CML Semiconductor Products
PRODUCT INFORMATION

FX105 Tone Detector

T-75-27-05

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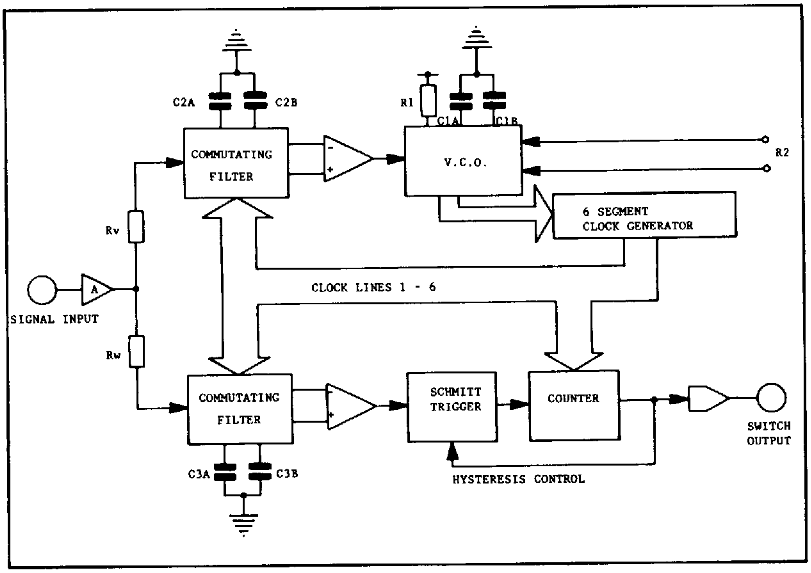
Publication D/105/3/12/0

CONSUMER MICROCIRCUITS

FUNCTIONAL SCHEMATIC FX-105



FX105
TONE DETECTOR

FEATURES

- OPERATES IN HIGH NOISE CONDITIONS
- ⩾40dB SIGNAL INPUT RANGE
- SIMULTANEOUS TONE DETECTION
- ADJUSTABLE BANDWIDTH
- HERMETICALLY SEALED CERAMIC PACKAGE
- WIDE FREQUENCY RANGE

DESCRIPTION

The FX-105 is a monolithic tone operated switch, designed for tone decoding in single and multitone signalling systems.

The device employs decoding techniques which allow tones to be recognised in the presence of high noise levels or strong adjacent channel tones.

Tone channel centre frequency and channel bandwidth can each be adjusted independently. The circuit has a high noise immunity against harmonic and sub-harmonic responses and is able to maintain a constant bandwidth and high noise immunity over a wide range of input signal levels.

V.C.O. SAMPLING WAVEFORMS FIG. 2 T-75-27-05

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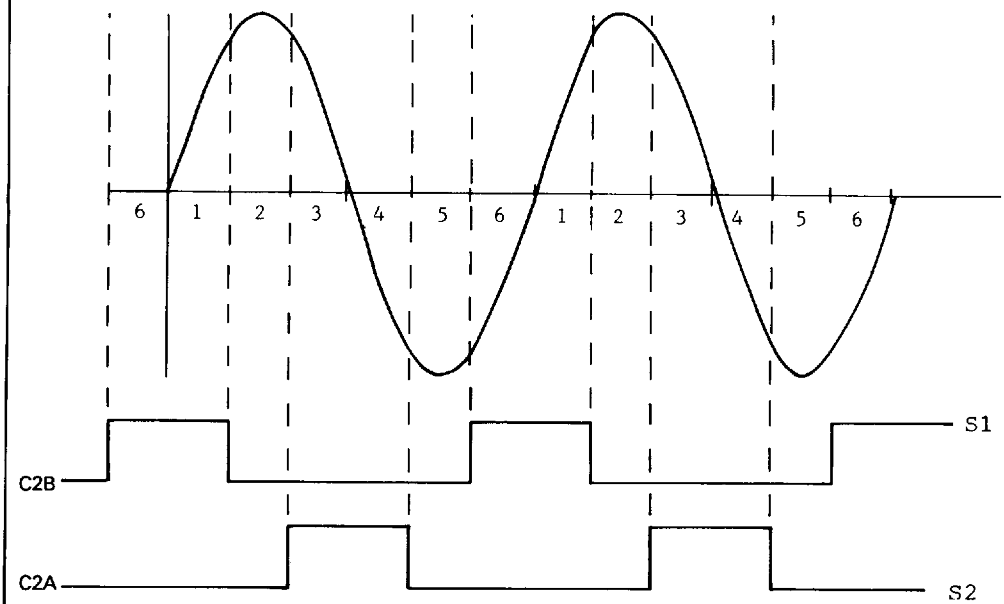


METHOD OF OPERATION

Input signals are A.C. coupled to the buffer input, which is internally biased at 50% of supply voltage, the signal appears at the output of the buffer as an A.C. voltage superimposed on the D.C. bias level. The signal is then coupled via RV and RW to the voltage controlled oscillator and word sampling switches, which sequentially connect C2 and C3 into circuit to form four sample and hold RC integrators.

