# CML Semiconductor Products

**PRODUCT INFORMATION**

# FX469 1200/2400/4800 Baud FFSK Modem

Publication D/469/6 April 1998

## Features

- **Selectable Data Rates**
  ***1200, 2400 and 4800 Baud***
- **Full-Duplex FFSK**
- **Rx and Tx Bandpass Filters**
- **Clock Recovery and Carrier Detect Facilities**
- **Rx and Tx Enable Functions**
- **Pin Selected Xtal/Clock Inputs**
  ***1.008MHz or 4.032MHz***
- **Radio and General Applications**
  - **Data-Over-Radio**
  - **PMR and Cellular Signalling**
  - **Portable Data Terminals**
  - **Personal/Cordless Telephone**

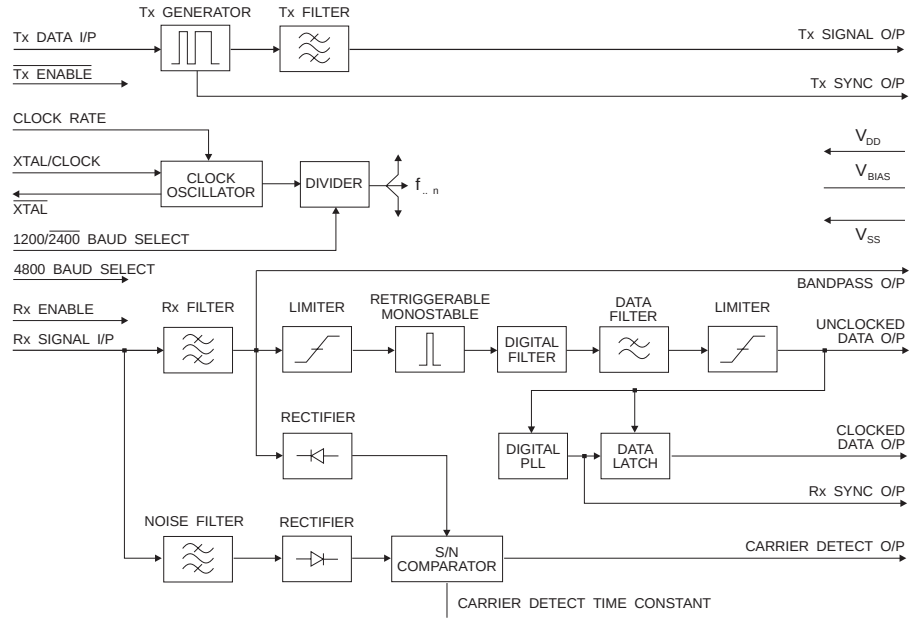



*Fig.1 Functional Block Diagram*

**FX469**

## Brief Description

The FX469 is a single-chip CMOS LSI circuit which operates as a full-duplex pin-selectable 1200, 2400 or 4800 baud FFSK Modem. The mark and space frequencies are 1200/1800, 1200/2400 and 2400/4800 Hz respectively. Tone frequencies are phase continuous; transitions occur at the zero crossing point.

Employing a common Xtal oscillator with a choice of two clock frequencies (1.008MHz or 4.032MHz) to provide baud-rate, transmit frequencies, and Rx and Tx synchronization, the transmitter and receiver operate entirely independently including individual section powersave functions.
The FX469 includes on chip circuitry for Carrier Detect and Rx Clock recovery, both of which are made available as output pins.

Rx, Tx and Carrier Detect paths each contain a bandpass filter to ensure the provision of optimum signal conditions both in the modem and for the Tx modulation circuitry.

The FX469 demonstrates a high sensitivity and good bit-error-rate under adverse signal conditions; the carrier detect time constant is set by an external capacitor, whose value should be arranged as required to further enhance this product's performance in high noise environments.

This low-power device requires few external components and is available in small outline plastic (S.O.I.C) and cerdip DIL packages.

