

# CML Semiconductor Products

PRODUCT INFORMATION

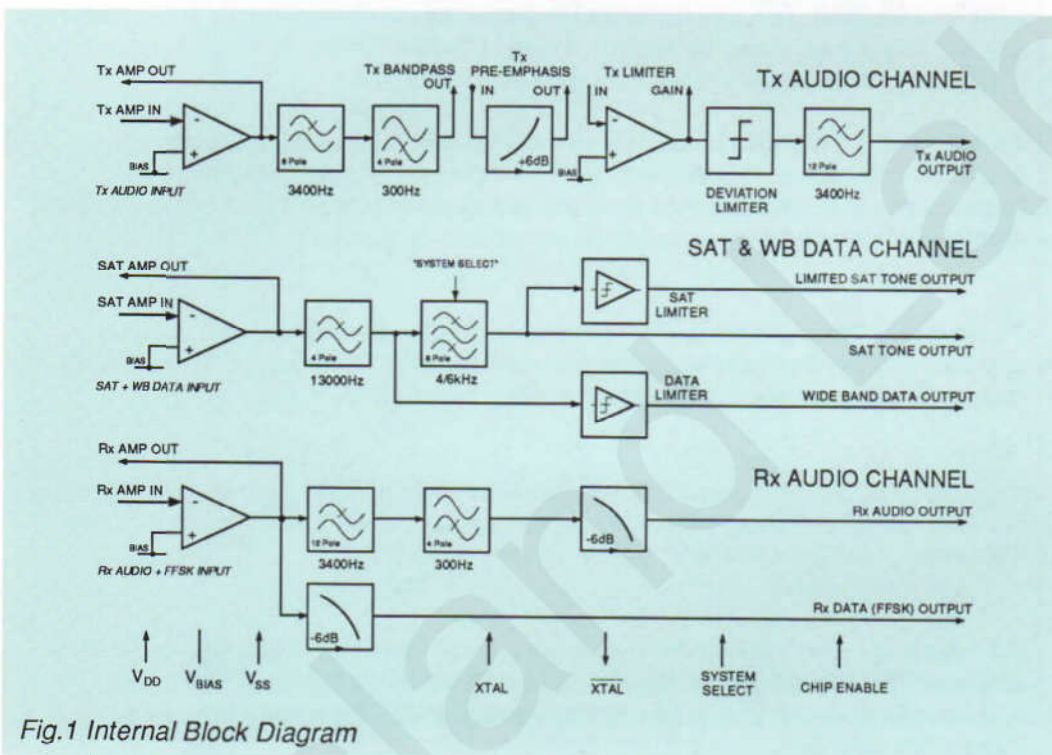
## FX346 AMPS, TACS, NMT Audio Processing Array

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Provisional Issue

With compliments  
of Island Labs

### Features/Applications

- AMPS, TACS, NMT Audio + Data Processing
- Speech, SAT and Data – Full Duplex Filtering
- Speech Bandpass and Deviation Limiter Filters
- SAT 4/6kHz Bandpass Filters
- 8/10kbit Rx Wideband Data Filter and Limiter
- Filters for Speech/FFSK, Pre/De-emphasis
- Input Gain Adjustment



# FX346

### Brief Description

The FX346 Audio Processing Array is a full-duplex Speech, SAT and Data Processor designed to meet the composite specifications of AMPS, TACS and NMT 450/900.

The product in detail :

#### The Rx Audio Path consisting:

- A 12th order lowpass filter.
- A 4th order highpass filter.
- Input gain adjustment and de-emphasis.

#### The Tx Audio Path consisting:

- Separate 6th and 12th order lowpass filters.
- A 4th order highpass filter.
- A linear deviation limiter.
- Input gain adjustment and pre-emphasis.

#### The Rx SAT and Data Path consisting:

- A 13kHz wideband data filter and limiter.
- Switchable 6th order 4/6kHz SAT bandpass filter.
- 1200 baud FFSK signal data limiter on chip.

