CML Semiconductor Products

PRODUCT INFORMATION

FX629 Delta Modulation Codec for Military Applications

CONSUMER MICROCIRCUITS

Publication D/629/1 December 1989
Provisional Issue

T-75-19

Features/Applications

- Designed to Meet Mil-Std-188-113
- Military Communications
- Delta MUX, Switch and Phone Applications
- Single-Chip Full-Duplex Codec
- On-Chip Input and Output Filters
- Programmable Sampling Clocks
- 3 or 4-bit Compand Algorithm
- Forced Idle Facility
- Powersave Facility
- Single 5V CMOS Process
- Full-Duplex CVSD* Codec

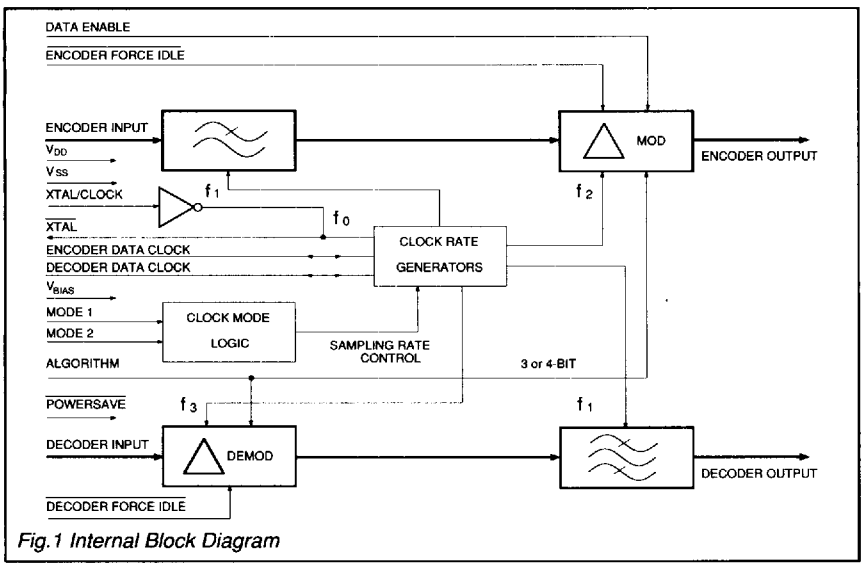

Fig.1 Internal Block Diagram

FX629

Brief Description

The FX629 is an LSI circuit designed as a *Continuously Variable Slope Delta Codec and is intended for use in military communications systems.

Designed to meet Mil-Std-188-113 with external components, the device is suitable for applications in military Delta Multiplexers, switches and phones.

Encoder input and decoder output filters are incorporated on-chip. Sampling clock rates can be programmed to 16, 32 or 64 k bits/second from an internal clock generator or may be externally applied in the range 8 to 64 k bits/second. Sampling clock frequencies are output for the synchronization of external circuits.

The encoder has an enable function for use in multiplexer applications.

Encoder and Decoder forced idle facilities are provided, forcing a 10101010..... pattern in encode and a $V_{DD}/2$ bias in decode.

The companding circuits may be operated with a pin-selected 3 or 4-bit algorithm.

The powersave facility puts the device into the standby mode thereby reducing current consumption when not operating.

A reference 1.024MHz oscillator uses an external clock pulse or Xtal input.

The FX629 is a low-power, 5 volt CMOS device and is available in 22-pin cerdip DIL and 28-lead ceramic leadless SMT packages.

Pin Number FX629J	Pin Number FX629M1	Function
1	1	**Xtal/Clock :** Input to the clock oscillator inverter. A 1.024MHz Xtal input or externally derived clock is injected here. See Clock Mode pins and Figure 3.
	2	No connection
2	3	**$\overline{\text{Xtal}}$:** Output of clock oscillator inverter. Xtal circuitry shown is in accordance with CML application note D/XT/1 April 1986.
3	4	No connection
4	5	**Encoder Data Clock :** A logic I/O port. External encode clock input or internal data clock output. Clock frequency is dependant upon clock mode 1, 2 inputs and Xtal frequency (see Clock Mode pins).
5	6	**Encoder Output :** The encoder digital output, this is a three state output whose condition is set by Data Enable and Powersave inputs as shown :
	7, 8	No connection
6	9	**$\overline{\text{Encoder Force Idle}}$:** When this pin is a logical '0' the encoder is forced to an idle state and the encoder digital output is 0101..., a perfect idle pattern. When this pin is a logical '1' the encoder encodes as normal. Internal 1MΩ Pullup.
7	10	**Data Enable :** Data is made available at the encoder output pin by control of this input. See Encoder Output pin. Internal 1MΩ Pullup.
8	11	No connection
9	12	**Bias :** Normally at V_{DD} /2 bias, this pin requires to be externally decoupled by a capacitor, C_4. Internally pulled to V_{SS} when "Powersave" is a logical '0'.
10	13	**Encoder Input :** The analogue signal input. Internally biased at V_{DD} /2, external components are required on this input. The source impedance should be less than 100Ω, output idle channel noise levels will improve with an even lower source impedance. See Fig. 3.
11	14	**V_{SS} :** Negative Supply.

Data Enable	$\overline{\text{Powersave}}$	Encoder Output
1	1	Enabled
0	1	High Z (o/c)
1	0	Vss

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Pin Number FX629J	Pin Number FX629M1	Function
12	15,16	No connection
13	17	**Decoder Output :** The recovered analogue signal is output at this pin, it is the buffered output of a bandpass filter and requires external components. During "Powersave" this output is o/c.
14	18,19	No connection
15	20	**$\overline{\text{Powersave}}$:** A logical '0' at this pin puts most parts of the codec into a quiescent non-operational state. When at a logical '1' the codec operates normally. Internal 1MΩ Pullup.
	21	No connection
16	22	**$\overline{\text{Decoder Force Idle}}$:** A logical '0' at this pin gates a 0101...pattern internally to the decoder so that the decoder output goes to $V_{DD}/2$. When this pin is at a logical '1' the decoder operates as normal. Internal 1MΩ Pullup.
17	23	**Decoder Input :** The received digital signal input. Internal 1MΩ Pullup.
18	24	**Decoder Data Clock :** A Logic I/O port. External decode clock input or internal data clock output, dependant upon clock mode 1, 2 inputs, see Clock Mode pins.
19	25	**Algorithm :** A logical '1' at this pin sets this device for a 3-bit companding algorithm. A logical '0' sets a 4-bit companding algorithm. Internal 1MΩ Pullup.
20	26	**Clock Mode 2 :**
21	27	**Clock Mode 1 :** Internal 1MΩ Pullups.