## Pin Number Function

| FX469 DW | FX469 LG/LS | FX469 J/P6 | Function |
|---|---|---|---|
| 1 | 1 | 1 | **Xtal/Clock :** The input to the on-chip inverter, for use with either a 1.008MHz or a 4.032MHz Xtal or external clock. Clock frequency selection is by the "Clock Rate" input pin. The selection of this frequency will affect the operational Data Rate of this device. Refer to Baud Selection information on the next page. Operation of any CML microcircuit without a Xtal or clock input may cause device damage. To minimise damage in the event of a Xtal/drive failure. it is recommended that the power rail ($V_{DD}$) is fitted with a current limiting device (resistor or fast-reaction fuse). |
| 2 | 2 | 2 | **XtalN :** Output of the on-chip inverter. |
| 3 | 3 | 3 | **Tx Sync O/P :** A squarewave, produced on-chip, to synchronize the input of logic data and transmission of the FFSK signal (See Figure 4). |
| 4 | 5 | 5 | **Tx Signal O/P :** When the transmitter is enabled, this pin outputs the (140-step pseudo sinewave) FFSK signal (See Figure 4).<br>With the transmitter disabled, this output is set to a high-impedance state. |
| 5 | 7 | 6 | **Tx Data I/P :** Serial logic data to be transmitted is input to this pin. |
| 6 | 8 | 7 | **Tx EnableN :** A logic '0' will enable the transmitter (See Figure 4). A logic '1' at this input will put the transmitter into powersave whilst forcing "Tx Sync Out" to a logic '1' and "Tx Signal Out" to a high-impedance state. This pin is internally pulled to $V_{DD}$. |
| 7 | 9 | 8 | **Bandpass O/P :** The output of the Rx Bandpass Filter. This output impedance is typically 10kW and may require buffering prior to use. |
| 8 | 10 | 9 | **Rx Enable :** The control of the Rx function. The control of other outputs is given below. |
| 9 | 11 | 10 | **$V_{BIAS}$:** The output of the on-chip analogue bias circuitry. Held internally at $V_{DD}/2$, this pin should be decoupled to $V_{SS}$ by a capacitor ($C_2$). (See Figure 2.<br>This bias voltage is maintained under all powersave conditions. |
| 10 | 12 | 11 | **$V_{SS}$:** Negative supply rail (GND). |

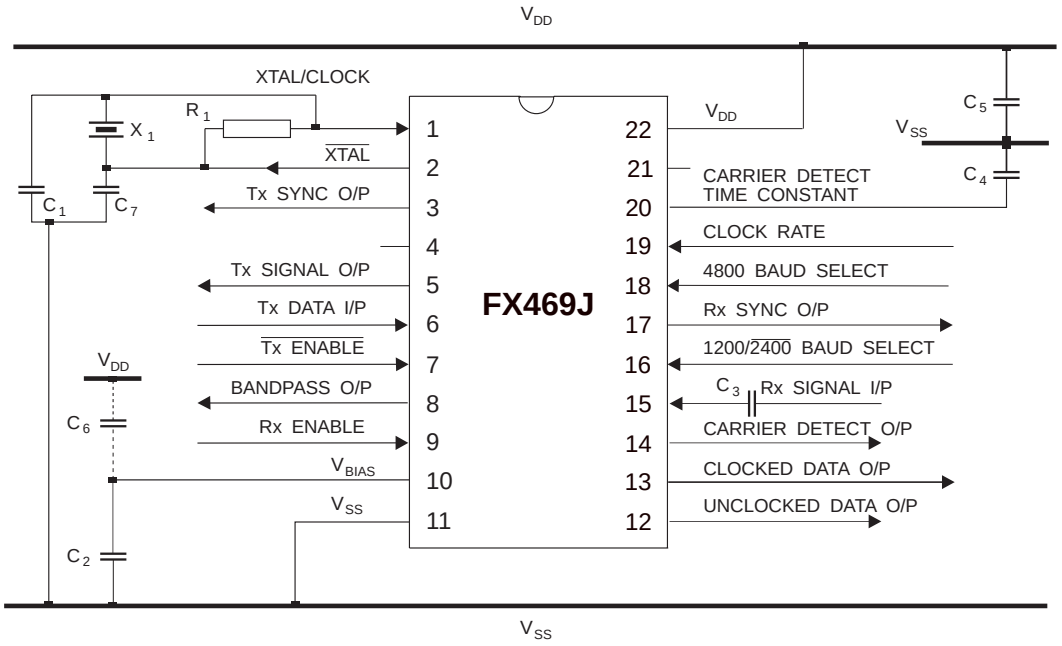
| Rx Enable | = | Rx Function | Clock Data O/P | Carrier Detect | Rx Sync Out |
|---|---|---|---|---|---|
| "1" | = | Enabled | Enabled | Enabled | Enabled |
| "0" | = | Powersave | "0" | "0" | 1" or "0" |

