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**

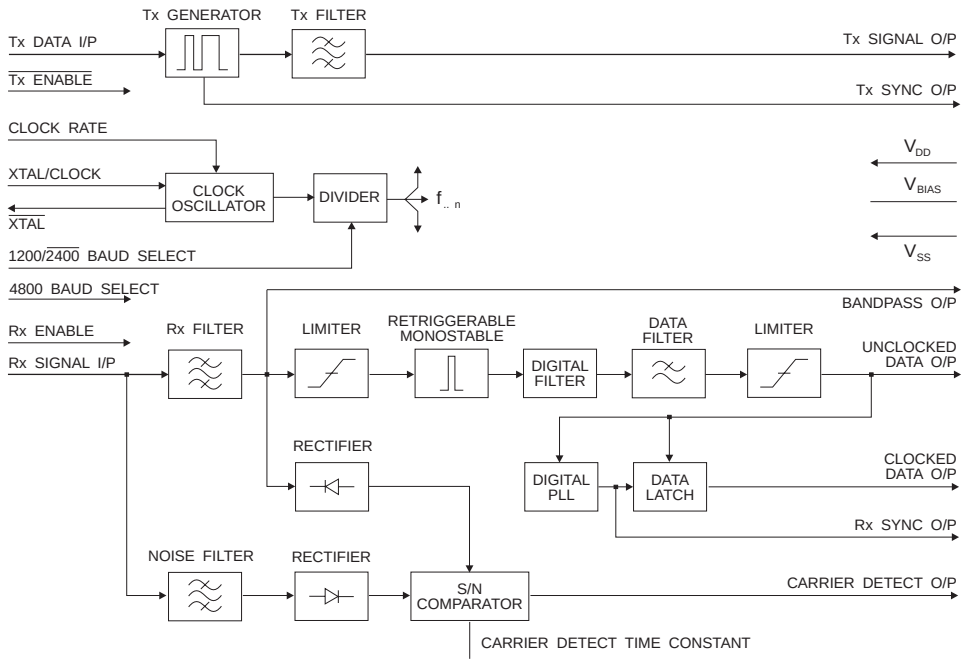


Fig.1 Functional Block Diagram

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). 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. This bias voltage is maintained under all powersave conditions.
10	12	11	**V_{SS}:** Negative supply rail (GND).

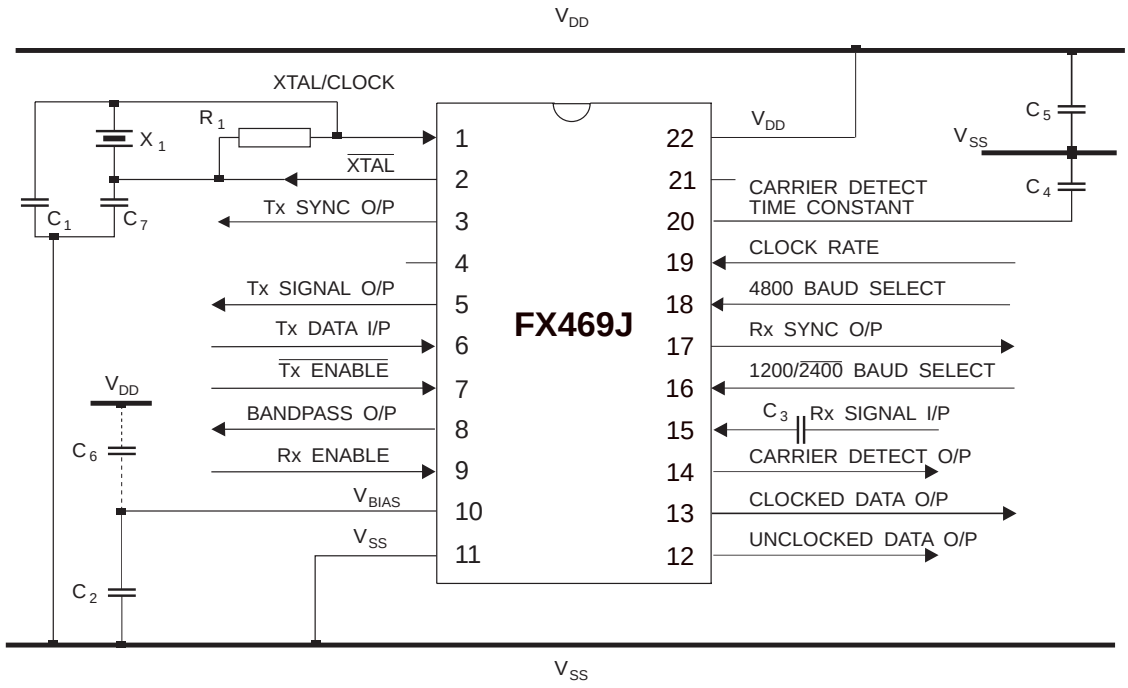
Rx Enable	=	Rx Function	Clock Data O/P	Carrier Detect	Rx Sync Out
"1"	=	Enabled	Enabled	Enabled	Enabled
"0"	=	Powersave	"0"	"0"	1" or "0"