Clock Mode 1	Clock Mode 2	Facility
0	0	External clocks
0	1	Internal, 64kb/s = f ÷ 16
1	0	Internal, 32kb/s = f ÷ 32
1	1	Internal, 16kb/s = f ÷ 64

Clock rates refer to f = 1.024 MHz Xtal/clock input. During internal operation the data clock frequencies are available at the ports for external circuit synchronization.
Independent or common data rate inputs to Encode and Decode data clock ports may be employed in the External Clocks mode. Optimum performance will be achieved when the applied external clocks are synchronous with the master Xtal/clock, and a sub-multiple of 128kHz.

22	28	**V_{DD} :** Positive Supply. A single + 5 volt power supply is required.

Codec Integration

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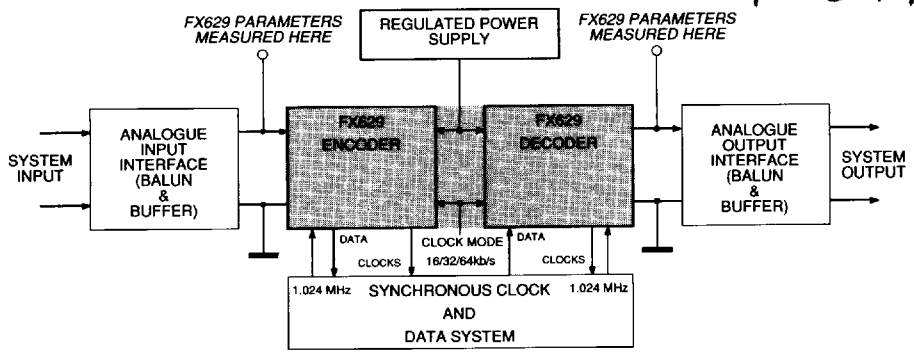

Fig.2 System Configuration Diagram – showing the FX629, which with the indicated interfacing, will conform to the Mil-Std-188-113 Specification

Component	Unit Value	**Note** – with reference to Figure 3 (below)
R_1	1M	Oscillator Inverter bias resistor.
R_2	Selectable	Xtal Drive limiting resistor.
C_1	33p	Xtal Circuit drain capacitor.
C_2	33p	Xtal Circuit gate capacitor.
C_3	1.0µ	Encoder Input coupling capacitor – The drive source impedance to this input should be less than 100Ω. Output Idle channel noise levels will improve with an even lower source impedance.
C_4	1.0µ	Bias decoupling capacitor.
C_5	1.0µ	V_{DD} decoupling capacitor.
X_1	1.024 MHz	A 1.024 MHz Xtal/clock input will yield exactly 16/32/64 kb/s data clock rates. Xtal circuitry shown is in accordance with CML application note D/XT/1 April 1986.

Tolerance :– Resistors ± 10% Capacitors ± 20%

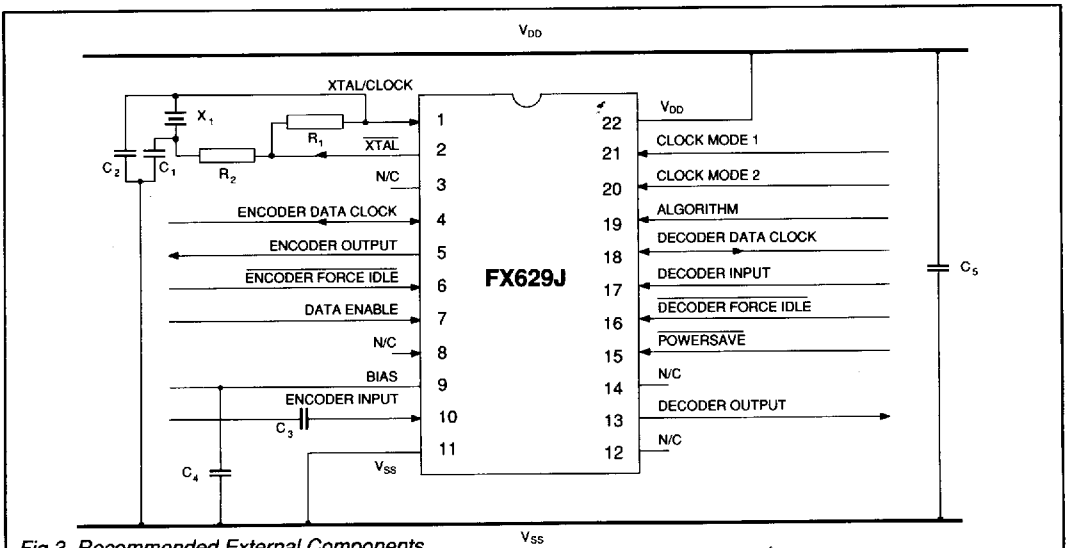

Fig.3 Recommended External Components

Codec Timing Information

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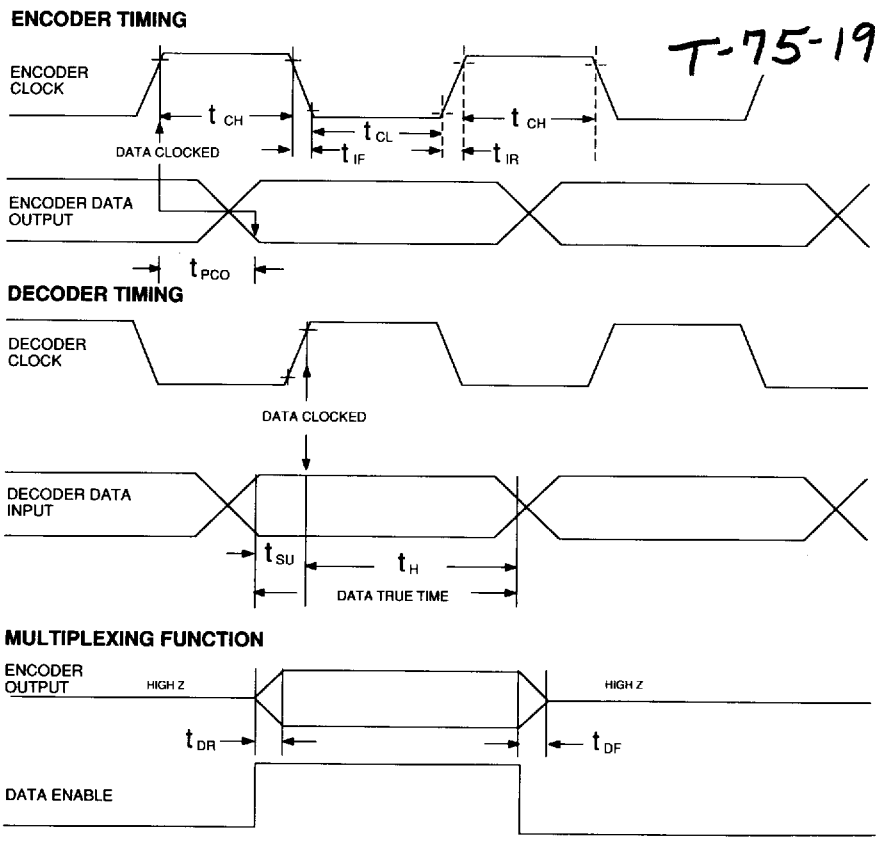