## Pin Number Function

| FX469 DW | FX469 LG/LS | FX469 J/P6 | Function |
|---|---|---|---|
| 11 | 13 | 12 | **Unclocked Data O/P:** The recovered asynchronous serial data output from the receiver. |
| 12 | 14 | 13 | **Clocked Data O/P:** The recovered synchronous serial data output from the receiver. Data is latched out by the recovered clock, available at the "Rx Sync O/P," (See Figure 5). |
| 13 | 15 | 14 | **Carrier Detect O/P:** When an FFSK signal is being received this output is a logic '1.' |
| 14 | 16 | 15 | **Rx Signal I/P:** The FFSK signal input for the receiver. This input should be coupled via a capacitor, $C_3$. |
| 15 | 18 | 17 | **Rx Sync O/P:** A flywheel squarewave output. This clock will synchronize to incoming Rx FFSK data (See Figure 5). |
| 16 | 19 | 16 | **1200/2400 Baud Select:** A logic '1' on this pin selects the 1200 baud option. Tone frequencies are: one cycle of 1200Hz represents a logic '1,' one-and-a-half cycles of 1800Hz represents a logic '0.' A logic '0' on this pin selects the 2400 baud option. Tone frequencies are: one-half cycle of 1200Hz represents a logic '1,' one cycle of 2400Hz represents a logic '0.' This function is also used, in part, to select the 4800 baud option. This pin has an internal 1MW pullup resistor.<br><br>**Operational Data Rate Configurations** are illustrated in the table below. |
| 17 | 20 | 18 | **4800 Baud Select:** A logic '1' on this pin combined with a logic '0' on the 1200/2400 Baud Select pin will select the 4800 option (1MW pulldown resistor). Tone frequencies are: one-half cycle of 2400Hz represents a logic '1,' one cycle of 4800Hz represents a logic '0.' This state can only be achieved using a 4.032MHz Xtal input. |
| 18 | 21 | 19 | **Clock Rate:** A logic input to select and allow the use of either a 1.008MHz or 4.032MHz Xtal/clock. Logic '1' = 4.032MHz, logic '0' = 1.008MHz. This input has an internal pulldown resistor (1.008MHz). |
| 19 | 22 | 20 | **Carrier Detect Time Constant :** Part of the carrier detect integration function. The value of $C_4$ connected to this pin will affect the carrier detect response time and hence noise performance (See Figure 2, Note 3). |
| 20 | 24 | 22 | **$V_{DD}$:** Positive supply rail. A single 5-volt supply is required. |
| | 4, 6, 17, 23 | 4, 21 | No internal connection, do not use. |

| Xtal/Clock Frequency | 1.008MHz | | 4.032MHz | | |
|---|---|---|---|---|---|
| **Clock Rate** pin | 0 | 0 | 1 | 1 | 1 |
| **1200/2400 Select** pin | 1 | 0 | 1 | 0 | 0 |
| **4800 Select** pin | 0 | 0 | 0 | 0 | 1 |
| **Baud Rate** | **1200** | **2400** | **1200** | **2400** | **4800** |

# Application Information




| Component | Value | Tolerance |
|---|---|---|
| $R_1$ | 1.0MW | ±10% |
| $C_1$ | 33.0pF | |
| $C_2$ | 1.0µF | ±20% |
| $C_3$ | 0.1µF | |
| $C_4$ | 0.1µF | ±10% |
| $C_5$ | 1.0µF | ±20% |
| $C_6$ | 1.0µF | |
| $C_7$ | 33.0pF | |
| $X_1$ | 1.008MHz or 4.032MHz | See 'Clock-Rate' Pin |

**Notes**

1. $V_{BIAS}$ may be decoupled to $V_{SS}$ and $V_{DD}$ using $C_2$ and $C_6$ when input signals are referenced to the $V_{BIAS}$ pin. For input signals referenced to $V_{SS}$, decouple $V_{BIAS}$ to $V_{SS}$ using $C_2$ only.
2. Use $C_5$ when input signals are referenced to $V_{SS}$, to decouple $V_{DD}$.
3. The value of $C_4$ determines the Carrier Detect time constant. A long time constant results in improved noise immunity but increased response time. $C_4$ may be varied to trade-off response time for noise immunity.
4. $C_7$ reduces Xtal voltage overshoot. Refer to CML Xtal Application Note D/XT/2 December 1991.

