (−3dB) | | — | 260 | — | Hz |
| Stopband Attenuation (f> 6kHz) | | — | 35 | — | dB |
| (f< 200Hz) | | — | 15 | — | dB |
| Output Noise (rms) | 2 | — | 1.6 | — | mV |
| Signal Input Range (rms) | 3 | — | 0.4 | 1.0 | V |
| Insertion Loss (1kHz) | | | 0 | | dB |
| Aliasing Frequency | | $\frac{\phi}{2n}$ | | | Hz |
| **Uncommitted Amplifier** | | | | | |
| Open loop gain | 4 | — | 30 | — | dB |
| Gain BW Product | | — | 1 | — | MHz |

**Notes:**

*1). For other frequencies see Fig. 3.*
*2). Measured with input ac short circuit*
*3). 'MAX' figure specified for nominal 3% distortion (30dB SINAD).*
*'TYP' figure specified for minimum distortion (MAX SINAD).*
*4). Relative to 1kHz, 100 mV rms input level.*

*Fig. 3 FX326 Typical Frequency Response and Group Delay Distortion*




**Xtal/Resonator Frequency Versus Filter Response**

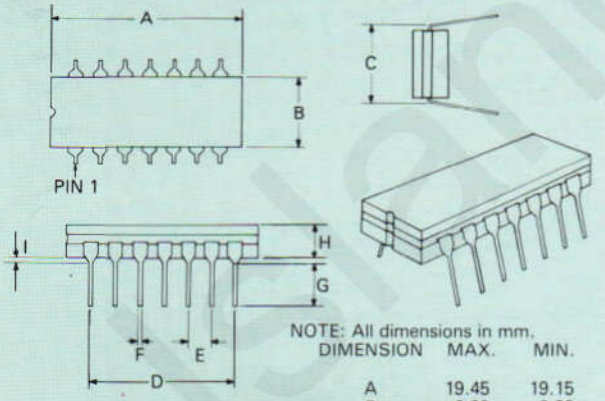
| RESPONSE CURVE | CLOCK FREQUENCY | S1 | S2 | |
|---|---|---|---|---|
| ——— | 1000 kHz | 0 | 0 | * |
| - - - - - - - - - - | 560 kHz | 0 | 1 | |
| ——— | 2000 kHz | 1 | 0 | |
| — — — — | 1000 kHz | 1 | 1 | |

## Package Outlines

The cerdip package of the FX326J is shown in *Figure 4.* The FX326LV1 of *Figure 5* is supplied in a conductive tray.

The FX326LV1 has an indent (spot) adjacent to Pin 1 and a chamfered corner between Pins 3 and 4 to allow complete identification. Pins number counter-clockwise when viewed from the top (indent side).

*Fig. 4* ***FX326J*** *D.I.L. Package*



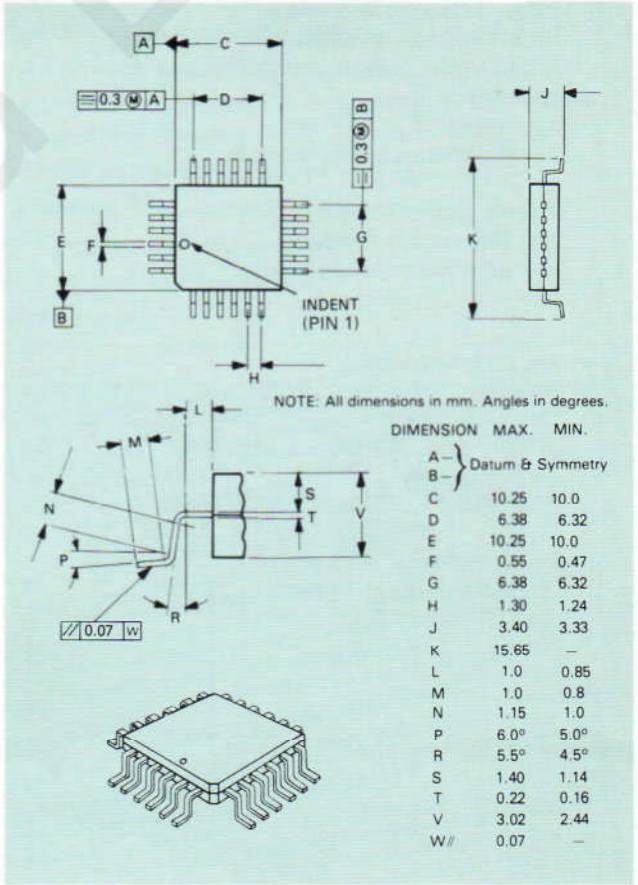

NOTE: All dimensions in mm.

| DIMENSION | MAX. | MIN. | |
|---|---|---|---|
| A | 19.45 | 19.15 | |
| B | 6.38 | 6.22 | |
| C | 8.00 | 7.75 | |
| D | 15.34 | 15.14 | |
| E | 2.54 | | Typical |
| F | 0.46 | | Dimension |
| G | 4.35 | | |
| H | 2.04 | 1.78 | |
| I | — | 0.5 | |

## Handling Precautions

The FX326J/LV1 is a CMOS LSI circuit which includes input protection. However, precautions should be taken to prevent static discharges which can cause damage.

*Fig. 5* ***FX326LV1*** *Package*




NOTE: All dimensions in mm. Angles in degrees.

| DIMENSION | MAX. | MIN. | |
|---|---|---|---|
| A | | | Datum & Symmetry |
| B | | | |
| C | 10.25 | 10.0 | |
| D | 6.38 | 6.32 | |
| E | 10.25 | 10.0 | |
| F | 0.55 | 0.47 | |
| G | 6.38 | 6.32 | |
| H | 1.30 | 1.24 | |
| J | 3.40 | 3.33 | |
| K | 15.65 | — | |
| L | 1.0 | 0.85 | |
| M | 1.0 | 0.8 | |
| N | 1.15 | 1.0 | |
| P | 6.0° | 5.0° | |
| R | 5.5° | 4.5° | |
| S | 1.40 | 1.14 | |
| T | 0.22 | 0.16 | |
| V | 3.02 | 2.44 | |
| W// | 0.07 | — | |

## Ordering Information

**FX326J** **14-pin Cerdip D.I.L.**

**FX326LV1** **24-pin quad plastic encapsulated, bent and cropped.**



**CONSUMER MICROCIRCUITS LIMITED**
WHEATON ROAD · INDUSTRIAL ESTATE EAST
WITHAM · ESSEX CM8 3TD · ENGLAND

Telephone: 0376 513833
Telex: 99382 CMICRO G
Telefax: 0376 518247