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. **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

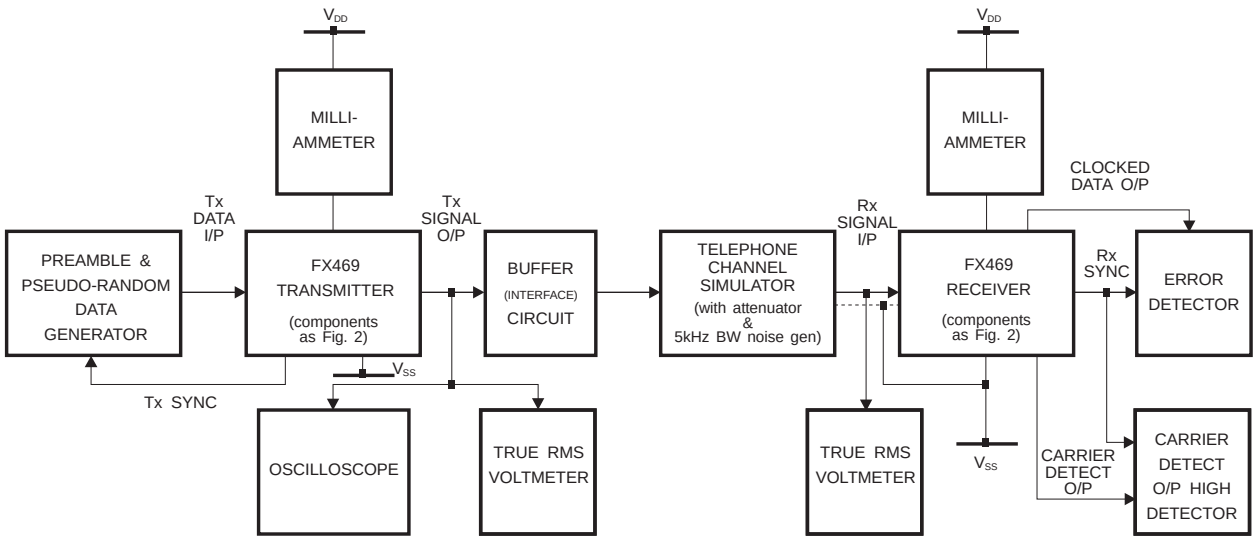


Fig.3 Suggested FX469 Test Set-Up

Application Information .....

