



# LC89977M

## CCD Delay Line for PAL

### Preliminary

### Overview

The LC89977M is CCD delay line for PAL television system that includes a chrominance signal crosstalk exclusion filter and a luminance signal 1-H delay line on chip.

### Features

- 5-V single-voltage power supply
- Built-in  $3 \times$  PLL frequency multiplier circuit allows 3fsc operation from an fsc (4.43 MHz) input.
- Can be switched between the PAL/GBI, and 4.43NTSC formats by setting control pin values.
- Includes a built-in crosstalk exclusion comb filter for the chrominance signal that provides high-precision comb characteristics in an adjustment-free circuit.
- Peripheral circuits provided on chip for operation with a minimum of external components.
- Positive-phase signal input, positive-phase signal output (luminance signal)

### Functions

- CCD shift registers (for chrominance and luminance signals)
- Timig generator and clock driver for CCD
- Delay time selective circuit
- CCD signal adder
- Auto-bias circuit
- Sync tip clamp circuit (luminance signal)
- Center bias circuit (chrominance signal)
- Sample-and-hold circuit
- $3 \times$  PLL frequency multiplier circuit
- 3fsc clock output circuit
- High voltage generator for CCD Reset Drain (RD)

### Specifications

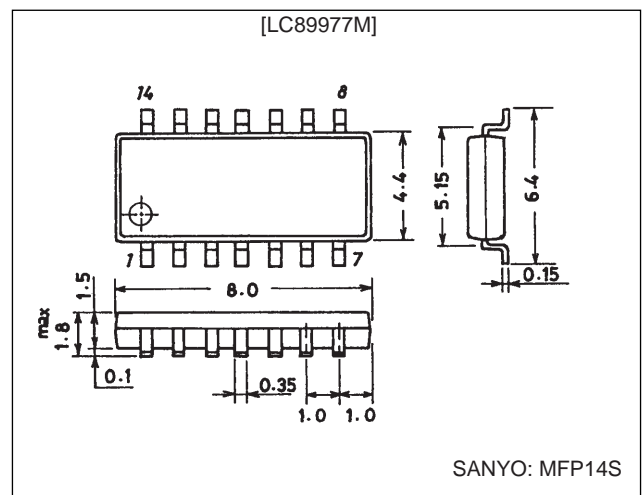
#### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{DD}$		-0.3 to +6.0	V
Allowable power dissipation	$P_d \text{ max}$		250	mW
Operating temperature	$T_{opr}$		-10 to +60	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +125	$^\circ\text{C}$

### Package Dimensions

unit: mm

#### 3111-MFP14S

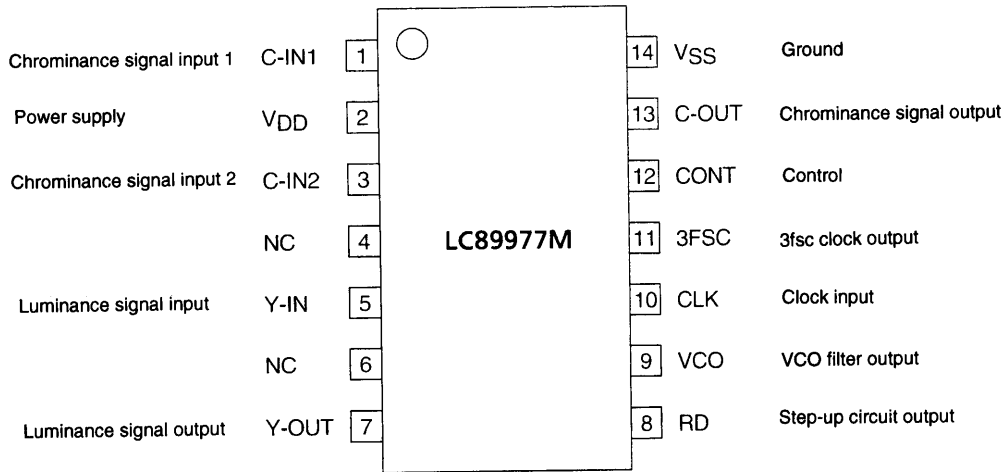


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## Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V <sub>DD</sub>		4.75	5.00	5.25	V
Clock input amplitude	V <sub>CLK</sub>		300	500	1000	mVp-p
Clock frequency	F <sub>CLK</sub>	Sine wave		4.43361875		MHz
Chrominance signal input amplitude	V <sub>IN-C</sub>			350	500	mVp-p
Luminance signal input amplitude	V <sub>IN-Y</sub>			400	572	mVp-p