TIMING

t_{CH} **Clock '1' Pulse Width** 1.0µs Min.	t_{IR} **Clock Rise Time** 100ns Typ.	t_{SU} **Data Set-up Time** 450ns Min.	$t_{SU} + t_H$ **= Data True Time**
t_{CL} **Clock '0' Pulse Width** 1.0µs Min.	t_{IF} **Clock Fall Time** 100ns Typ.	t_H **Data Hold Time** 600ns Min.	t_{PCO} **Clock to Output Delay Time** 750ns Max.
	t_{DR} **Data Rise Time** 100ns Typ.	t_{DF} **Data Fall Time** 100ns Typ.	**Xtal Input Frequency** 1.024MHz.

Fig.4 Codec Timing Diagrams

Digital to Analogue Performance ..... Using the bit sequence tests shown in Table 1 (below) at the Decoder Input pin, the analogue signals measured at the Decoder Output pin are 800Hz ± 10Hz at the levels described.

Sample Rate	Bit Sequence at Decoder Input	"Run of Threes" (%)	Output Level (dBm0)
16kbit/s	1101101101001001O	0	-29.2 ± 2
32kbit/s	1101101101010100100100100100101010110110	0	-30.0 ± 2
16kbit/s	1111101101000001O	30	0 ± 1
32kbits	1111110110101010000100000010010101011110	30	0 ± 1

Table 1 Bit Sequence Tests and Results at 800Hz

Typical Codec Performance ..... relative to the Mil-Std-188-113 Specification

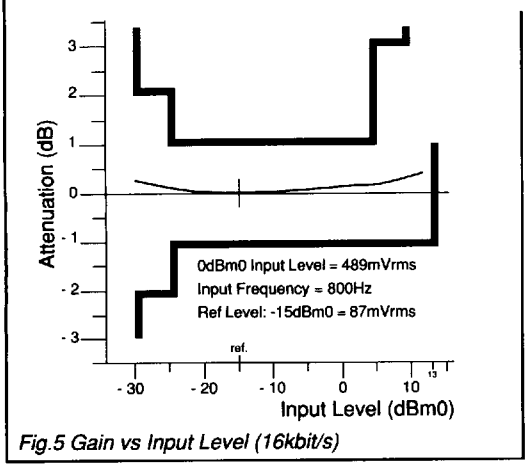

Fig.5 Gain vs Input Level (16kbit/s)

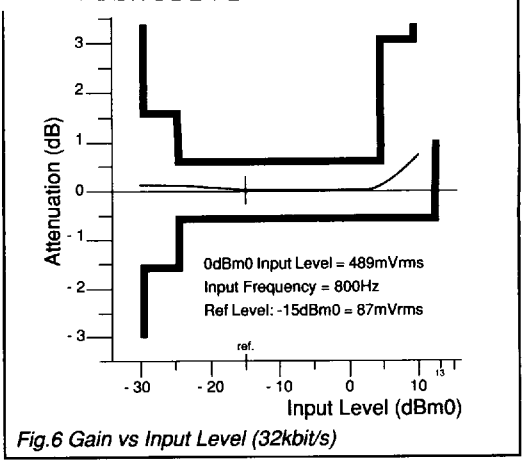

Fig.6 Gain vs Input Level (32kbit/s)

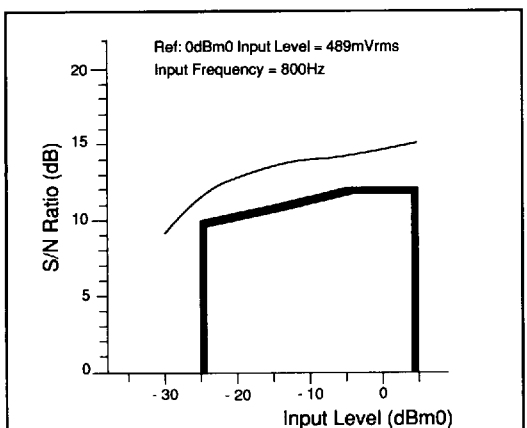

Fig.7 S/N vs Input Level (16kbit/s)

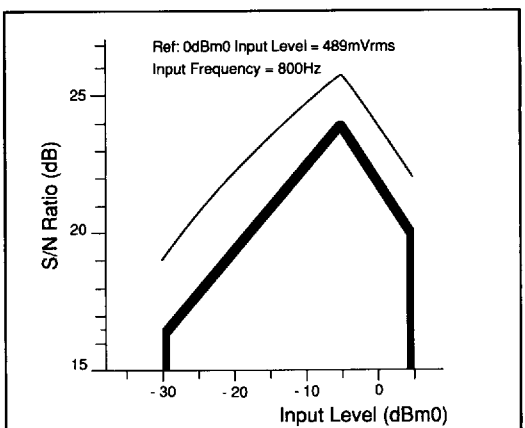

Fig.8 S/N vs Input Level (32kbit/s)