*Fig.2 External Components*

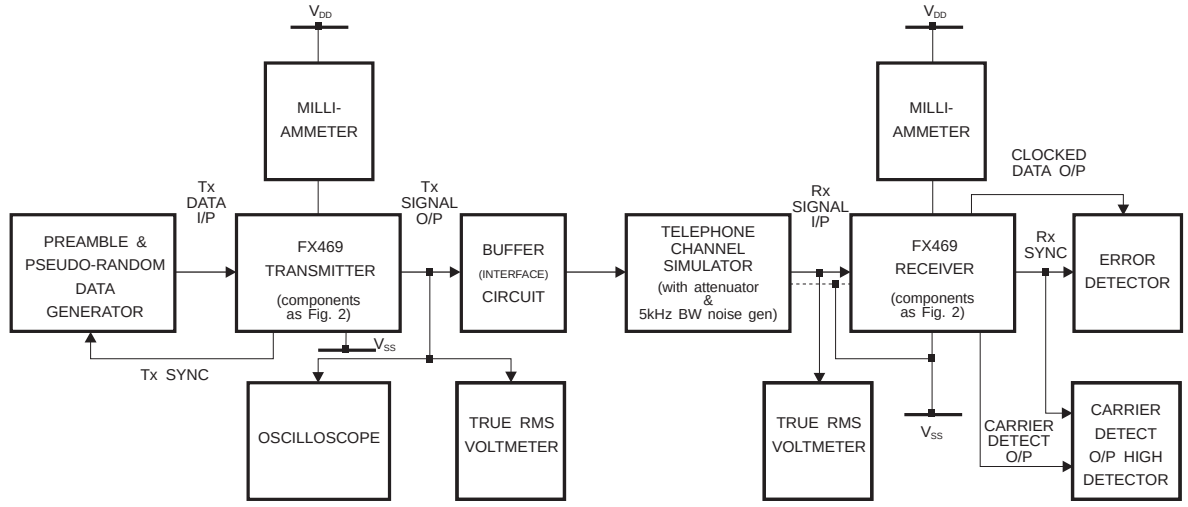



*Fig.3 Suggested FX469 Test Set-Up*

## Application Information .....

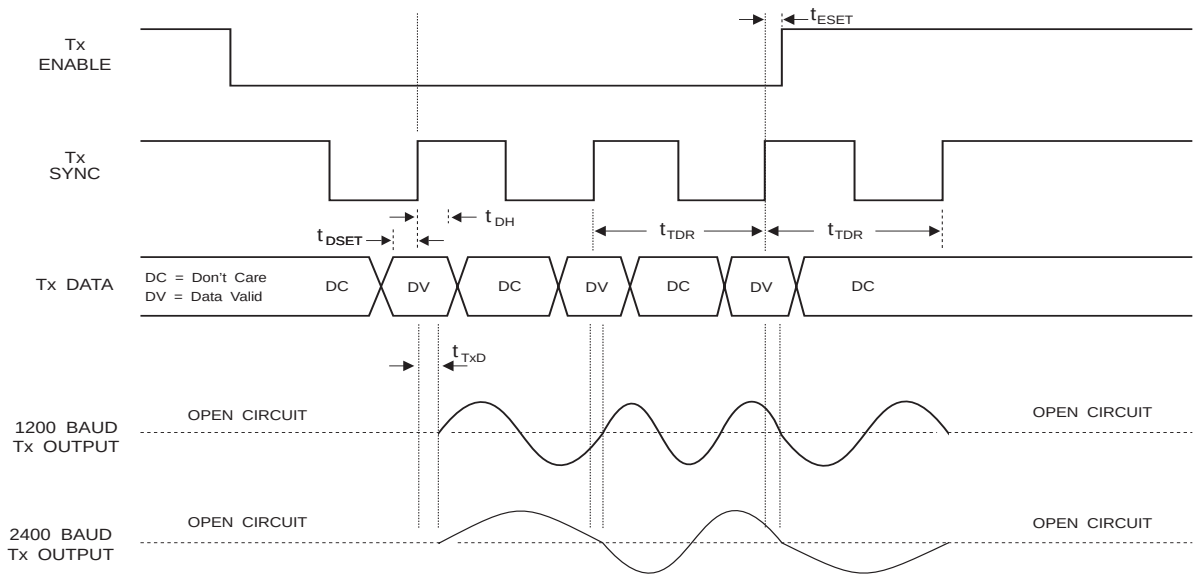



*Fig.4 Transmitter Timing*

| Characteristics | | Note | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Tx Delay, Signal to Disable Time | $t_{ESET}$ | 3 | 2.0 | - | 800 | µs |
| Data Set-Up Time | $t_{DSET}$ | 1 | 2.0 | - | - | µs |
| Data Hold Time | $t_{DH}$ | | 2.0 | - | - | µs |
| Tx Delay to O/P Time | $t_{TxD}$ | | - | 1.2 | - | µs |
| Tx Data Rate Period | $t_{TDR}$ | 3 | - | 833 | - | µs |
| Rx Data Rate Period | $t_{RDR}$ | 3 | 800 | - | 865 | µs |
| Undetermined State | | | - | - | 2.0 | µs |
| Internal Rx Delay | $t_{ID}$ | | - | 1.5 | - | ms |