All filter stages, excluding the Rx data paths, may be de-powered for minimum current drain.

Operation in AMPS/TACS or NMT mode is controlled via a single logic input.

The FX346, in combination with the FX009 Digitally Controlled Amplifier Array and analogue switches offers a complete speech and processing solution for cellular radio. All filter sampling clocks are generated on-chip using an external 4.0MHz Xtal or clock pulse input. The FX346 is a low-power, single 5-volt device available in 24-pin cerdip DIL or SMD plastic packages.



## Pin Number

## Function

DIL FX346J	Quad FX346LG/LS	
1	1	<b>Xtal/Clock</b> : The input to the clock oscillator circuitry. The clock oscillator components are on-chip and require only a single 4MHz Xtal or clock pulse input. Clock oscillations are maintained in "powersave" (Chip Enable = "0"). See Figure 2.
2	2	<b>Xtal</b> : The output of the clock oscillator circuitry. See Figure 2.
3	3	<b>Chip Enable</b> : The Chip Enable logic input. When a logic "0" the chip is put into a powersave mode, with only the minimum amount of monitoring circuitry enabled, to reduce current consumption. A logic "1" will enable all circuitry. This input operates in conjunction with the System Select input, signal paths are as shown in Table 1.
4	4	<b>System Select</b> : A logic input to select signal paths to either the AMPS/TACS or NMT specification. This input operates in conjunction with the Chip Enable input, signal paths are as shown in Table 1. Logic "1" = AMPS/TACS, logic "0" = NMT.
5	5	<b>Tx Amp Out</b> : The "gain output" pin of the Transmit Audio Channel audio input amplifier. This output, together with the Tx Amp In pin is used, with external components, to set the required input gain/attenuation of this channel. See Figures 1 and 2.
6	6	<b>Tx Amp In</b> : The input pin to the Transmit Audio Channel. This inverting input, together with the Tx Amp Out pin is used, with external components, to set the required input gain/attenuation of the channel. See Figures 1 and 2.
7	7	<b>V<sub>BIAS</sub></b> : The output of the on-chip analogue bias circuitry, internally set to $V_{DD}/2$ this pin requires to be decoupled to $V_{SS}$ with a capacitor, $C_1$ . $V_{BIAS}$ is maintained during "powersave" (Chip Enable = "0"). See Figure 2 and Table 1.
8	8	<b>SAT Amp In</b> : The input to the Supervisory Audio Tone (SAT) and Wideband Data Channel. This inverting input, together with the SAT Amp Out pin is used, with external components, to set the required input gain/attenuation of the channel. See Figures 1 and 2.
9	9	<b>SAT Amp Out</b> : The "gain output" pin of the Supervisory Audio Tone (SAT) and Wideband Data Channel. This pin, together with the SAT Amp In pin is used, with external components, to set the required input gain/attenuation of the channel. Attention is drawn to the data circuit sensitivity (Specification page 6). See Figures 1 and 2.
10	10	<b>Rx Amp Out</b> : The "gain output" pin of the Receive Audio Channel. This pin, together with the Rx Amp In pin is used, with external components, to set the required input gain/attenuation of the channel. See Figures 1 and 2.
11	11	<b>Rx Amp In</b> : The input to the Receive Audio Channel. This inverting input, together with the Rx Amp Out pin is used, with external components, to set the required input gain/attenuation of the channel. See Figures 1 and 2.