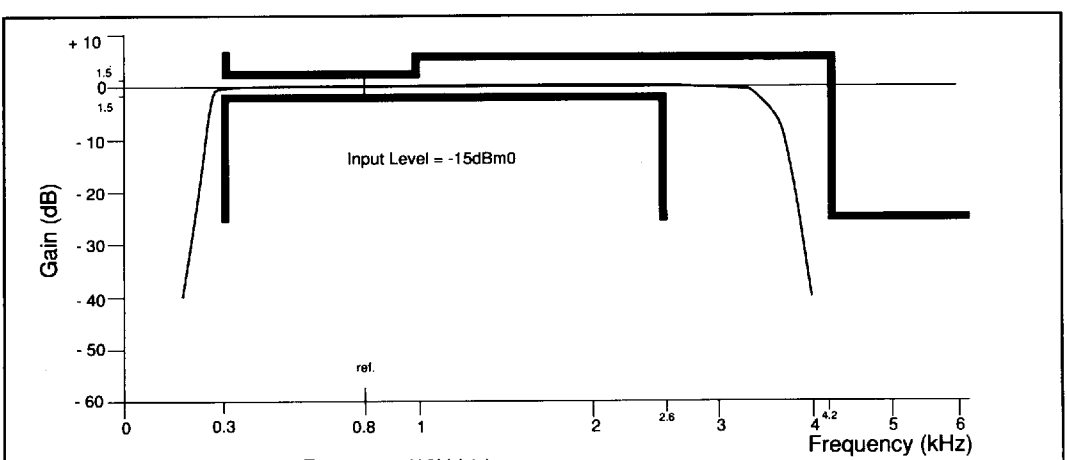

Fig.9 Attenuation Distortion vs Frequency (16kbit/s)

Typical Codec Performance ..... relative to the Mil-Std-188-113 Specification

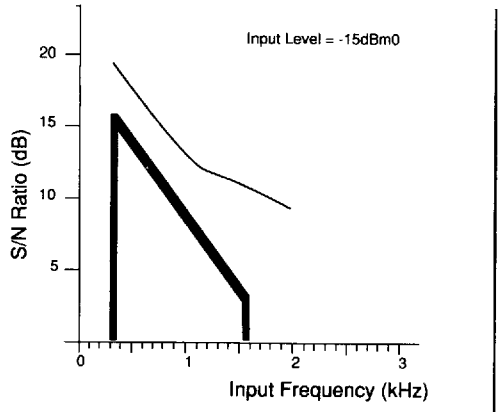

Fig.10 S/N vs Input Frequency (16kbit/s)

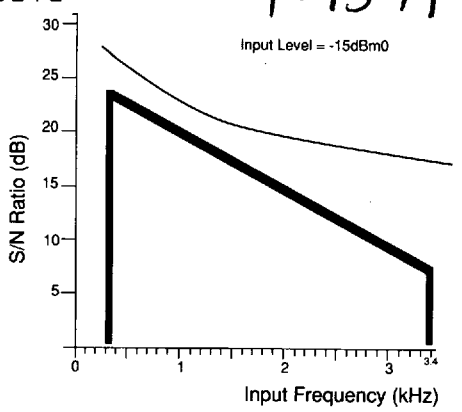

Fig.11 S/N vs Input Frequency (32kbit/s)

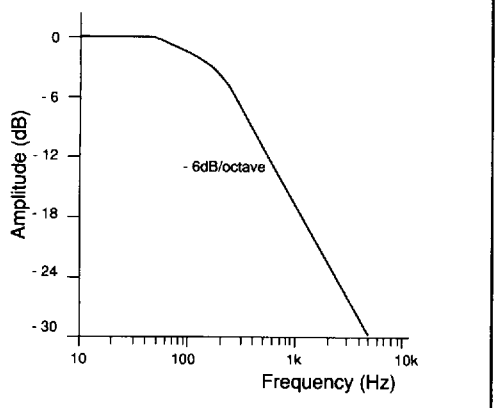

Fig.12 Principal Integrator Response

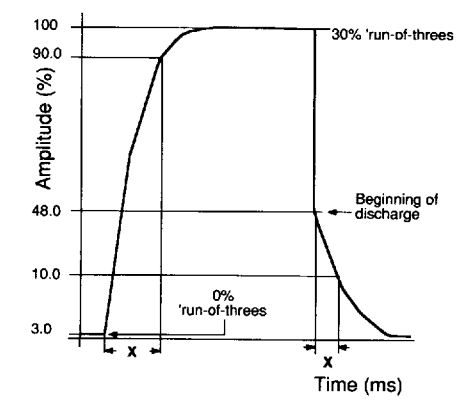

Fig.13 Compand Envelope

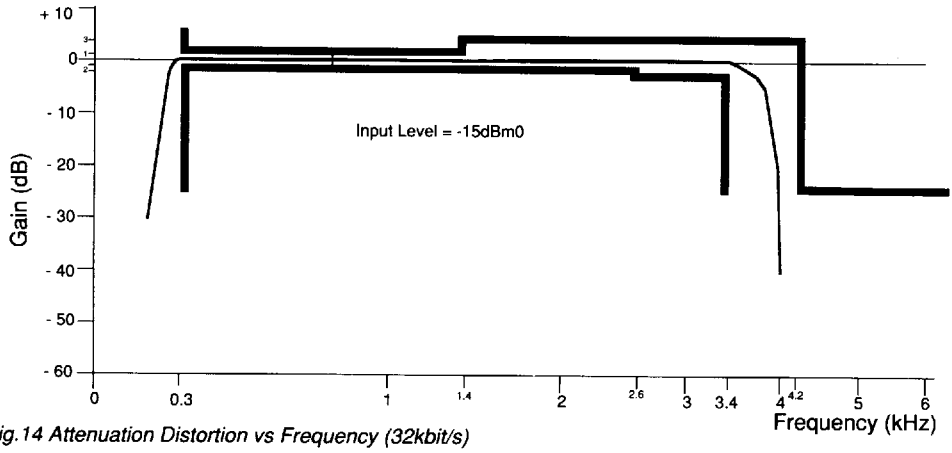

Fig.14 Attenuation Distortion vs Frequency (32kbit/s)

Specifications

Absolute Maximum Ratings

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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)
Source/sink current (supply pins)		± 30mA
(other pins)		± 20mA
Total device dissipation @ 25°C		800mW Max.
Derating		10mW/°C
Operating temperature range:	**FX629J**	-40°C to +85°C (cerdip)
	FX629M1	-40°C to +85°C (cerquad)
Storage temperature range:	**FX629J**	-55°C to +125°C (cerdip)
	FX629M1	-55°C to +125°C (cerquad)

Operating Limits

All characteristics are measured using the following parameters unless otherwise specified:
V_{DD} = 5.0V, T_{AMB} = 25°C, Xtal/Clock f_o = 1.024MHz, Audio Level 0dB ref (0dBm0) = 489 mV rms.
Audio Test Frequency = 800 Hz. Sample Clock Rate = 32kb/s. Compand Algorithm = 3-bit.