1. Consider the Xtal/Clock tolerance.
2. All Tx timings are related to the Tx Sync Output.
3. 1200 baud example.

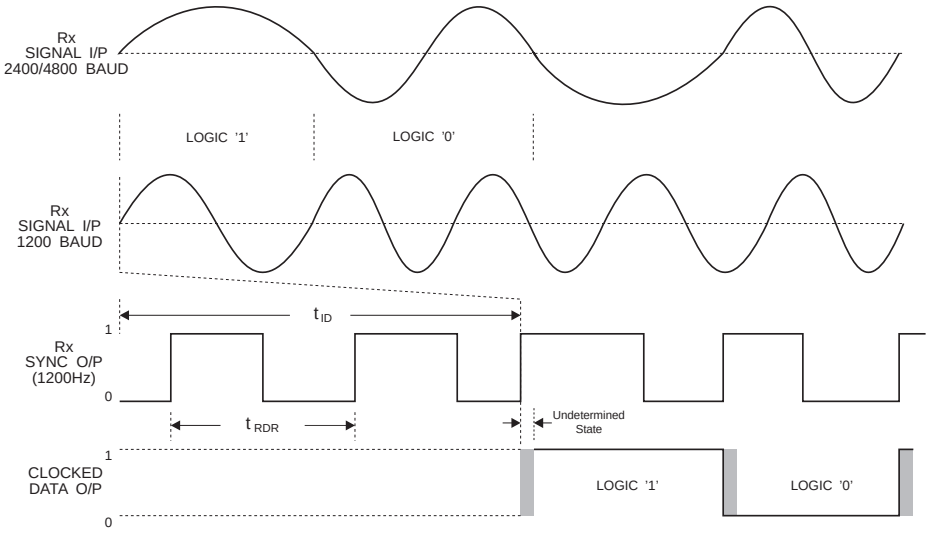



*Fig.5 Rx Timing Diagram*

# 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: | **FX469DW/LG/LS/P6** | -30°C to +70°C (plastic) |
| | **FX469J** | -30°C to +85°C (cerdip) |
| Storage temperature range: | **FX469DW/LG/LS/P6** | -40°C to +85°C (plastic) |
| | **FX469J** | -55°C to +125°C (cerdip) |

## Operating Limits

All device characteristics are measured under the following conditions unless otherwise specified:
$V_{DD}$ = 5.0V, $T_{AMB}$ = 25°C. Audio Level 0dB ref: = 300mVrms. Xtal/Clock = 4.032MHz.
Signal-to-Noise Ratio measured in the Bit-Rate Bandwidth Baud Rate = 1200 baud.