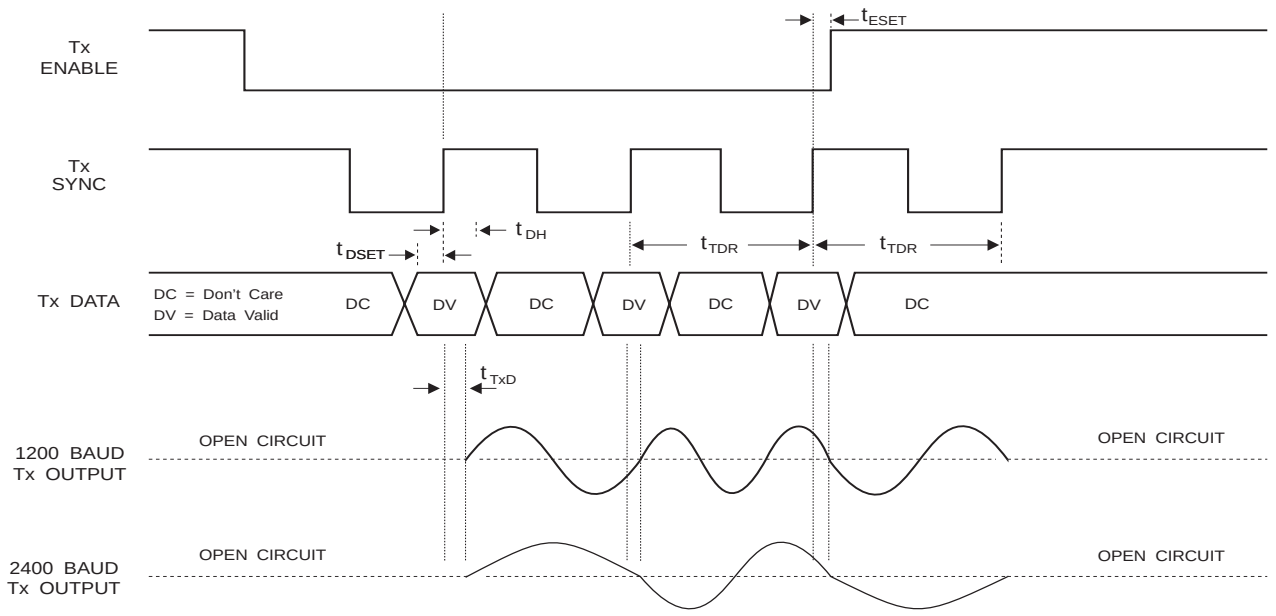


Fig.4 Transmitter Timing

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.

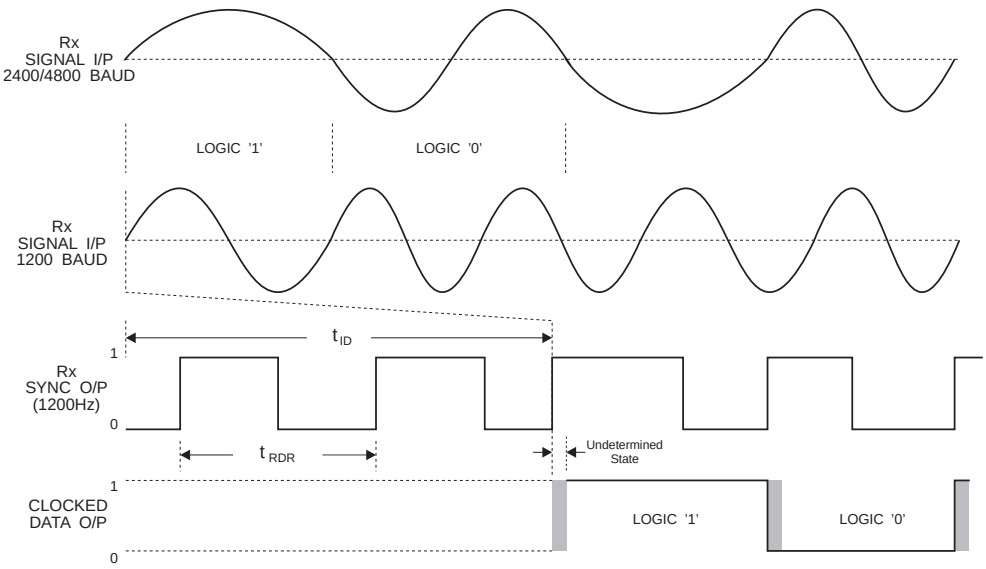


Fig.5 Rx Timing Diagram

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.