## Pin Number

## Function

DIL FX346J	Quad FX346LG/LS	
12	12	$V_{SS}$ : Negative supply rail (GND).
13	13	<b>SAT Tone Out</b> : The filtered Supervisory Audio Tone (SAT) output. AMPS/TACS (-6dB) = 6kHz $\pm$ 200Hz. NMT (-6dB) = 4kHz $\pm$ 200Hz.
14	14	<b>Rx Wideband Data Out</b> : The filtered, limited, wideband data output. This data channel produces a limited rectangular wave output. Attention is drawn to the data circuit sensitivity ( Specification page 6 ). See Figures 1 and 2.
15	15	<b>Limited SAT Tone Out</b> : The filtered, limited Supervisory Audio Tone (SAT). Attention is drawn to the data circuit sensitivity ( Specification page 6 ). See Figures 1 and 2.
16	16	<b>Rx Audio Out</b> : The bandpass filtered, de-emphasized audio output of the Rx Audio Channel.
17	17	<b>Rx Data Out</b> : The de-emphasized, received data output. This data process may require filtering by low group delay filters before demodulation by modems such as : CML – FX419, FX429, FX439.
18	18	<b>Tx Audio Out</b> : The processed audio to the transmission mixing and modulation circuitry.
19	19	<b>Tx Limiter Gain</b> : The "gain output" of the Tx Limiter Amplifier. This amplifier, using gain setting components, is used to produce the correct signal level for application to the Deviation Limiter. For limiter levels refer to the Specification page 6. Recommended circuitry is shown in Figure 2.
20	20	<b>Tx Limiter In</b> : The input to the Tx Limiter Amplifier. This input should be connected via external components to the Tx Pre-emphasis Out pin as shown in Figure 2.
21	21	<b>Tx Pre-emphasis Out</b> : The output of the on-chip +6dB/octave pre-emphasis circuitry. This output should be connected to the Tx Limiter Amplifier via external components as shown in Figure 2.
22	22	<b>Tx Pre-emphasis In</b> : The input to the on-chip transmitter pre-emphasis circuitry. This input would normally be connected to the output of an external audio compressor circuit.
23	23	<b>Tx Bandpass Out</b> : The output of the first stage of bandpass filtering in the Transmit Audio Channel. This output will normally be connected to the input of an external audio compressor circuit. See Figures 1 and 2.
24	24	$V_{DD}$ : Positive supply rail. A single +5-volt power supply is required.