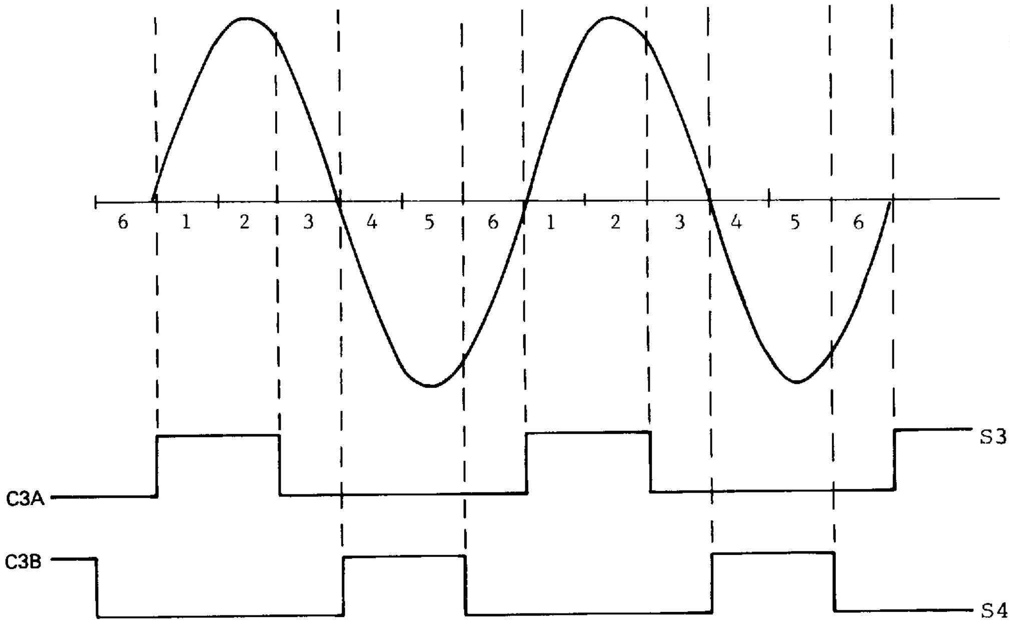
With no input signal, each capacitor charges to the D.C. bias level and differential voltages are zero. When an input signal is applied, each capacitor receives an additional charge according to the integrated average of the signal waveform during the interval the capacitor is switched into circuit.

Figure 2 above shows the operating sequence of the V.C.O. sampling switches and their phase relationship to a locked on inband signal. As can be seen from Figure 2 C2A and C2B should not receive any additional charge as they always sample the input as it crosses the D.C. bias level. Should the signal not be locked to the V.C.O. then a positive or negative charge voltage will appear on C2A or C2B, this voltage when differentially amplified is applied to the V.C.O. as an error correcting signal to enable the V.C.O. to achieve lock.

Figure 3 shows the operating sequence of the 'Word' sampling switches and their relationship to a locked on inband signal. As can be seen from Figure 3 the charge being applied to C3A should always be positive and the charge applied to C3B should always be negative with respect to the common bias level.

These capacitor potentials are differentially amplified and applied to a D.C. comparator, which switches at a predetermined threshold voltage. The comparator output is a logic signal used to control a counter which switches the FX-105 output ON when the comparator output is maintained in the 'Word Present' state for a minimum number of consecutive signal samples. The output switch reduces the comparator threshold by 50% when turned on, thereby introducing threshold hysterises which minimises output chatter with marginal input signal amplitudes.

WORD SAMPLING WAVEFORMS FIG. 3



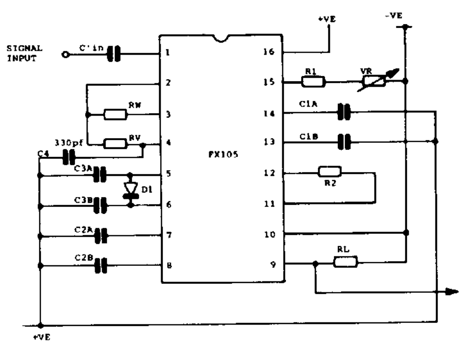
METHOD FOR CALCULATING EXTERNAL COMPONENT VALUES

The external components shown below in Figure 4 are used to adjust the various performance parameters of the FX-105. The signal to noise performance, turn on delay and signal bandwidth are all interrelated factors which should be optimised to meet the requirements of the application.

By selecting component values in accordance with the following graphs nominally optimum circuit performance is obtained for any given application.

FIG. 4

FX105 EXTERNAL COMPONENT CONNECTIONS



The user should first define the following application parameters.

A. The centre frequency to be detected (f'o).

B. The FX-105 Minimum Usable Bandwidth (MUBW). This is obtained by taking into account the worst case tolerances on the input tone frequency and variations in the FX-105 f'o due to supply voltage (0.07%/%) and ambient temperature (0.02%/°C) changes.

C. The maximum permissible FX-105 response time.

D. The minimum input signal amplitude.

Using this information the appropriate component values can be calculated, and the signal to noise performance obtained may then be read from a chart.