| Characteristics | | See Note | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Static Values** | | | | | | |
| Supply Voltage | | | 4.5 | 5.0 | 5.5 | V |
| Supply Current | Rx Enabled Tx Disabled | | - | 3.6 | - | mA |
| | Rx and Tx Enabled | | - | 4.5 | - | mA |
| | Rx and Tx Disabled | | - | 650 | - | µA |
| Logic '1' Level | | 1 | 4.0 | - | - | V |
| Logic '0' Level | | 1 | - | - | 1.0 | V |
| Digital Output Impedance | | | - | 4.0 | - | kW |
| Analogue and Digital Input Impedance | | | 100 | - | - | kW |
| Tx Output Impedance | | | - | 0.6 | 1.0 | kW |
| On-Chip Xtal Oscillator | | | | | | |
| | $R_{IN}$ | | 10.0 | - | - | MW |
| | $R_{OUT}$ | | 5.0 | - | 15.0 | kW |
| Inverter d.c. Voltage Gain | | | 10.0 | - | 20.0 | V/V |
| Gain Bandwidth Product | | | 4.1 | - | - | MHz |
| Xtal Frequency | | 2 | - | 1.008 | - | MHz |
| Xtal Frequency | | 2 | - | 4.032 | - | MHz |
| **Dynamic Values** | | | | | | |
| **Receiver** | | | | | | |
| Signal Input Dynamic Range | SNR = 50dB | 3, 4 | 100 | 230 | 1000 | mVrms |
| Bit Error Rate | SNR = 12dB | 4 | | | | |
| | 1200 Baud | | - | 2.5 | - | $10^{4}$ |
| | 2400 Baud | | - | 1.5 | - | $10^{3}$ |
| | 4800 Baud | | - | 1.5 | - | $10^{3}$ |
| | SNR = 20dB | 4 | | | | |
| | 1200/2400/4800 Baud | | - | <1.0 | - | $10^{8}$ |
| **Receiver Synchronization** | **SNR =12dB** | 7 | | | | |
| Probability of Bit 16 Being Correct | | | - | 0.995 | - | |
| **Carrier Detect** | | 5, 10 | | | | |
| Sensitivity | | 7, 8 | - | - | 150 | mVrms |
| Probabilty of C.D. Being High | | | | | | |
| After Bit 16 | SNR = 12dB | 5, 9 | | 0.995 | | |
| 0dB Noise | No Signal | 9 | | 0.05 | | |

## Specification .....

| Characteristics | See Note | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **Transmitter Output** | | | | | |
| Tx Output Level | | - | 775 | - | mVrms |
| Output Level Variation | | | | | |
| 1200/1800Hz or 1200/2400Hz or 2400/4800Hz | | 0 | - | ±1.0 | dB |
| Output Distortion | | - | 3.0 | 5.0 | % |
| 3rd Harmonic Distortion | | - | 2.0 | 3.0 | % |
| Logic '1' Carrier Frequency 1200 Baud | 6 | - | 1200 | - | Hz |
| 2400 Baud | 6 | - | 1200 | - | Hz |
| 4800 Baud | 6 | - | 2400 | - | Hz |
| Logic '0' Carrier Frequency 1200 Baud | 6 | - | 1800 | - | Hz |
| 2400 Baud | 6 | - | 2400 | - | Hz |
| 4800 Baud | 6 | - | 4800 | - | Hz |
| Isochronous Distortion | | | | | |
| 1200Hz - 1800Hz/1800Hz - 1200Hz | | - | 25.0 | 40.0 | µs |
| 1200Hz - 2400Hz/2400Hz - 1200Hz | | - | 20.0 | 30.0 | µs |
| 2400Hz - 4800Hz/4800Hz - 2400Hz | | | - | 10.0 | 20 µs |

**Notes**

1. With reference to $V_{DD}$ = 5.0 volts.
2. Xtal frequency, type and tolerance depends upon system requirements.
3. See Figure 5 (variation of BER with Input Signal Level).
4. SNR = Signal-to-Noise Ratio in the Bit-Rate Bandwidth.
5. See Figure 2.
6. Dependent upon Xtal tolerance.
7. 10101010101 ...01 pattern.
8. Measured with a 150mVrms input signal (no noise); 1200/2400 baud operation.
9. Reference (0dB) level for C.D. probability measurements is 230mVrms.
10. For 1200 and 2400 baud operation only; when operating at 4800 baud the Carrier Detect output should be ignored.