## External Components

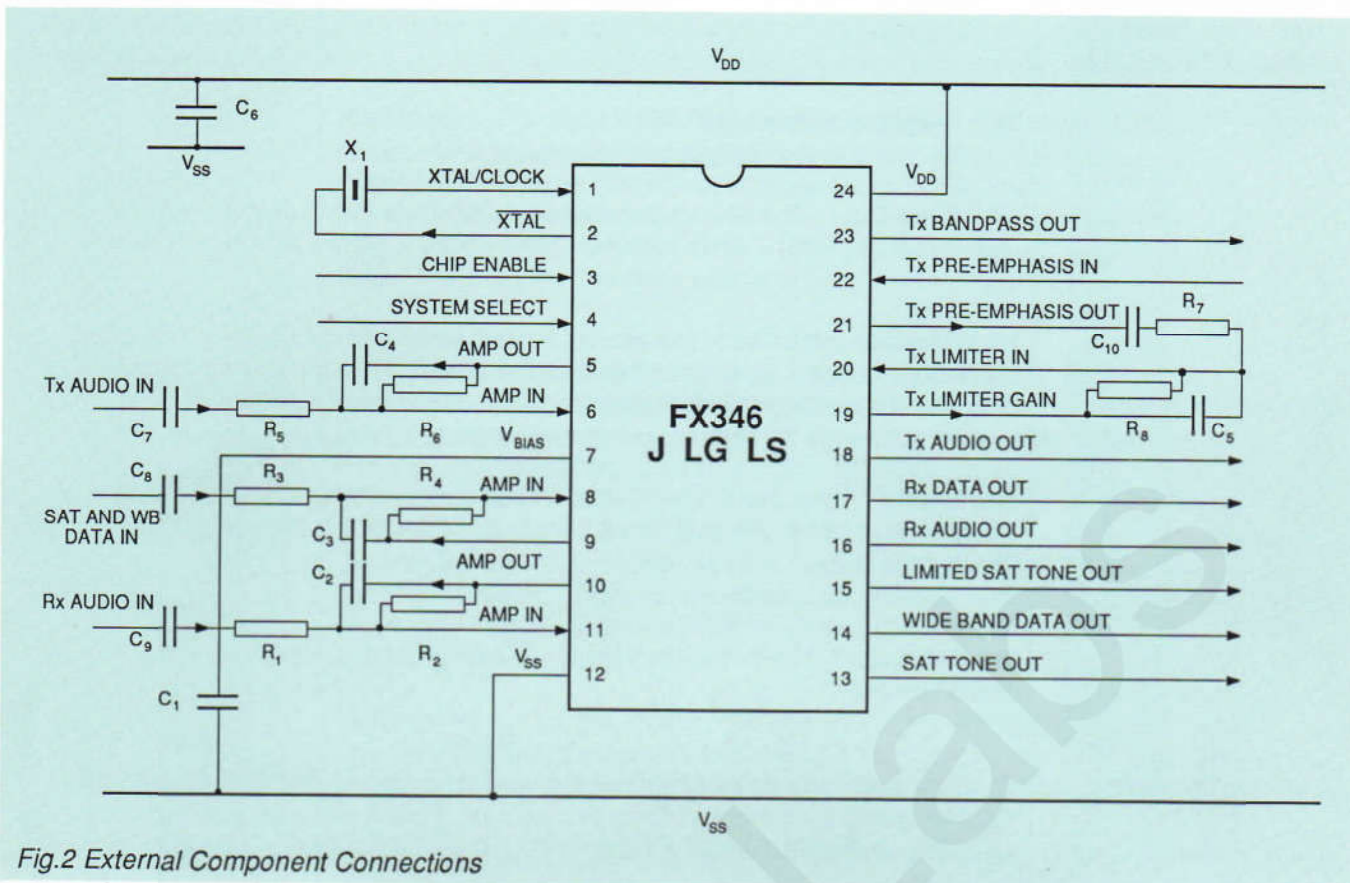


Fig.2 External Component Connections

### Component Value Notes

Figure 2 shows the recommended components for use with the FX346. The notes below give component values and/or calculations.

$R_2/R_1$ ,  $R_4/R_3$ ,  $R_6/R_5$ ,  $R_8/R_7$ .

Gain component combinations to set the gains of the Tx Audio, SAT and WB Data, Rx Audio and Limiter inputs.

Gain is calculated using the formula:

$$\text{Gain} = \frac{R_{\text{FEEDBACK}}}{R_{\text{INPUT}}}$$

– taking into account the effect of the parallel feedback capacitor.

It is recommended that all gain resistor values are kept above 10kΩ.

$C_1$ .

$V_{\text{BIAS}}$  decoupling capacitor = 1.0μF.

$C_2$ ,  $C_4$  and  $C_5$ .

Feedback capacitor values should be calculated (taking into account gain resistors  $R_1$ ,  $R_2$ ,  $R_5$ ,  $R_6$ ,  $R_7$  and  $R_8$ ) to give a -3dB point at approximately 15kHz for Rx and Tx Channel, this for anti-alias filtering.

$C_3$ .

Feedback capacitor = 10.0pF.

$C_6$ .

Power supply decoupling capacitor = 1.0μF.

$C_8$ .

Input coupling capacitor = 0.1μF.

$C_7$ ,  $C_9$  and  $C_{10}$ .

Input coupling capacitors = 1.0μF.

### Component Tolerances

Resistors ± 10%

Capacitors ± 20%

To maintain low current consumption, Output Buffers, anti-alias Clock Frequency Filters and input internal pullup or pulldown resistors are **not** included on-chip.

A noisy or badly regulated power supply can cause instability and/or variance of selected gains.



## Application Information

Table 1 (below) shows the signal and data path conditions relevant to the System Select and Chip Enable inputs. Note that the oscillator circuitry and  $V_{BIAS}$  line are enabled under all conditions.