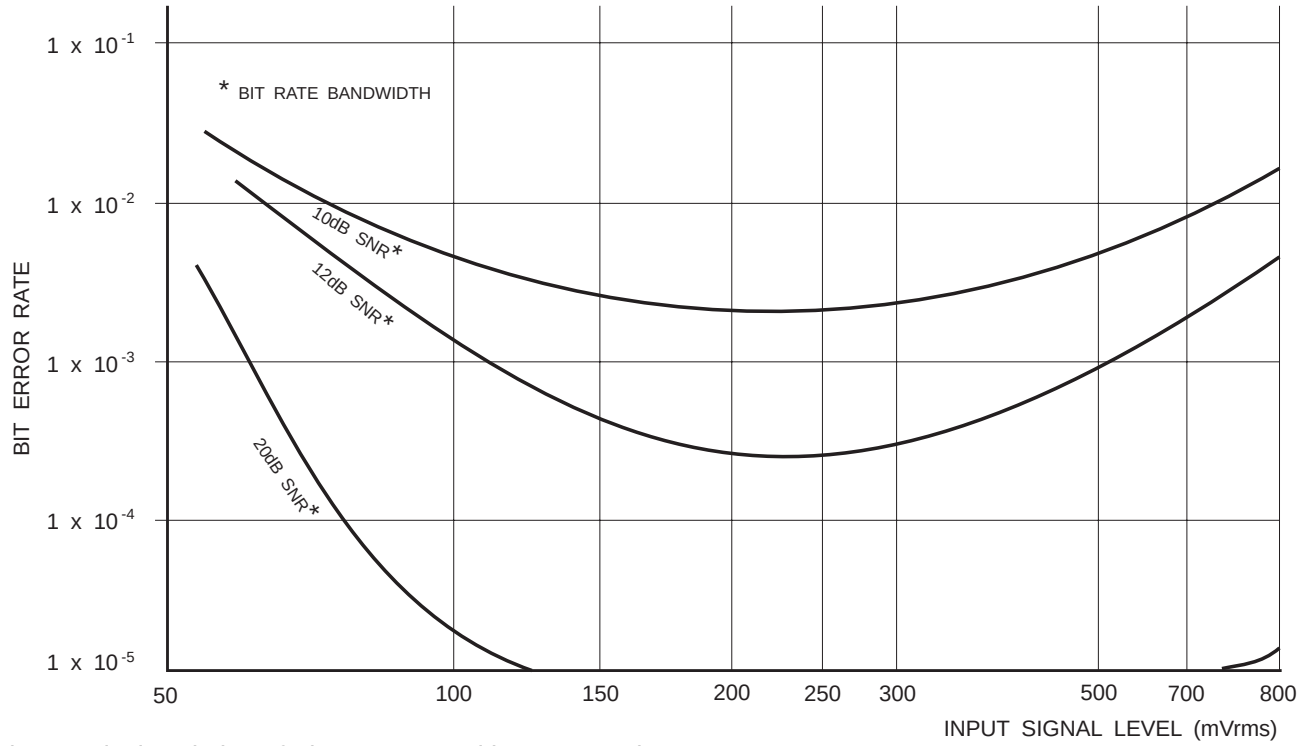


Fig.6 Typical Variation of Bit Error Rate with Input Level

Application Information

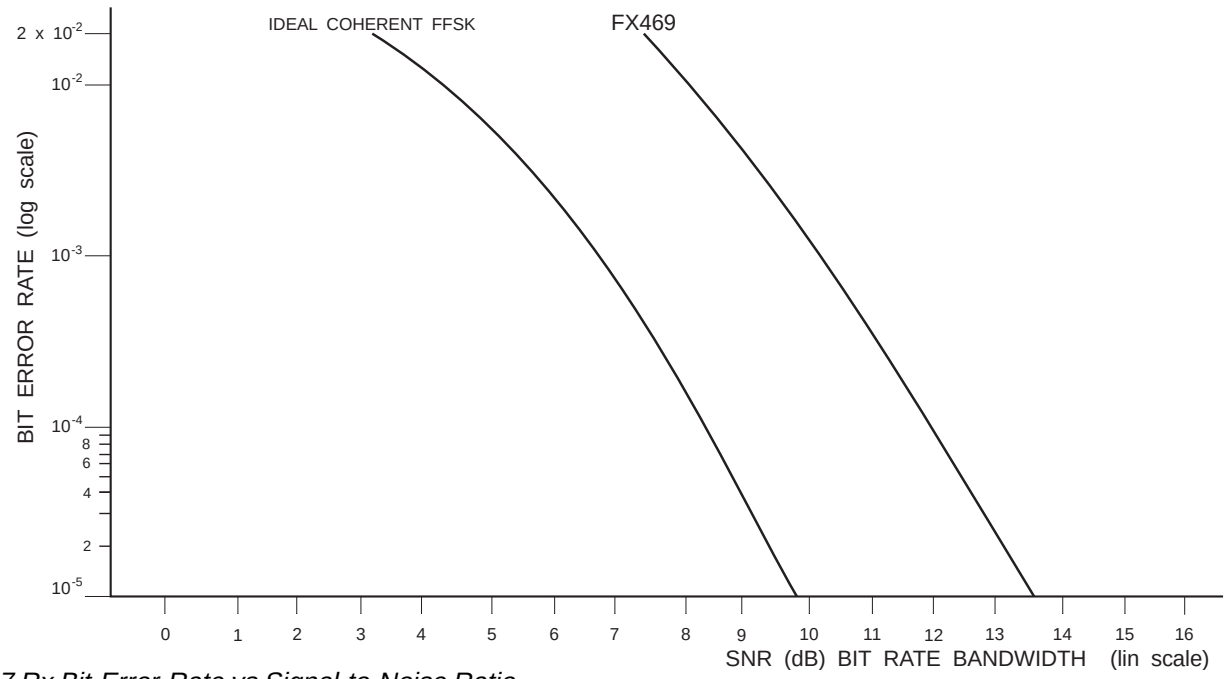


Fig.7 Rx Bit-Error-Rate vs Signal-to-Noise Ratio

Package Outlines

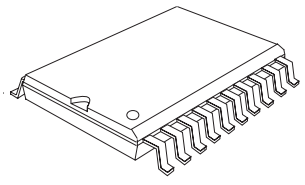
The FX469 is available in the package styles outlined below. Mechanical package diagrams and specifications are detailed in Section 10 of this document.
Pin 1 identification marking is shown on the relevant diagram and pins on all package styles number anti-clockwise when viewed from the top.

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)