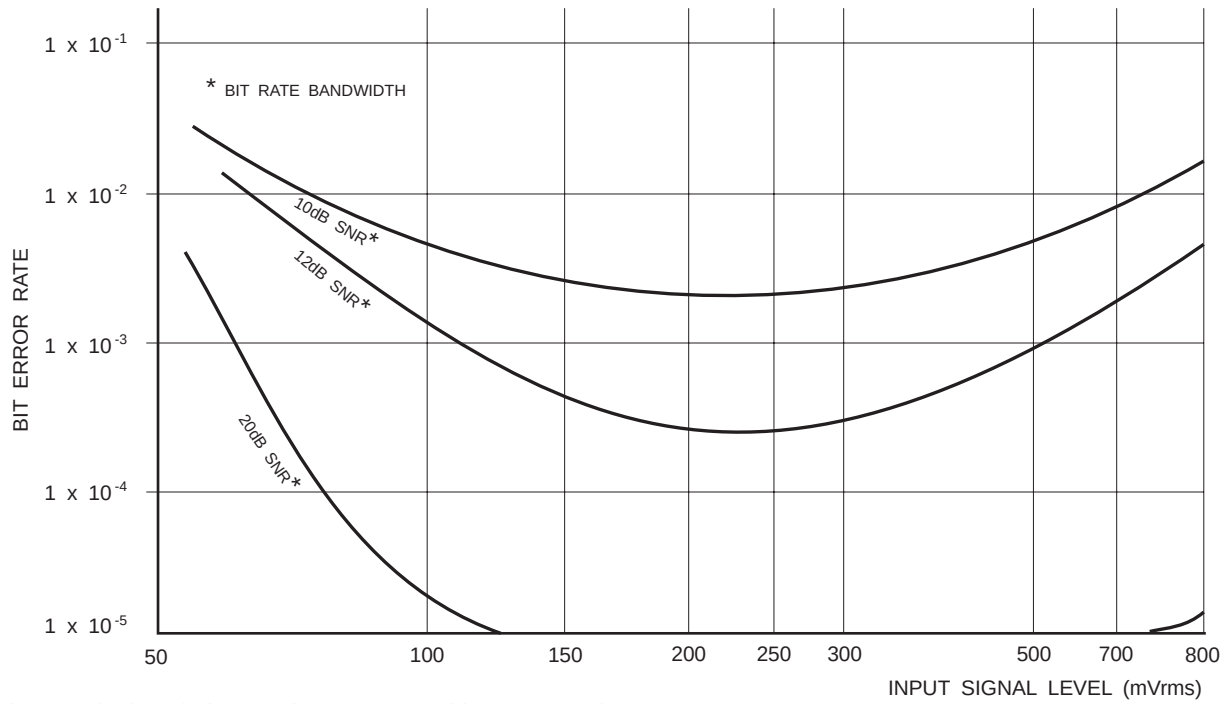



*Fig.6 Typical Variation of Bit Error Rate with Input Level*

## Application Information

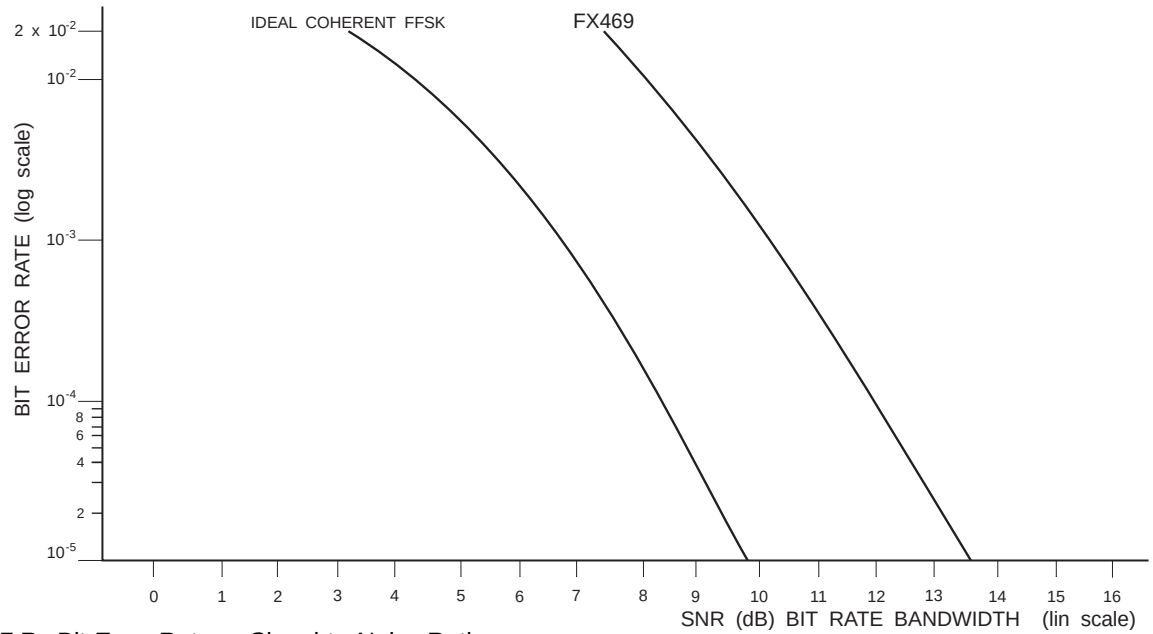



*Fig.7 Rx Bit-Error-Rate vs Signal-to-Noise Ratio*

## Package Outlines

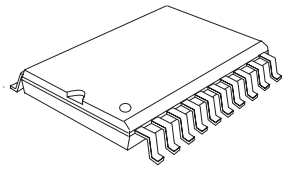
The FX469 is available in the package styles outlined below. Mechanical package diagrams and specifications are detailed in Section 10 of this document.
Pin 1 identification marking is shown on the relevant diagram and pins on all package styles number anti-clockwise when viewed from the top.

## Handling Precautions

The FX469 is a CMOS LSI circuit which includes input protection. However precautions should be taken to prevent static discharges which may cause damage.

**FX469DW** 20-pin plastic S.O.I.C. (D3)

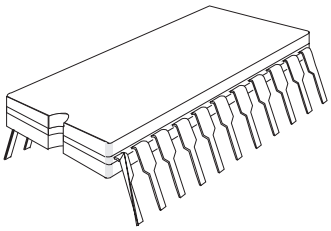
NOT TO SCALE



| | |
|---|---|
| Max. Body Length | 12.95mm |
| Max. Body Width | 7.59mm |

**FX469J** 22-pin cerdip DIL (J3)

NOT TO SCALE