FUNCTION			SIGNAL PATH				
System Select	4MHz Oscillator	$V_{BIAS}$	Tx Audio	SAT Tone	WB Data	Rx Audio	Rx Data
<b>AMPS/TACS</b>							
Chip Enable = "1"	Enabled	Enabled	Enabled	6kHz, Enabled	Enabled	Enabled	Enabled
Chip Enable = "0"	Enabled	Enabled	Disabled	Disabled	Enabled	Disabled	Disabled
<b>NMT</b>							
Chip Enable = "1"	Enabled	Enabled	Enabled	4kHz, Enabled	Enabled	Enabled	Enabled
Chip Enable = "0"	Enabled	Enabled	Disabled	Disabled	Disabled	Disabled	Enabled

Table 1 Signal Path Selection

Figure 3 (below) demonstrates the possible audio and data functions performed by the FX346 Audio Processing Array when employed within the audio stages of either an NMT, AMPS or TACS mobile application.

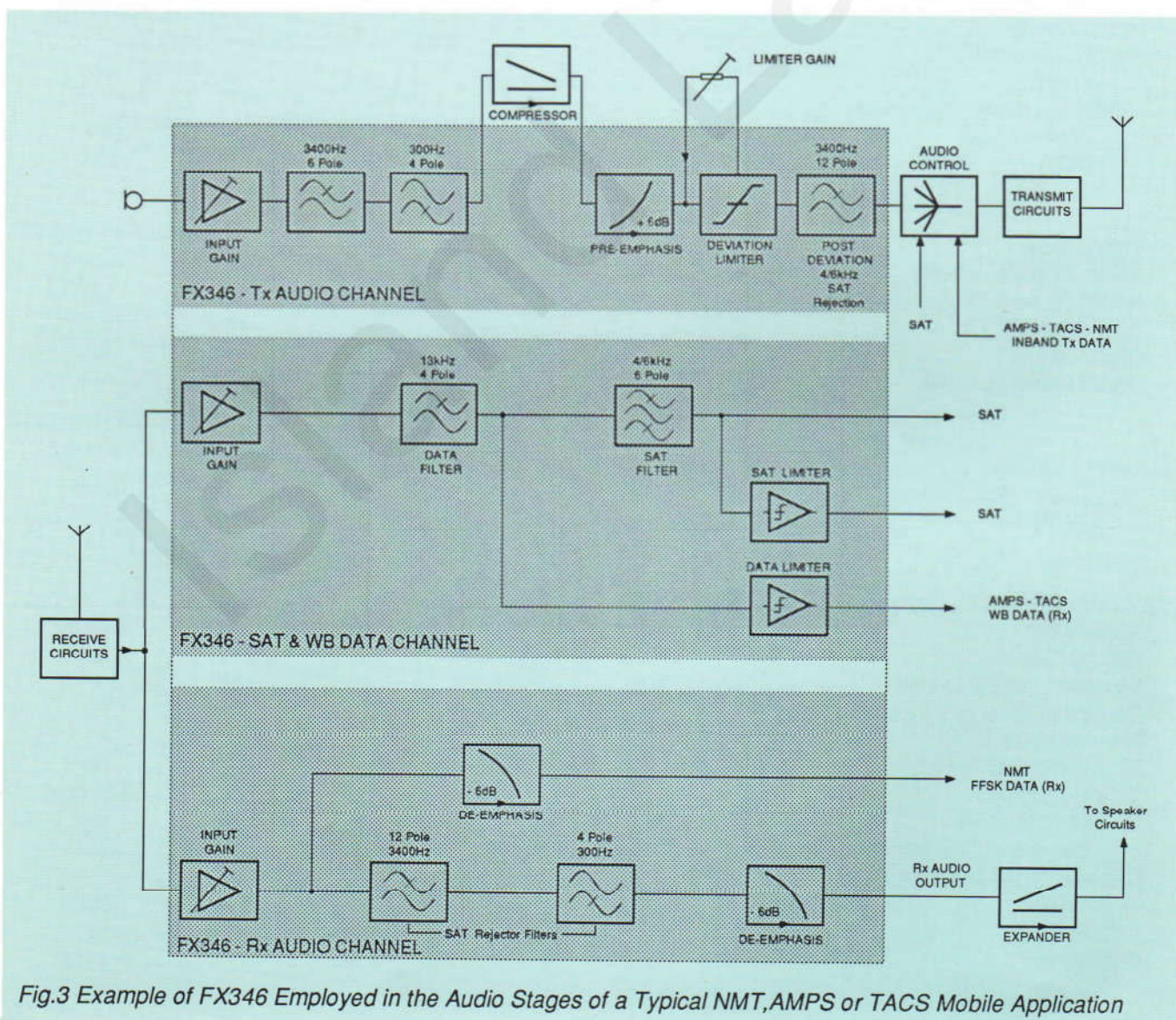


Fig.3 Example of FX346 Employed in the Audio Stages of a Typical NMT,AMPS or TACS Mobile Application



## 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>FX346J</b>	-30 $^{\circ}C$ to +85 $^{\circ}C$ (cerdip)
<b>FX346LG/LS</b>	-30 $^{\circ}C$ to +70 $^{\circ}C$ (plastic)
Storage temperature range: <b>FX346J</b>	-55 $^{\circ}C$ to +125 $^{\circ}C$ (cerdip)
<b>FX346LG/LS</b>	-40 $^{\circ}C$ to +85 $^{\circ}C$ (plastic)