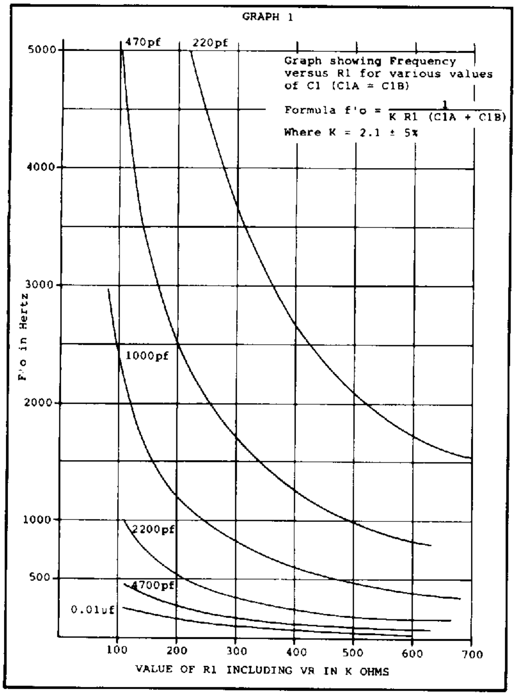
Using the graphs overleaf the following worked example may be used to calculate component values for any given application.

A. FX-105 centre band frequency (f'o) = 2800Hz.

B. FX-105 bandwidth = 6%.

C. FX-105 maximum response time = 50ms.

D. Minimum input signal amplitude = 200mVolts R.M.S.



R1 C1A C1B

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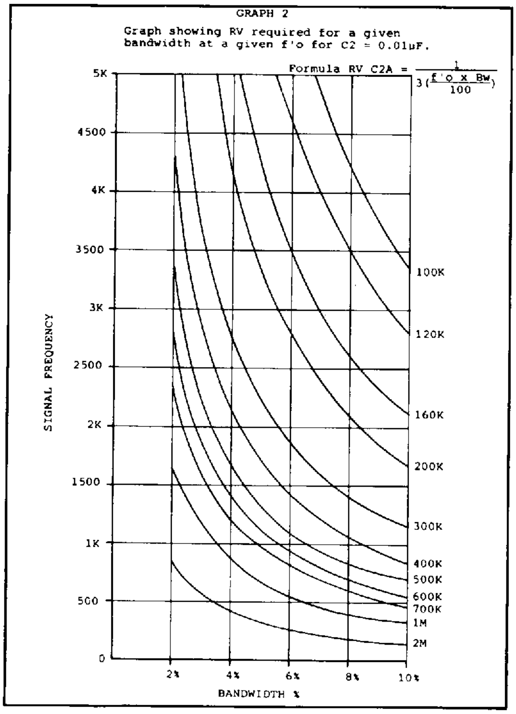
These components set the free running frequency of the V.C.O. and thereby the centre band frequency of the FX-105.

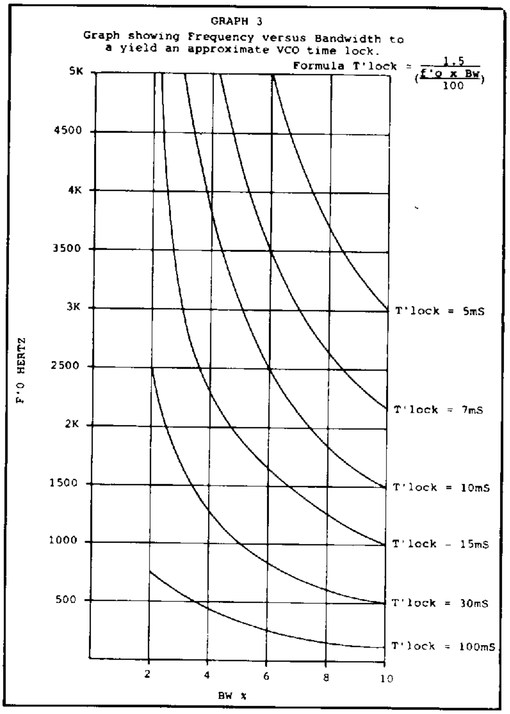
By using graph number 1 the frequency 2800Hz can be seen to correspond to a value of capacitor of 220 picofarads and a resistor value of 385k ohms, this resistance can be achieved with a 300k ohm fixed resistor for R1 and a 100k ohm potentiometer.

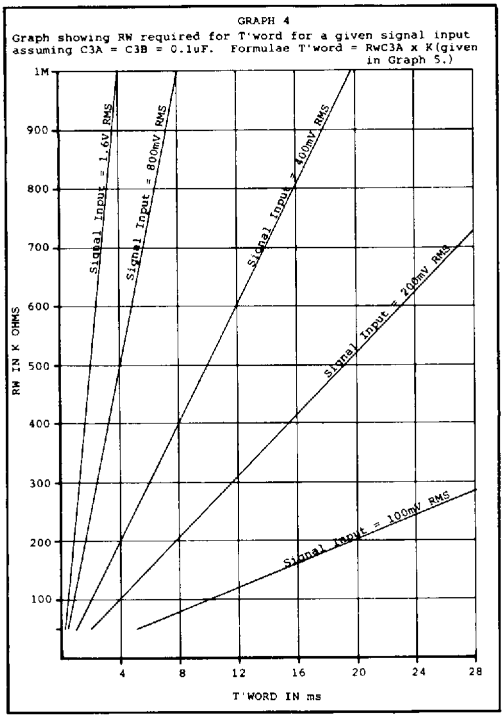
Graph number 2 shows that for a frequency of 2800Hz and a bandwidth of 6% a resistor RV of 200k ohms and a capacitance for C2A and C2B of 0.01 microfarads will be required.