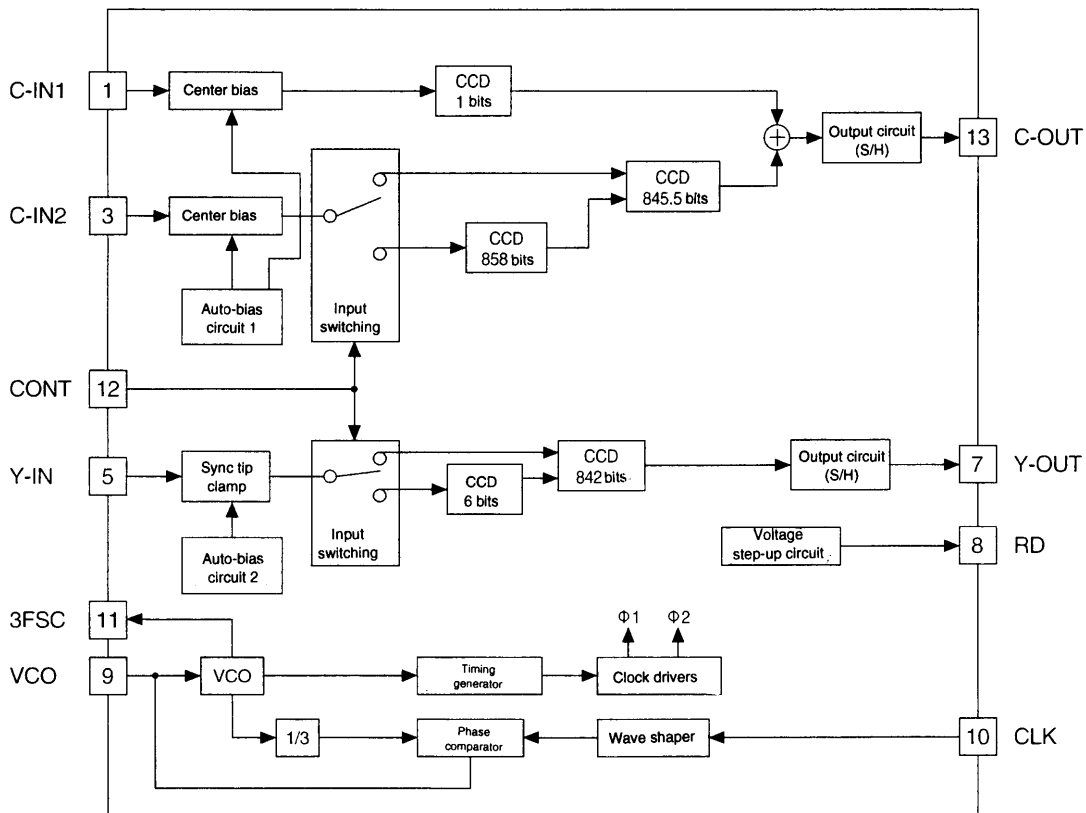
## Pin Assignment



Top view

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## Block Diagram



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## LC89977M

### Control Pin Functions

CONT	Mode (representative)	Chrominance signal delay (number of CCD stages)	Luminance signal delay (number of CCD stages)
Low	PAL/GBI	2H (1703.5) + 0H (1)	1H (848)
High	4.43NTSC	1H (845.5) + 0H (1)	1H (842)

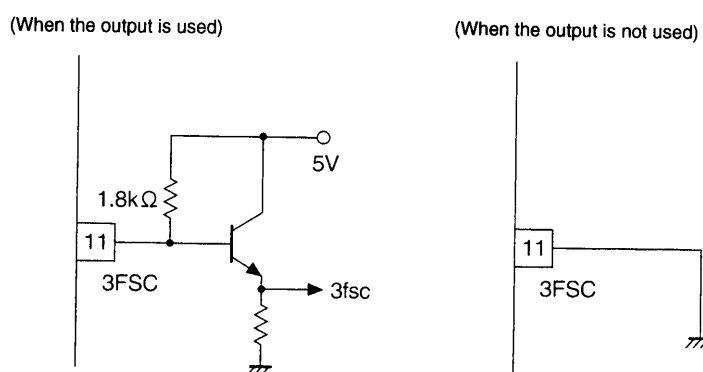
### Switching Voltage Levels

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Switching voltage level: low	$V_L$		-0.3	0.0	+0.5	V
Switching voltage level: high	$V_H$		2.0	5.0	6.0	V

Note: \*Since the control pins have built-in pull-down resistors (about 70 k $\Omega$ ), leaving these pins opens effectively sets them to the low level.

### Function of the 3FSC Pin

This pin provides a 3fsc clock signal generated by the  $3 \times$  PLL frequency multiplier circuit.