### Operating Limits

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

$V_{DD} = 5.0V$ ,  $T_{AMB} = 25^{\circ}C$ . Xtal/Clock  $f_0 = 4.0$  MHz. Audio level 0dB ref. = 300mVrms.

Characteristics	Note	Min.	Typ.	Max.	Unit
<b>Static Values</b>					
Supply Voltage ( $V_{DD}$ )		4.5	5.0	5.5	V
Input Logic '1'	3	3.5	-	-	V
Input Logic '0'	3	-	-	1.5	V
Supply Current -	6				
- Enabled		-	12.0	-	mA
- Disabled (Chip Enable = 0) -					
- AMPS/TACS		-	1.75	-	mA
- NMT		-	1.5	-	mA
<b>Impedance</b>					
Audio Amplifier Input/s		10.0	-	-	M $\Omega$
Audio Op-Amp Output/s		-	6.0	10.0	k $\Omega$
Audio Output		-	-	10.0	k $\Omega$
Digital Inputs		100	1000	-	k $\Omega$
Digital (data) Output/s		-	6.0	10.0	k $\Omega$
<b>Dynamic Values</b>					
Xtal/Clock Frequency		-	4.0	-	MHz
Input Amplifier Gain/s		-	-	40.0	dB
<b>Tx Audio Channel</b>					
Audio Input Level	1	-	300	-	mVrms
Overall Gain	1, 7, 8	-	0	-	dB
Deviation Limiter Levels	3, 5	1.0	-	4.0	V
Bandpass Frequency Range (-3dB)	8	300	-	3400	Hz
Pre-emphasis -					
- Passband		300	-	3400	Hz
- Response		-	6.0	-	dB/octave
- Gain at 1kHz		-	0	-	dB
- Passband Deviation from Ideal		-1.0	-	1.0	dB
Channel Stopband Attenuation -					
≤ 160Hz		-	25	-	dB
≥ 5500Hz		-	40.0	-	dB
Output Noise	2	-	1.50	-	mVrms