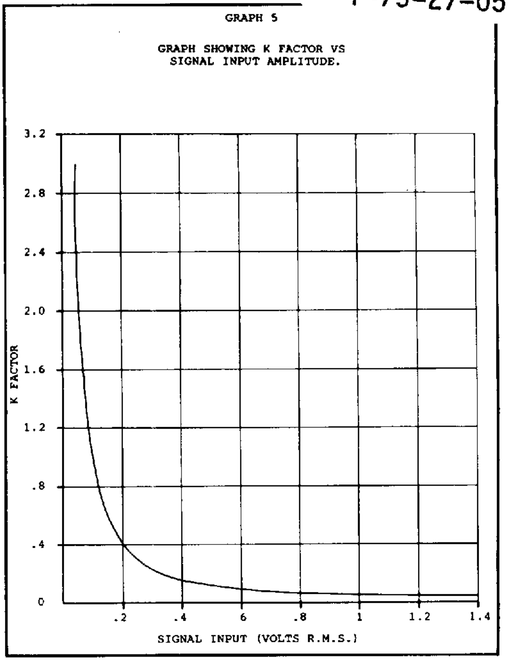
The response time of the FX-105 is the sum of the V.C.O. 'Lock' time (T'lock) and the 'Word' integration time (T'word).

Graph number 3 shows that for a frequency of 2800Hz and a bandwidth of 6% the approximate 'Lock' time will be 9 milliseconds, as we have a maximum response time of 50 milliseconds, this allows for a 'Word' time of 41 milliseconds.









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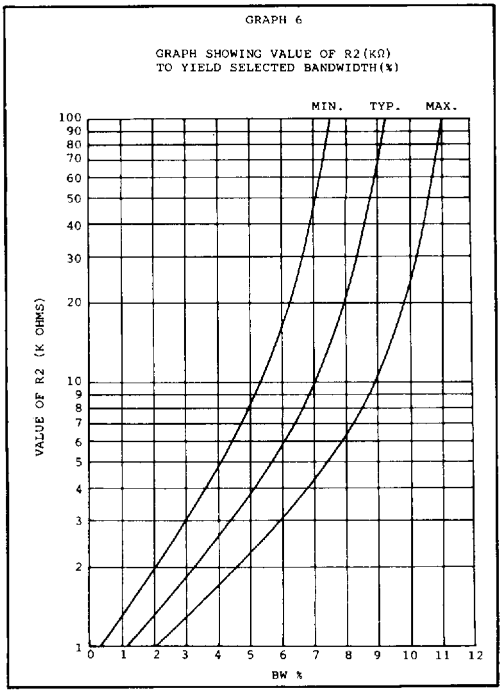
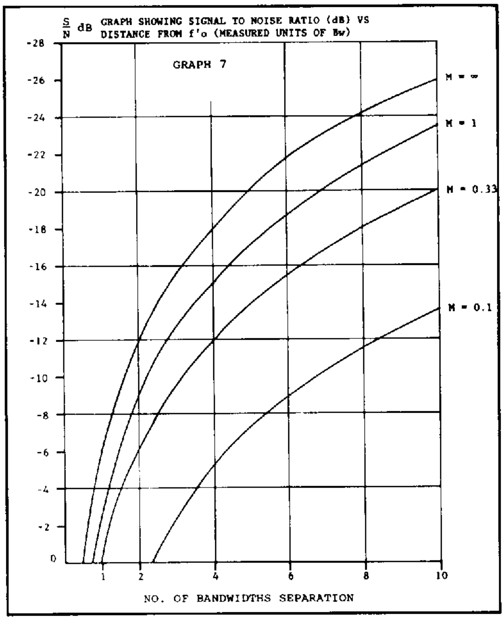




Graph number 4 shows that for a signal amplitude of 200mVolts, a resistor value RW of 510k ohms with a 0.1 microfarad capacitor for C3A and B will yield a 'Word' time of 20ms. This will yield a response time of 9ms + 20ms = 29ms.

Graph 6 shows the range of values for R2 to yield a given bandwidth. The exact bandwidth given by any value of R2 will vary with differing production batches, therefore in applications where an exact bandwidth is required R2 should be a variable resistor which is adjusted on test.

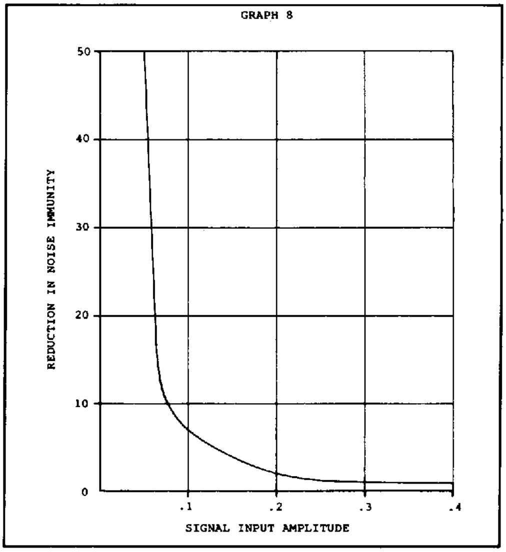
To calculate the worst case signal to noise ratio the FX-105 will work with the above component values. The formula is as follows:

$$M = \frac{f'o \times Bw}{100} \times (Rw\ C3A)$$

$$\therefore M = \frac{2800 \times 6}{100} \times (0.51M\Omega \times 0.1\mu F)$$