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### Electrical Characteristics at $V_{DD} = 5.0$ V, $T_a = 25^\circ$ C, $F_{CLK} = 4.43361875$ MHz, $V_{CLK} = 500$ mVp-p

Parameter	Symbol	Switch states				Ratings			Unit
		SW1	SW2	SW3	Test conditions	min	typ	max	
Supply current	$I_{DD-1}$	a	a	b	*1	27	32	37	mA
	$I_{DD-2}$	b	a	b	*1				
[Chrominance signal characteristics] (with no input to Y-IN)									
DC output voltage	$V_{INC-1}$	a	a	b	*2	1.9	2.4	2.9	V
	$V_{INC-2}$	b	a	b	*2				
	$V_{OUTC-1}$	a	a	b	*2	1.4	1.9	2.4	V
	$V_{OUTC-2}$	b	a	b	*2				
Voltage gain	$G_{VC-1}$	a	a	b	*3	-2	0	+2	dB
	$G_{VC-2}$	b	a	b	*3				
Comb depth	$C_{D-1}$	a	a	b	*4		-40	-35	dB
	$C_{D-2}$	b	a	b	*4				
Linearity	$L_{NC-1}$	a	a	b	*5	-0.3	0.0	+0.3	dB
	$L_{NC-2}$	b	a	b	*5				
Clock leakage (3fsc)	$L_{CK3C-1}$	a	a	b	*6		10	50	mVrms
	$L_{CK3C-2}$	b	a	b	*6				
Clock leakage (fsc)	$L_{CK1C-1}$	a	a	b	*6		0.5	1.5	mVrms
	$L_{CK1C-2}$	b	a	b	*6				
Noise	$N_{C-1}$	a	a	b	*7		0.5	2.0	mVrms
	$N_{C-2}$	b	a	b	*7				
Output impedance	$Z_{OC-1}$	a	a	a, b	*8	200	350	500	$\Omega$
	$Z_{OC-2}$	b	a	a, b	*8				
0-H delay time	$T_{DC-1}$	a	a	b	*9		130		ns
	$T_{DC-2}$	b	a	b	*9				

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Parameter	Symbol	Switch states				Ratings			Unit
		SW1	SW2	SW3	Test conditions	min	typ	max	
[Luminance signal characteristics] (With no signals input to C-IN1 and C-IN2)									
DC output voltage	V <sub>IN1-1</sub>	a	a	b	*10	1.3	1.8	2.3	V
	V <sub>IN1-2</sub>	b	a	b	*10				
	V <sub>OUT1-1</sub>	a	a	b	*10	0.7	1.2	1.7	V
	V <sub>OUT1-2</sub>	b	a	b	*10				
Voltage gain	G <sub>V1-1</sub>	a	a	b	*11	-2	0	+2	dB
	G <sub>V1-2</sub>	b	a	b	*11				
Frequency response	G <sub>F1-1</sub>	a	b	b	*12	-2	0	+2	dB
	G <sub>F1-2</sub>	b	b	b	*12				
Differential gain	D <sub>G1-1</sub>	a	a	b	*13	0	5	8	%
	D <sub>G1-2</sub>	b	a	b	*13				
Differential phase	D <sub>P1-1</sub>	a	a	b	*13	0	5	8	deg
	D <sub>P1-2</sub>	b	a	b	*13				
Linearity	L <sub>S1-1</sub>	a	a	b	*14	37	40	43	%
	L <sub>S1-2</sub>	b	a	b	*14				
Clock leakage (3fsc)	L <sub>CK31-1</sub>	a	a	b	*15		10	50	mVrms
	L <sub>CK31-2</sub>	b	a	b	*15				
Clock leakage (fsc)	L <sub>CK11-1</sub>	a	a	b	*15		0.5	1.5	mVrms
	L <sub>CK11-2</sub>	b	a	b	*15				
Noise	N <sub>1-1</sub>	a	a	b	*16		0.5	2.0	mVrms
	N <sub>1-2</sub>	b	a	b	*16				
Output impedance	Z <sub>O1-1</sub>	a	a	c, b	*17	250	400	550	Ω
	Z <sub>O1-2</sub>	a	b	c, b	*17				
Delay time	T <sub>D1-1</sub>	a	a	b	*18		63.81		μs
	T <sub>D1-2</sub>	b	a	b	*18		63.36		μs

### Test Conditions

- The supply current with no input signal
- The pin output voltage (the center bias voltage) with no input signal
- Measure the C-OUT output when a 350-mVp-p sine wave is input to C-IN1 and C-IN2.

$$G_{VC} = 20 \log \frac{\text{C-OUT output [mVp-p]}}{350 \text{ [mVp-p]}} \text{ [dB]}$$

Test frequencies:

$$G_{VC-1}: 4.429662 \text{ MHz (PAL/GBI)}$$

$$G_{VC-2}: 4.425694 \text{ MHz (4.43NTSC)}$$

- Measure the comb depth from the C-OUT output when a 350-mVp-p sine wave with frequency  $f_a$  is input to C-IN1 and C-IN2, and when a sine wave of frequency  $f_b$  is input.