## Specification .....

Characteristics	Note	Min.	Typ.	Max.	Unit
<b>SAT and Wideband Data Channel</b>					
Input Level	1	–	300	–	mVrms
Data Limiter Sensitivity	1, 10	–	–	–	–
– Limited SAT Tone (4kHz & 6kHz)		–	10	–	mVrms
– Wideband Data		–	20	–	mVrms
<b>13kHz Lowpass Filter –</b>					
– Passband (-3dB)		–	–	15.0	kHz
– Passband Gain (100Hz – 13kHz)		-1.0	–	+1.0	dB
– Passband Ripple (100Hz – 13kHz)		–	2.0	–	dB
– Stopband Attenuation ( $\geq 25$ kHz)		–	30.0	–	dB
<b>SAT Bandpass Filter –</b>					
<b>NMT 4kHz –</b>					
– Passband Frequency Range (-6dB)	4, 9	3800	–	4200	Hz
– Passband Gain		–	10.0	–	dB
– Passband Ripple (4kHz $\pm$ 55Hz)		–	–	2.0	dB
– Stopband Attenuation (<2kHz, >6kHz)		35.0	37.0	–	dB
– Output Noise	2	–	10.0	–	mVrms
– Aliasing Frequency		50.0	–	–	kHz
<b>AMPS/TACS 6kHz –</b>					
– Passband Frequency Range (-6dB)	9	5800	–	6200	Hz
– Passband Gain		–	10.0	–	dB
– Passband Ripple (6kHz $\pm$ 55Hz)		–	2.0	3.0	dB
– Stopband Attenuation (<4kHz, >8kHz)		–	35.0	–	dB
– Output Noise	2	–	7.5	–	mVrms
<b>Rx Audio Channel</b>					
Input Level (Rx Audio, Rx Data)	1	–	300	–	mVrms
Gain	1, 7, 8	–	0	–	dB
Passband Frequency Range (-3dB)	4	260	–	3400	Hz
Output Noise	2	–	1.5	–	mVrms
<b>Rx Data Channel</b>					
<b>De-emphasis (Audio and Data) –</b>					
– Passband		300	–	3400	Hz
– Response		–	-6.0	–	dB/octave
– Gain at 1kHz		–	0	–	dB
– Passband Deviation from Ideal		-1.0	–	+1.0	dB

### Notes

1. With the Input Op-Amp gain/s at unity.
2. Measured at the output with the channel input a.c. short circuit.
3. These levels are referenced to  $V_{DD}$  and in this case measured with  $V_{DD} = 5.0$  volts.
4. Specified over the full operating voltage and temperature range.
5. Limiter input at  $V_{BIAS}$ .
6. To maintain low current consumption, buffers and clock filters are not included on-chip in series with outputs.
7. Input frequency 1.0kHz.
8. With no pre-/de-emphasis effect.
9. Shows the SAT Tone Output specification in the selected mode.
10. The minimum level at the SAT Amp Input to produce a valid logic output.

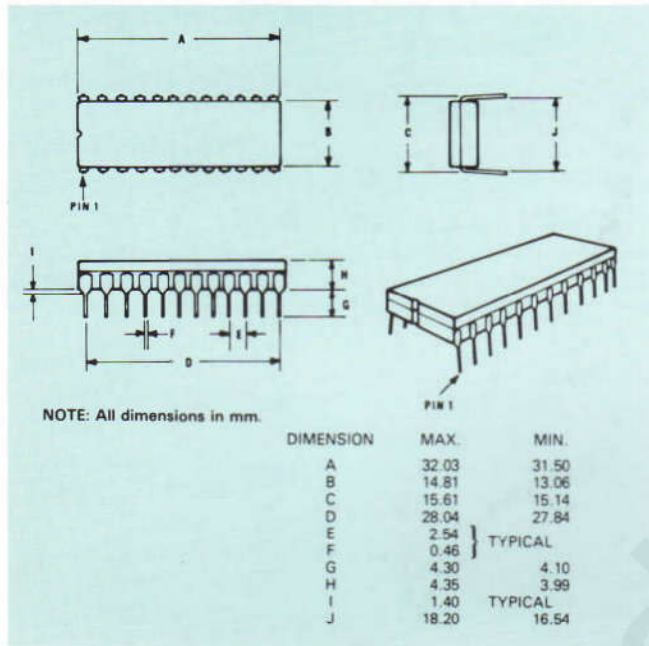


## Package Outline

The FX346J, the cerdip package is shown in Figure 4. The 'LG' version is shown in Figure 5 and the 'LS' version in Figure 6.