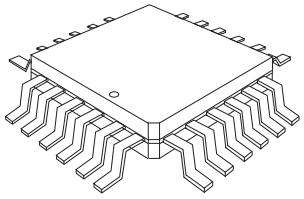


| | |
|---|---|
| Max. Body Length | 27.38mm |
| Max. Body Width | 9.75mm |

## Package Outlines .....

**FX469LG** 24-pin quad plastic encapsulated bent and cropped (L1)

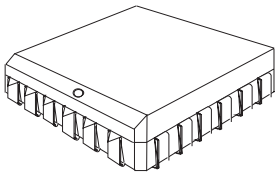
NOT TO SCALE



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

**FX469LS** 24-lead plastic leaded chip carrier (L2)

NOT TO SCALE



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

## Ordering Information

**FX469DW** 20-pin surface mount S.O.I.C.

**FX469J** 22-pin cerdip DIL

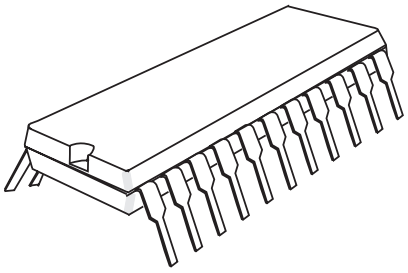
**FX469LG** 24-pin quad plastic encapsulated bent and cropped (L1)

**FX469LS** 24-lead plastic leaded chip carrier (L2)

**FX469P6** 22-pin plastic DIL

**FX469P6** 22-pin plastic DIL

NOT TO SCALE



Max. Body Length 27.94mm
Max. Body Width 9.14mm

**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.

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