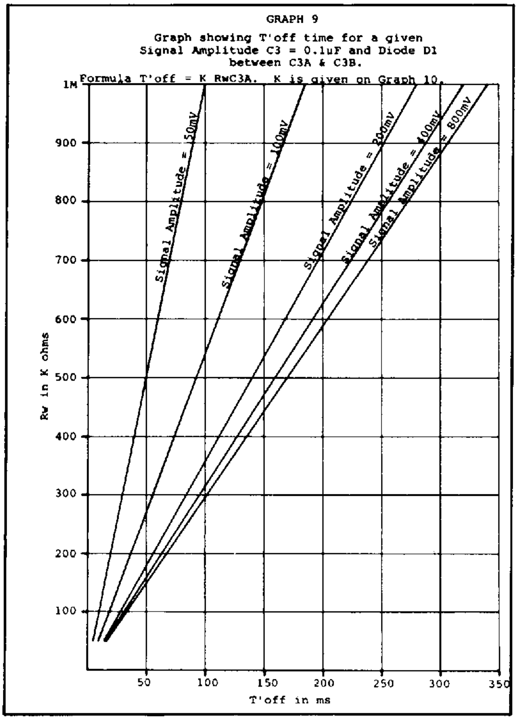
$$\therefore M = 168 \times 0.051$$

$$\therefore M \simeq 8.57$$



By substituting the value for M of 8.57 in graph number 7 the signal to noise ratio of an adjacent tone can be found, this then has to be decreased depending upon the tone amplitude. The figure to decrease SNR by is given in graph 8.

Graphs 9 and 10 show the approximate time the FX-105 will take to turn off after an inband signal has been removed. The turn off time is calculated with a diode (1N914 or similar) between pins 5 and 6 as shown in Figure 4. The effect of this diode is to greatly reduce the turn off time with signal input amplitudes greater than 300mV R.M.S.



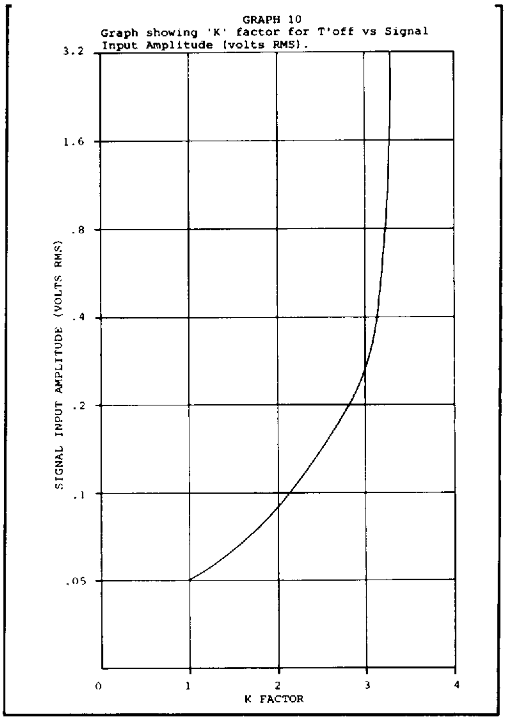
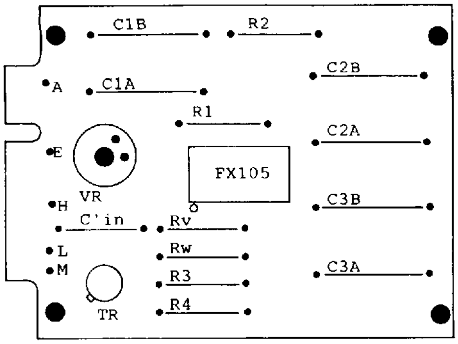


FIG.5

COMPONENT LAYOUT C-05 P.C.B.



EDGE CONNECTIONS.

A = +ve
E = -ve
H = Signal Input
L = Switch Output
M = Buffer Output

To assist engineers in designing systems utilising the FX-105, C.M.L. have produced a printed circuit board, allowing the necessary external components to be connected, so that a full working system may be easily and quickly constructed. Please note there is no provision on the P.C.B. for capacitor C4 or diode D1 and it is recommended that these components are added for improved system operation.

Due to the FX-105's ability to decode tones in the presence of adjacent channel tones or noise, the device is ideally suited to applications where a number of tones are sequentially or simultaneously transmitted over a common link. In the example shown in Figure 6 a number of single tone transmitters (FX-205) are transmitting over a common link such as cable, radio, optical, etc., to a number of receivers (FX-105). The transmitters may transmit either individually or simultaneously to the FX-105s without the possibility of missing a call or receiving a false call.