To allow complete identification, the 'LG' and 'LS' packages have an indent spot adjacent to pin 1 and a chamfered corner between pins 3 and 4. Pins number anti-clockwise when viewed from the top (indent side).

Fig.4 FX346J 24-pin DIL Package



## Handling Precautions

The FX346 is a CMOS LSI circuit which includes input protection. However precautions should be taken to prevent static discharges which may cause damage.

Fig.5 FX346LG 24-pin Package

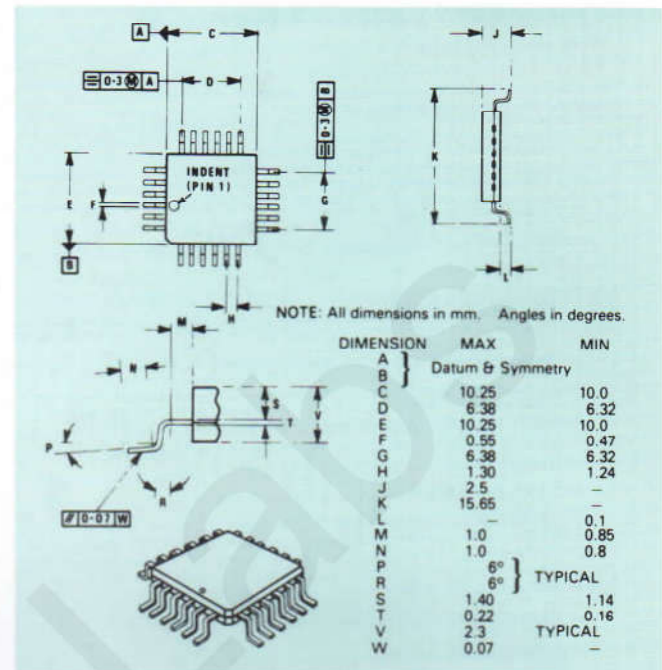
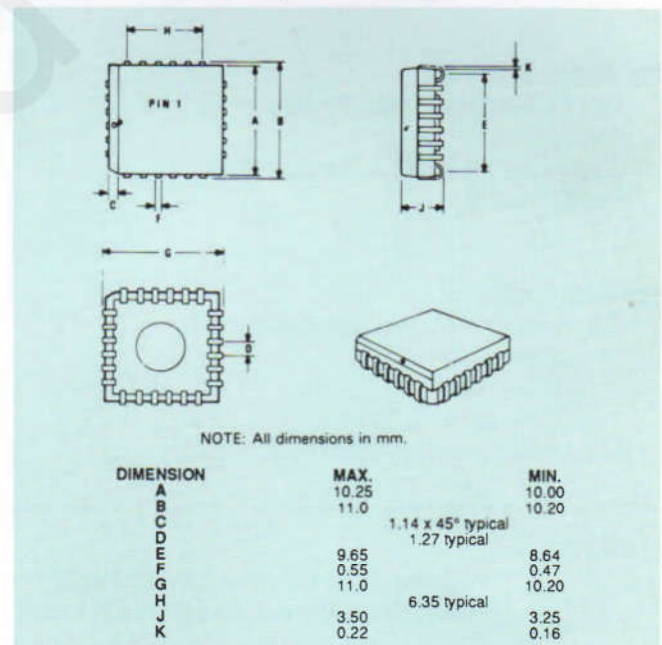


Fig.6 FX346LS 24-pin Package



## Ordering Information

FX346J	24-pin cerdip DIL
FX346LG	24-pin quad plastic encapsulated bent and cropped
FX346LS	24-lead plastic leaded chip carrier

CML does not assume any responsibility for the use of any circuitry described. No circuit patent licences are implied and CML reserves the right at any time without notice to change the said circuitry.



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