Characteristics	See Note	Min.	Typ.	Max.	Unit
Static Values					
Supply Voltage	1	4.5	5.0	5.5	V
Supply Current (Enabled)		–	5.5	–	mA
Supply Current (Powersave)		–	0.4	–	mA
Inputs Logic '1'	8	3.5	–	–	V
Inputs Logic '0'	8	–	–	1.5	V
Outputs Logic '1'	8	4.0	–	–	V
Outputs Logic '0'	8	–	–	1.0	V
Digital Input Impedance (Logic I/O pins)		1.0	10.0	–	MΩ
Digital Input Impedance (Logic input pins, pullup resistor)	2	300	–	–	kΩ
Digital Output Impedance		–	–	4	kΩ
Analogue Input Impedance	4	–	1.0	–	kΩ
Analogue Output Impedance	7	–	–	800	Ω
Three State Output Leakage Current (output disabled)		-4.0	–	+4.0	µA
Insertion Loss	3	-2.0	–	+2.0	dB
Dynamic Values	1,9				
Encoder:					
Analogue Signal Input Levels	5,9	-35.0	–	+12.0	dBm0
Principle Integrator Frequency		127	159	212	Hz
Encoder Passband			3400		Hz
Compand Time Constant		4.0	5.0	6.0	ms
Decoder:					
Analogue Signal Output Levels	5,9	-35.0	–	+12.0	dBm0
Decoder Passband		300	–	3400	Hz
Encoder Decoder (Full codec):					
Compression Ratio (Cd = 0.3 to Cd = 0.0)		–	16:1	–	
Passband		300	–	3400	Hz
Stopband		4.2	–	–	kHz
Stopband Attenuation (4200Hz to 6000Hz)		25.0	–	–	dB
(> 6kHz)		–	60.0	–	dB
Passband Gain		–	0	–	dB
Passband Ripple (300Hz –1400Hz)		-1.0	–	+1.0	dB
(1400Hz – 2600Hz)		-1.0	–	+3.0	dB
(2600Hz – 3400Hz)		-2.0	–	+3.0	dB
Output Noise (Input short circuit)	9	–	-55.0	–	dBm0
Perfect Idle Channel Noise (Encoder forced)	9	–	-57.0	–	dBm0
Group Delay Distortion	6				
(1000Hz to 2600Hz)		–	–	450	µs
(600Hz to 2800Hz)		–	–	750	µs
(500Hz to 3000Hz)		–	–	1.5	ms
Xtal/Clock Frequency		–	1024	–	kHz

Specifications .....

Process Information

The following Table gives details of the process and test controls employed in the manufacture of the FX629 'Mil Std' Delta Codec.

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Function	Reference	Remarks
Hermeticity		
Fine Leak Test –	Mil Std 883C	using Method 1014 – test condition A1.
Coarse Leak Test –	Mil Std 883C	using Method 1014 – test condition C.
Burnin	Mil Std 883C	using Method 1015 – test condition E. 168 Hours @ 85°C with 5v power, and clocks applied.
Temperature Cycling	Mil Std 883C	using Method 1010 – test condition B. 10 cycles -55°C to +125°C.
The following mechanical assembly tests are Qualified to BS9450		
Vibration	BS9450	Section 1.2.6.8.1 55Hz to 500Hz at 98 m/sec acceleration.
Shock	BS9450	Section 1.2.6.6 981 m/sec for 6 msec.
Low Pressure	BS9450	Section 1.2.6.12
Transport and Storage –		225mmHg (altitude 9000m).
Operation –		600mmHg (altitude 2400m).
Humidity	BS9450	Section 1.2.6.4 96 Hours @ 45°C, 95% relative humidity plus condensed water.

Notes:
1. Dynamic characteristics are specified at 5V unless otherwise specified.
2. All logic inputs except, Encoder and Decoder Data Clocks.
3. For an Encoder/Decoder combination, insertion loss contributed by a single component is half this figure.
4. Driven with a source impedance of <100Ω.
5. Recommended values – See Figures 5, 6, 7 and 8.
6. Group Delay Distortion for the full codec is relative to the delay with 820Hz, -20dB at the encoder input.
7. An Emitter Follower output stage.
8. 4.0V = 80% V_{DD}, 3.5V = 70% V_{DD}, 1.5V = 30% V_{DD}, 1.0V = 20% V_{DD}.
9. Analogue Voltage Levels used in this Data Sheet: 0dBm0 = 489mVrms = - 4dBm = 0dB. -15dBm0 = 87mVrms. - 20dBm0 = 49mVrms = - 24dBm.

Application Recommendations

Due to the very low levels of signal and idle channel noise required in Military applications – a noisy or badly regulated power supply could cause instability putting the overall system performance out of specification. Adherence to the points noted below will assist in minimizing this problem.

(a) Care should be taken on the design and layout of the printed circuit board.

(b) All external components (as recommended in Figure 3) should be kept close to the package.

(c) Tracks should be kept short, particularly the Encoder Input capacitor and the V_{BIAS} capacitor.

(d) Xtal/clock tracks should be kept well away from analogue inputs and outputs.

(e) Inputs and outputs should be screened wherever possible.

(f) A "ground plane" connected to V_{SS} will assist in eliminating external pick-up on the input and output pins.

(g) It is recommended that the power supply rails have less than 1mVrms of noise allowed.

(h) The source impedance to the Encoder Input pin must be less than 100Ω, Output Idle channel noise levels will improve with even lower source impedances.

Package Outline

The FX629J cerdip package is shown in Figure 15 with the FX629M1 ceramic package shown in Figure 16 .
To ensure correct pin identification, the FX629M1 package has a relieved corner between pins 4 and 5. Pins number anti-clockwise when viewed from the top.

Handling Precautions

The FX629 is a CMOS LSI circuit which includes input protection. However precautions should be taken to prevent static discharges which may cause damage.