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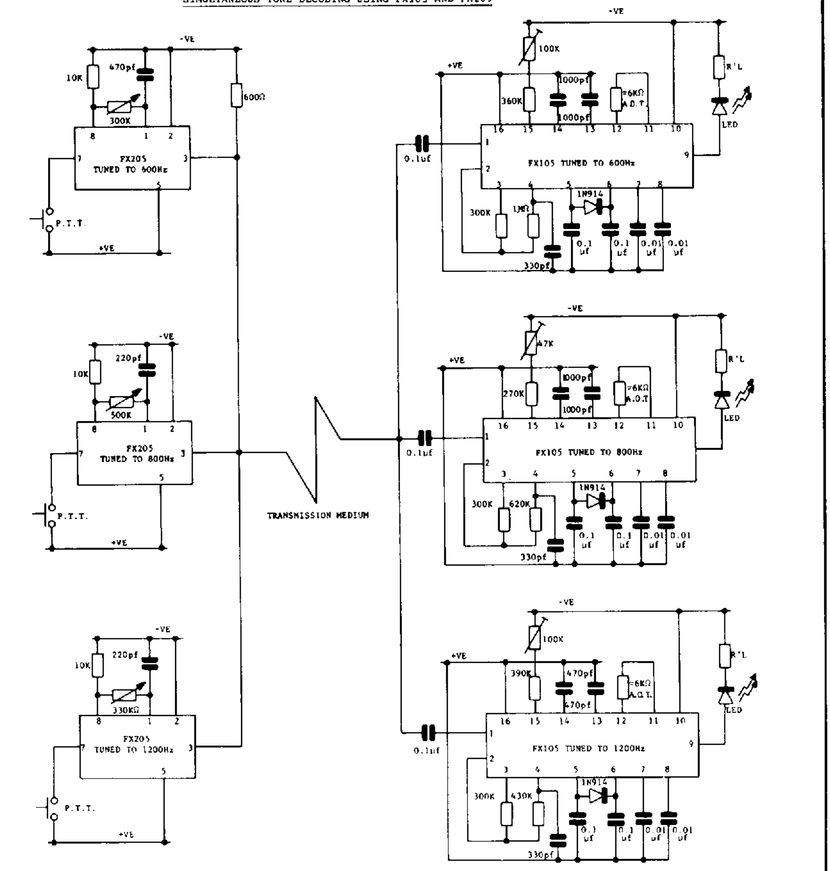
FIG.6

SIMULTANEOUS TONE DECODING USING FX105 AND FX205



SPECIFICATION T-75-27-05

MAX. RATINGS Failure to observe may result in device damage.

MAX. VOLTAGE BETWEEN ANY PIN AND +VE SUPPLY (pin 16) .... −20V and +0.3V
OPERATING TEMPERATURE RANGE .... −30°C to +85°C
STORAGE TEMPERATURE RANGE .... −55°C to +125°C
DEVICE DISSIPATION (at 20°C ambient temperature) 400mW
MAX. OUTPUT SWITCH LOAD CURRENT 10mA

CHARACTERISTICS

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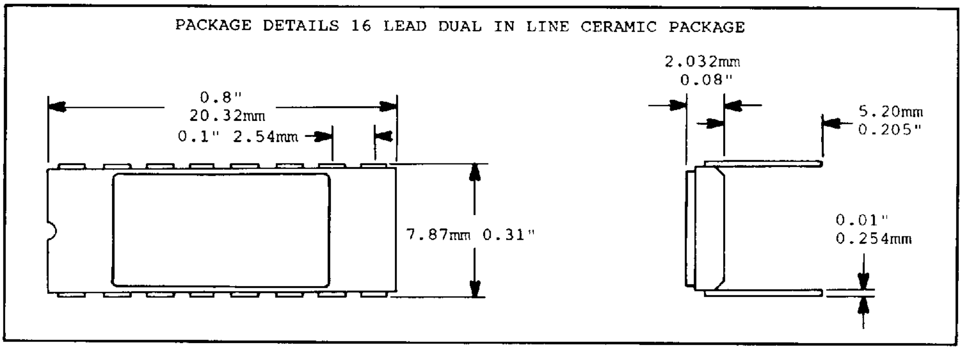
Note: Due to A.C. signal coupling either supply polarity may be 'ground'.

SYMBOL	PARAMETER	NOTES	MIN.	TYP.	MAX.	UNITS
V_s	Supply voltage	Operating range	10	12	15	Volts
I_s	Supply current	Total, excluding loads		5		mA
	Signal Input	Signal + noise range	0.055		5[1]	Volts R.M.S.
F'o	Channel Frequency		0.04		5	kHz
Bw	Bandwidth		2%		10%	
	O/P switch load current				10	mA
Zin	Input impedance			200		k ohm
	Frequency Stability	vs T'AMB		0.02%/°C		
	Frequency Stability	Per 1% change in supply volts		0.07%		

NOTE

1. For input voltages greater than VDD x 0.143 pins 1 and 2 should be open circuit and the signal applied via C'in to the junction of RV and RW.



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Section 11

CONSUMER MICROCIRCUITS

Packaging and Applications

CML Packaging

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

- 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.