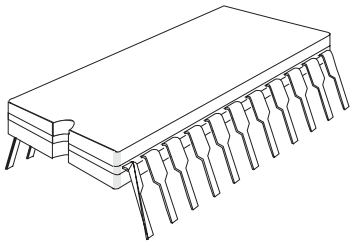
NOT TO SCALE



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

FX469J 22-pin cerdip DIL (J3)

NOT TO SCALE

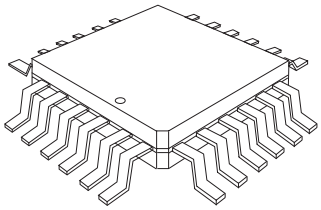


Max. Body Length	27.38mm
Max. Body Width	9.75mm

Package Outlines .....

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

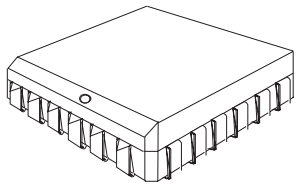
NOT TO SCALE



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

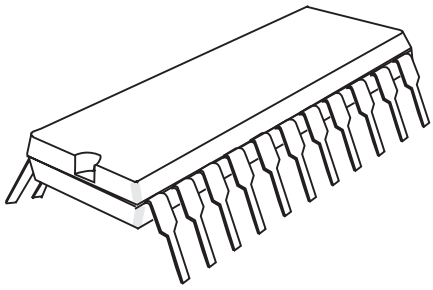
FX469LG 24-pin quad plastic encapsulated bent and cropped (L1)

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