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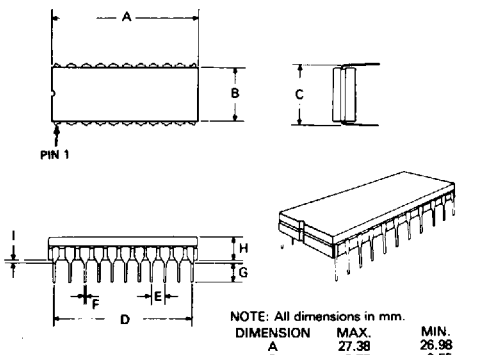
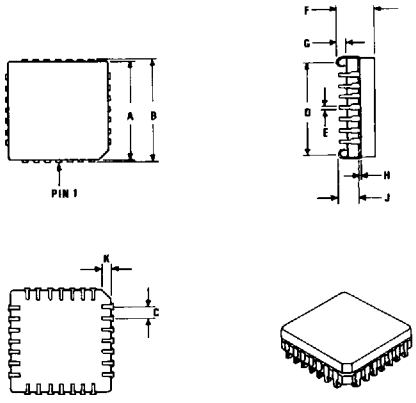
Fig.15 ***FX629J DIL Package***



NOTE: All dimensions in mm.

DIMENSION	MAX.	MIN.
A	27.38	26.98
B	9.75	9.55
C	10.60	10.40
D	25.50	25.30
E	2.54	TYPICAL DIMENSION
F	0.46	
G	4.35	
H	4.27	3.99
I	—	0.5

Fig.16 ***FX629M1 CLCC Package***



NOTE: All dimensions in mm. Angles in degrees

DIMENSION	MAX.	MIN.
A	11.60	11.35
B	12.15	12.05
C	1.27 TYPICAL	
D	10.82	10.03
E	8.46 TYPICAL	
F	4.38	4.20
G	1.15	1.05
H	0.58 TYPICAL	
J	2.75	2.60
K	45° TYPICAL	

Ordering Information

FX629J 22-pin cerdip DIL

FX629M1 28-lead ceramic, leaded chip carrier (CLCC)

Integrated Circuits Data Book

T-90-20

Section 11

CONSUMER MICROCIRCUITS

Packaging and Applications

CML Packaging

For ease and convenience CML products are packaged for despatch in industry standard bulk or individual packaging as described below.

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- Trays (17cm x 10.5cm) and cardboard boxes with conductive foam.
- 50-pocket conductive trays for surface-mount microcircuits.
- Anti-static coated tubes, of various sizes, with thumbplugs.
- 13-inch reel Tape-and-Reel packaging which fully conforms to the latest EIC specification. The conductive embossed tape provides a secure cavity sealed with a peel-back cover tape. 500 units/reel – no partial reel counts are available.

CML Tape and Reel Specification

1. Scope

The specification relates to the tape packaging of integrated circuits suitable for use in "surface mount" assembly. It includes only those dimensions which are essential for the purchaser to use the product.

2. Dimensions (Refer to Figures 1a, 1b and 1c)

2.1	**Tape width**		W = 24 + 0.3mm
2.2	**Carrier Tape Thickness**		t = 0.3mm Max.
2.3	**Pitch of Sprocket Holes**		Po = 4.0 + 0.1mm
2.4	**Diameter of Sprocket Holes**		D = 1.5 + 0.1mm 1.5 - 0.00mm
2.5	**Distance**		E = 1.75 + 0.1mm
2.6	**Distance, centre to centre**		F = 11.5 + 0.1mm
2.7	**Dimension, centre to centre**		
2.7.1	LG		P2 = 10 + 0.1mm
2.7.2	LH		P2 = 6 + 0.1mm
2.7.3	LS		P2 = 6 + 0.1mm
2.8	**Embossed Pocket Dimension Ao and Bo**		
2.8.1	LG		Ao = 15.8 + 0.1mm
2.8.2	LG		Bo = 15.8 + 0.1mm
2.8.3	LH		Ao = 13.1 + 0.1mm
2.8.4	LH		Bo = 13.1 + 0.1mm
2.8.5	LS		Ao = 11.7 + 0.1mm
2.8.6	LS		Bo = 11.7 + 0.1mm
2.9	**Embossed Tape Dimension Ko**		
2.9.1		LG	Ko = 2.8 + 0.1mm
2.9.2		LH	Ko = 4.9 + 0.1mm
2.9.3		LS	Ko = 4.3 + 0.1mm
2.10	**Pitch of Component Compartments**		
2.10.1		LG	P = 20 + 0.1mm
2.10.2		LH	P = 16 + 0.1mm
2.10.3		LS	P = 16 + 0.1mm
2.11	**Outside Dimension of Pocket**		
2.11.1		LG	B1 = 16.4 + 0.1mm
2.11.2		LH	B1 = 13.8 + 0.1mm
2.11.3		LS	B1 = 12.3 + 0.1mm
2.12	**Pocket Centre Holes**		
2.12.1		LG	D1 = 2.0mm Min.
2.12.2		LH	D1 = 2.0mm Min.
2.12.3		LS	D1 = 2.0mm Min.

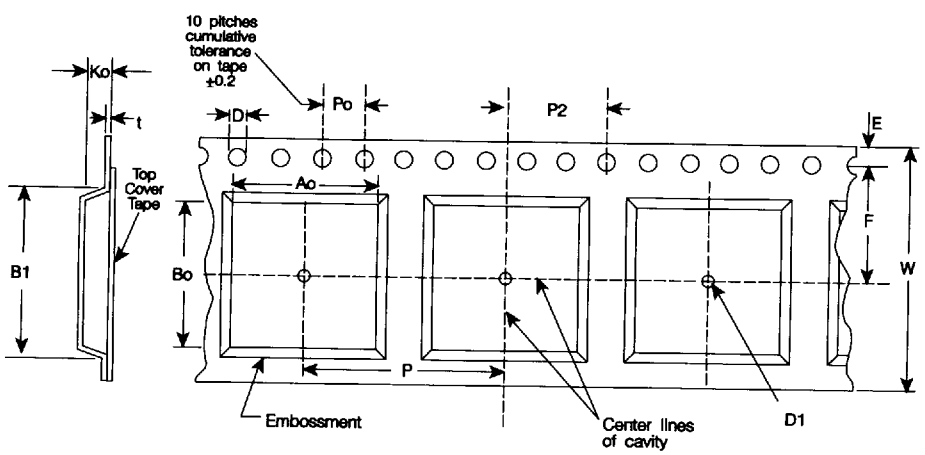

Fig.1a

CML Packaging .....