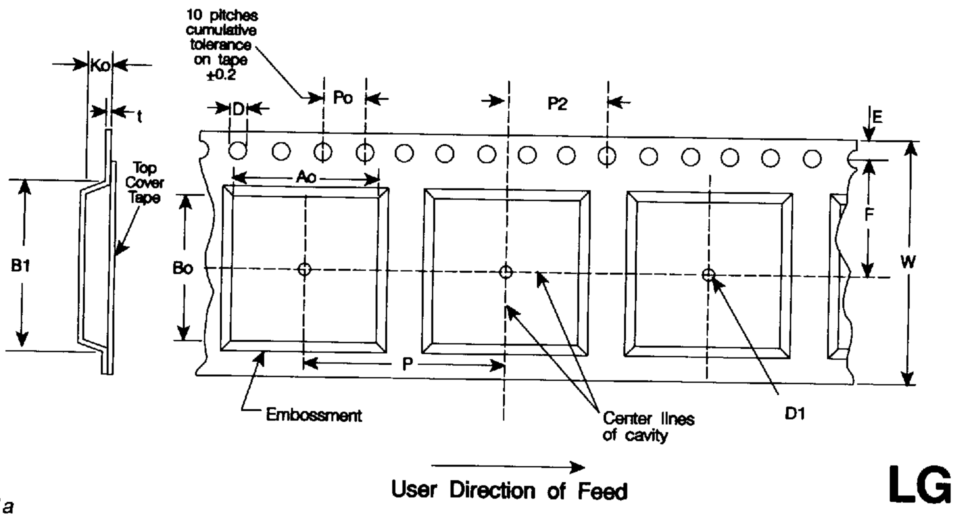

Fig.1a

CML Packaging ......

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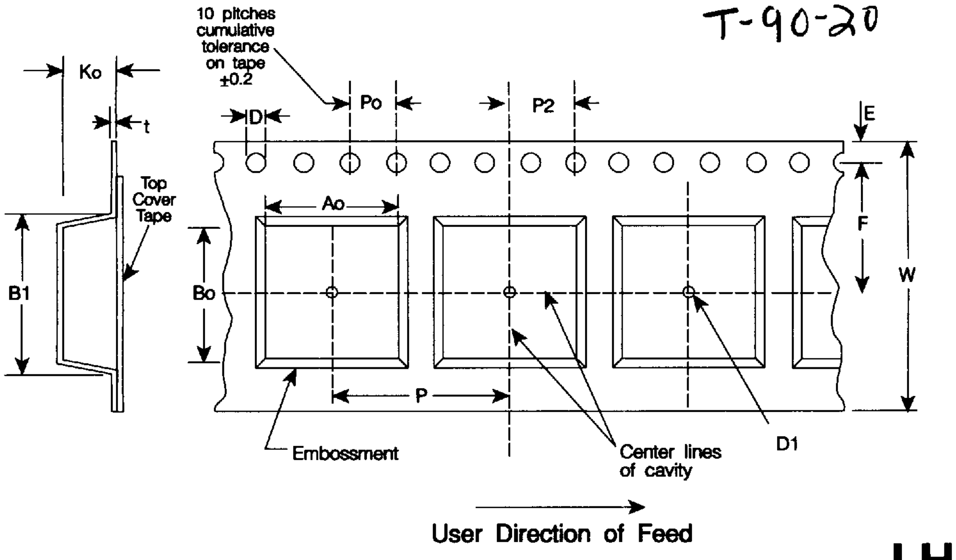