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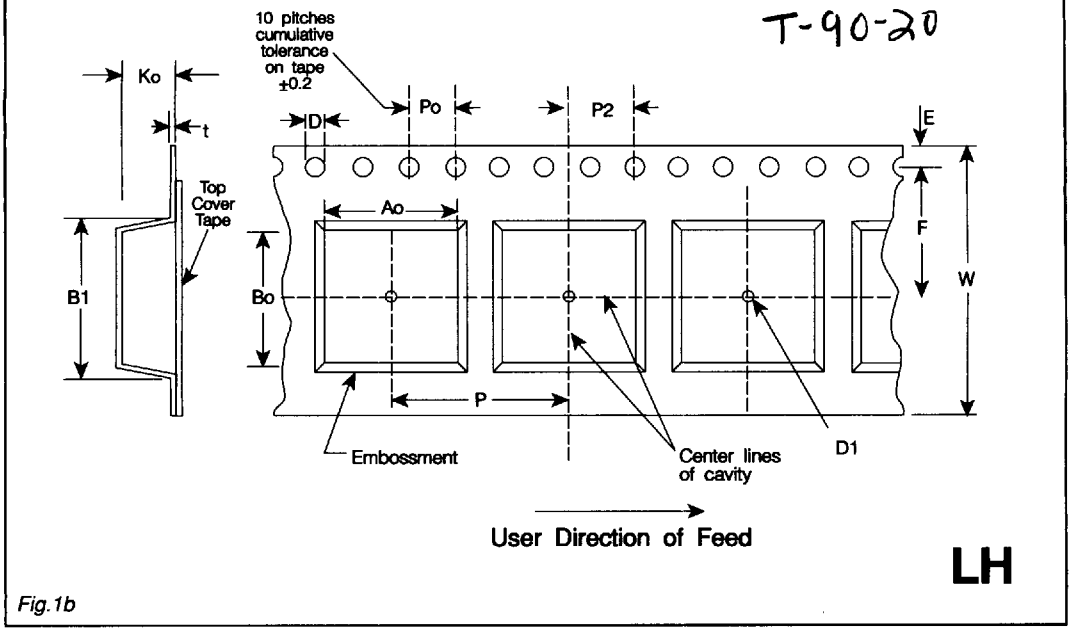

Fig.1b

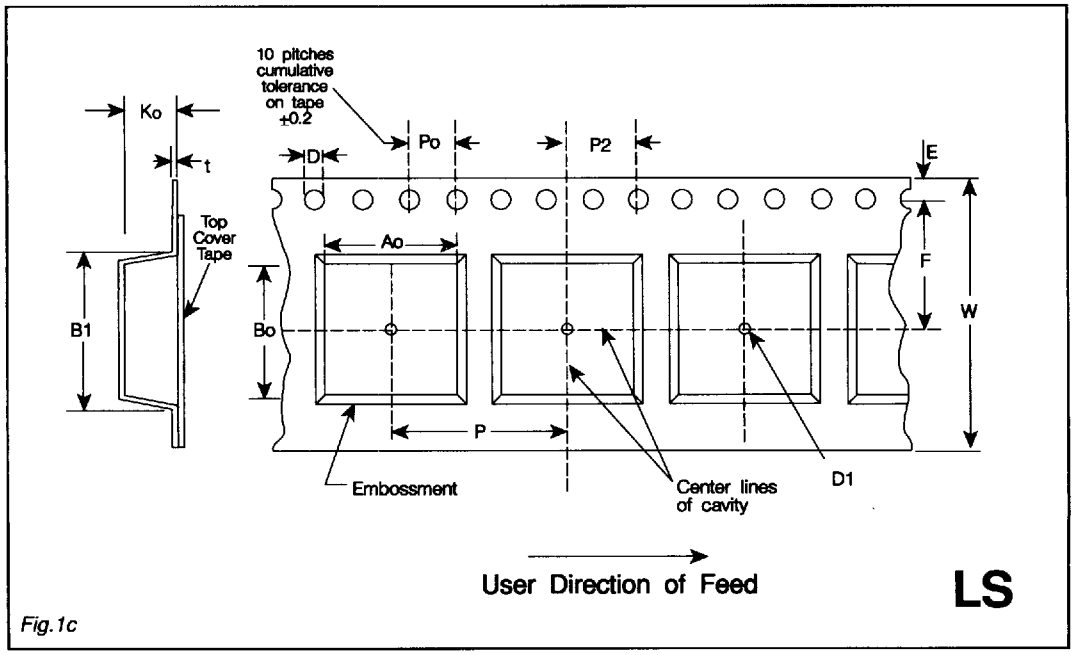

Fig.1c

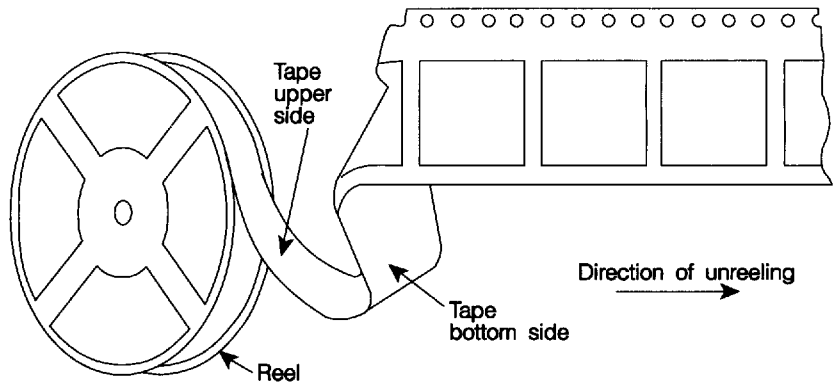

Fig.2 Tape Top and Bottom Orientation

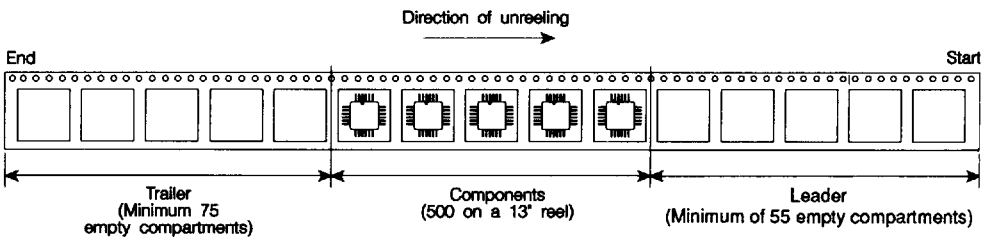

Fig.3 Layout of Tape

3. Materials

3.1 Carrier tape to be made of a conductive grade of polystyrene.

3.2 Conductive polycarbonate is also an approved carrier tape material and may be used under certain circumstances.

3.3 Cover tape is an anti-static grade of polypropylene/polyester film with a strip of pressure sensitive adhesive approximately 1mm wide along each edge.