Fig.1b

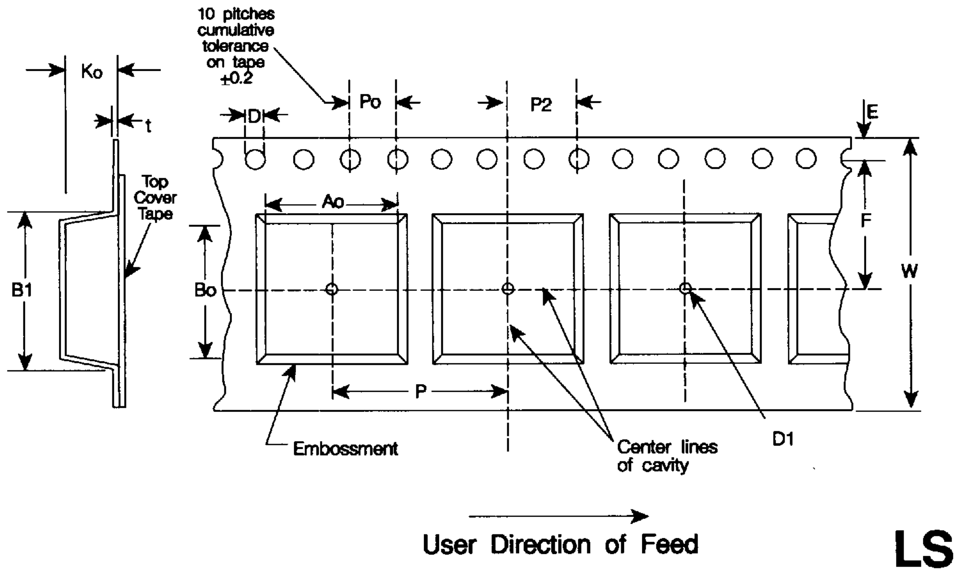

Fig.1c

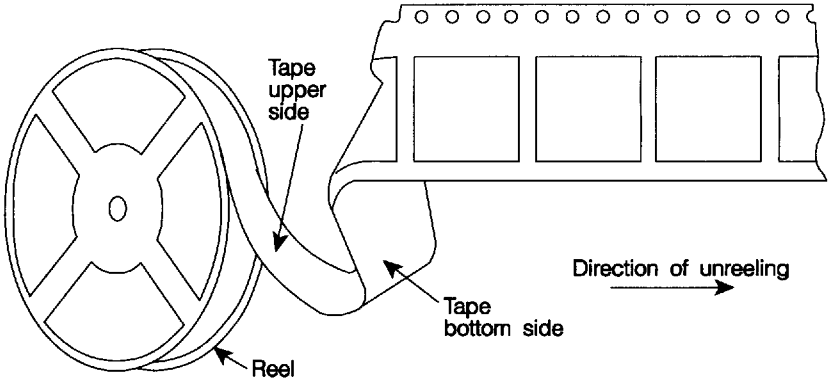

Fig.2 Tape Top and Bottom Orientation

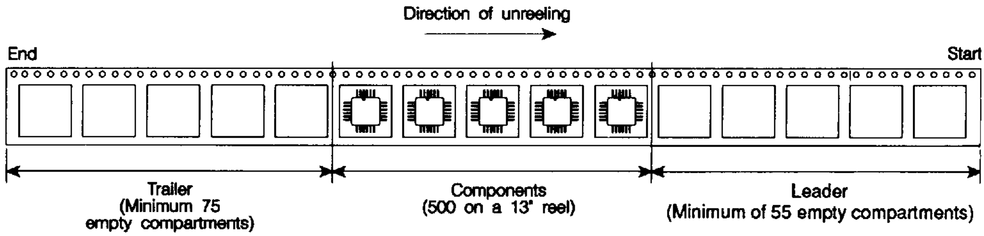

Fig.3 Layout of Tape

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).

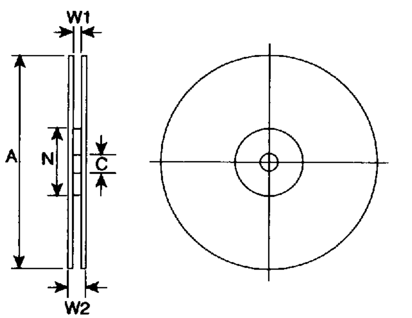

Fig.4 Reel Dimensions

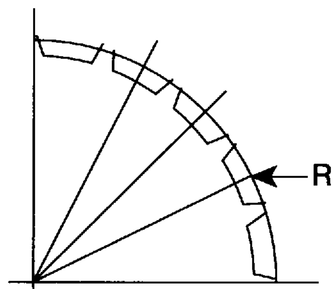

Fig.5 Minimum Radius = 30mm

Fig.6a

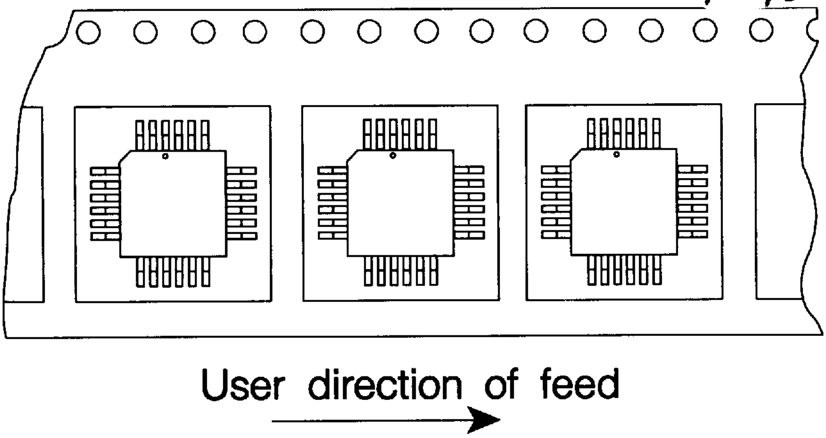

Fig.6b

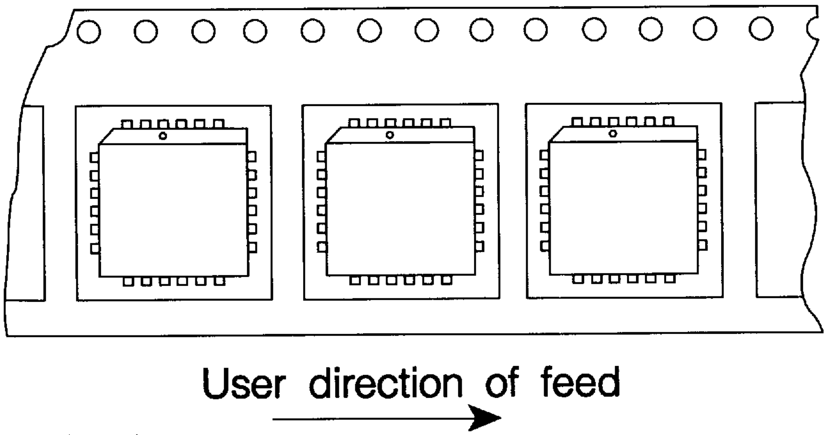

Fig.6 Component Orientation

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 ......

6. Packaging

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

Dimensions

	A	C	N	W1	W2
6.1.1	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

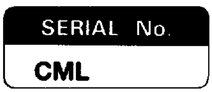
6.7 The tape will be prevented from unreeling by winding a paper tape around the reel and fixing with adhesive tape.

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.