4. Polarity and Orientation of Components in Tape

4.1 All components will be placed such that Pin 1 is adjacent to the sprocket holes (See Figures 6a and 6b).

4.2 The mounting side of the component shall be oriented to the bottom side of the tape (See Figure 2).

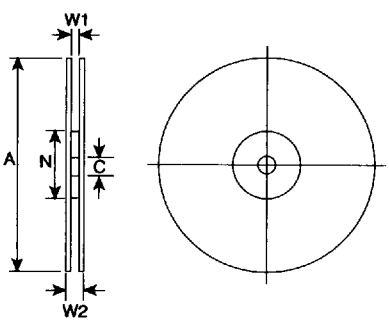

Fig.4 Reel Dimensions

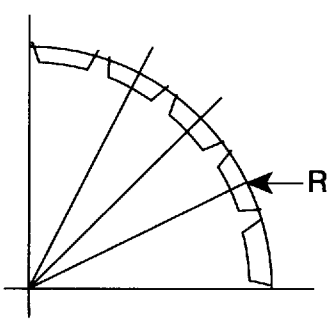

Fig.5 Minimum Radius = 30mm

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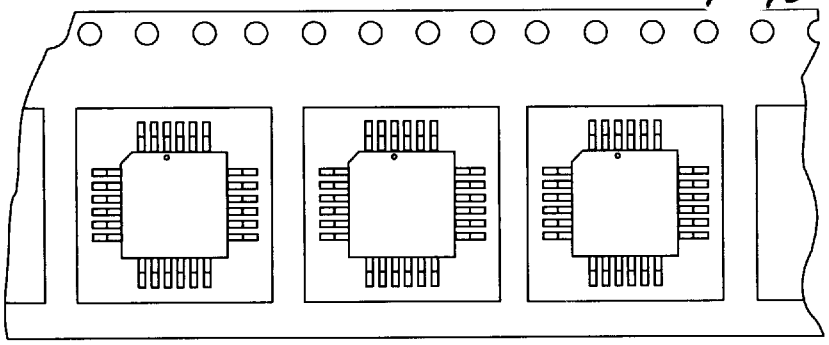
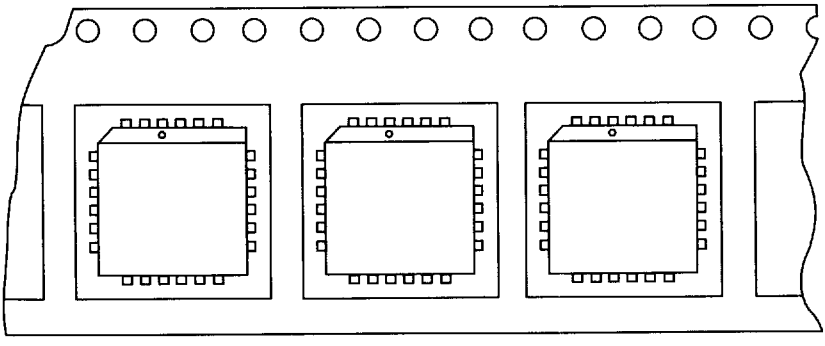
Fig.6a



User direction of feed

Fig.6b



User direction of feed

Fig.6 Component Orientation

5. Fixing of Components in Tape

5.1 Cover tapes shall not cover the sprocket holes.

5.2 Tapes in adjacent layers shall not stick together in the packing.

5.3 The adhesive of the cover tape shall not adversely effect the mechanical and electrical characteristics and marking of the components.

5.4 Components shall not stick to the carrier tape or the cover tape.

5.5 The tapes shall be suitable to withstand storage of the taped components without danger or migration of the terminations or the giving off of vapours which would impair soldering or deteriorate the component properties or termination by chemical action.

5.6 When the tape is bent with a minimum radius (See Figure 5) of 30mm, the tape shall not be damaged and the components shall remain in their position and orientation in the tape.

5.7 The peel strength of the cover tape shall be 50 ±25 grams measured at 175° - 180° with respect to the carrier tape along its longitudinal axis. The peel speed shall be 240mm/min.

5.8 After baking at 60°C for 48 hours or storage in ideal conditions for three months, the peel strength shall remain within the specified limits.

CML Packaging .....

CONSUMER MICROCIRCUITS

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6. Packaging

6.1 Tape will be wound on anti-static plastic reels (See Figure 4)

Dimensions

6.1.1	A	C	N	W1	W2
	Reel Dia.	Centre Hole	Hub Outer Dia.	Inside Cheek Width	Outside Cheek Width
	330mm	12.7mm	62.5mm	24.5mm	28.8mm

6.2 There will be a leader of a minimum of 55 empty compartments, at the start of the carrier tape (See Figure 3).

6.3 There will be no missing components between the first and last part of working tape in any reel.

6.4 At the end of the tape there will be a trailer of a minimum of 75 empty compartments (See Figure 3).

6.5 The tape shall release from the reel hub as the last portion of the carrier tape unwinds from the reel.

6.6 Components on a reel.

6.6.1 LG = 500
6.6.2 LH = 500
6.6.3 LS = 500

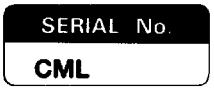
6.7 The tape will be prevented from unreeling by winding a paper tape around the reel and fixing with adhesive tape.

6.8 All reels will display:

1. Device Type
2. Quantity on reel
3. Date code
4. A static hazard warning label
5. CML Serial Number

6.9 Reel packed into anti-static bubble bag then in a cardboard box, with appropriate labelling as in paragraph 6.8.

6.10 Ideal storage conditions are 15°C to 20°C with a relative humidity of 60% - 70%.



Handling Precautions

CML microcircuits are CMOS LSI devices which include input protection. However precautions should be taken, at all times, to prevent static discharges which may cause device damage.

- It is recommended that the user initially stores and transports the microcircuit in the original supplied packaging.
- At all times observe anti-static precautions including the correct use of a conductive wrist-band and cord.
- Keep benches, personnel and test equipment at the same electrical potential.
- Ensure that the microcircuit is stored and operated well away from any potential source of static discharge.
- Do not insert or remove a microcircuit from an application whilst any power remains applied.
- Whenever possible ensure that the microcircuit is inserted after all other components have been mounted.
- Do not apply signals to a microcircuit until the power supply is suitably established.