$$C_D = 20 \log \frac{\text{The C-OUT output for an } f_b \text{ input [mVp-p]}}{\text{The C-OUT output for an } f_a \text{ input [mVp-p]}} \text{ [dB]}$$

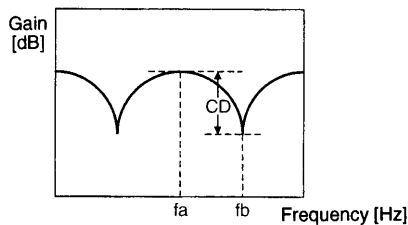
Test Frequencies

$$C_{D-1}: 4.429662 \text{ MHz}$$

$$G_{D-2}: 4.425694 \text{ MHz}$$

$$4.425756 \text{ (PAL/GBI)}$$

$$4.417819 \text{ (4.43NTSC)}$$



5. Measure the C-OUT output when a 200-mVp-p sine wave is input to C-IN1 and C-IN2, and when a 500-mVp-p sine wave is input, and calculate the gain difference as follows:

$$L_{NC} = 20 \log \left( \frac{\text{The output for a 500-mVp-p input [mVp-p]}}{500 \text{ [mVp-p]}} \bigg/ \frac{\text{The output for a 200-mVp-p input [mVp-p]}}{200 \text{ [mVp-p]}} \right) [\text{dB}]$$

Test Frequencies

- $L_{NC-1}$  4.429662MHz (PAL/GBI)
- $L_{NC-2}$  4.425694MHz (4.43NTSC)

6. Measure the 3fsc (13.3 MHz) and fsc (4.43 MHz) components in the C-OUT output with no input signal.  
 7. Measure the noise in the C-OUT output with no input signal.  
 Measure the noise with a noise meter with a 200-kHz high-pass filter and a 5-MHz low-pass filter.  
 8. Input a 350-mVp-p sine wave to C-IN1 and C-IN2. Let V1 be the C-OUT output when SW3 is set to the 'a' position, and let V2 be the C-OUT output when SW3 is set to the 'b' position.

$$Z_{OC} = \frac{V2 \text{ [mVp-p]} - V1 \text{ [mVp-p]}}{V1 \text{ [mVp-p]}} \times 500 \text{ [dB]}$$

Test Frequencies

- $Z_{OC-1}$ : 4.429662 MHz (PAL/GBI)
- $Z_{OC-2}$ : 4.425694 MHz (4.43NTSC)

9. The delay time in the C-OUT output with respect to the C-IN1 input. This is the CCD 1-bit delay.  
 10. The pin output voltage (clamp voltage) with no input signal.  
 11. Measure the Y-OUT output with a 200-kHz 400-mVp-p sine wave input to Y-IN.

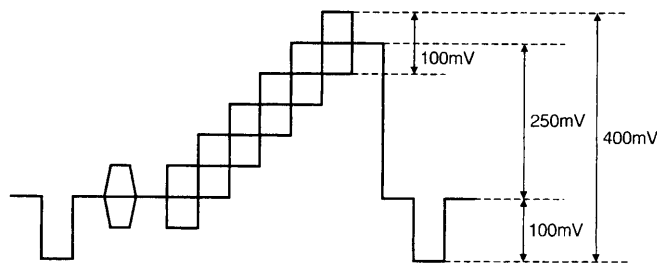
$$G_{VY} = 20 \log \frac{\text{Y-OUT output [mVp-p]}}{400 \text{ [mVp-p]}} \text{ [dB]}$$

12. Measure the Y-OUT output when a 200-kHz 200-mVp-p sine wave is input to Y-IN, and when a 3.3-MHz 200-mVp-p sine wave is input.

$$G_{FY} = 20 \log \frac{\text{The Y-OUT output for a 3.3-MHz input [mVp-p]}}{\text{The Y-OUT output for a 200-kHz input [mVp-p]}} \text{ [dB]}$$

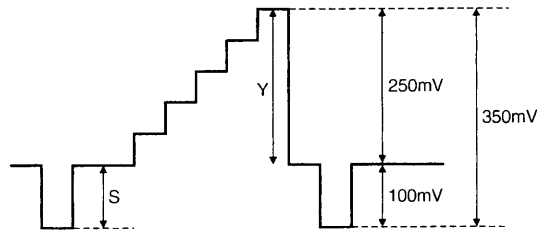
Here, adjust Vbias so that the clamp level is +250 mV.

13. Apply a 5-step staircase wave (as in the figure below) to Y-IN, and measure the differential gain and differential phase in the Y-OUT output using a vector scope.



14. Apply a 5-step staircase wave (as in the figure below) to Y-IN, and measure the luminance level (Y) and the sync level (S) in the Y-OUT output.

$$L_S = \frac{S \text{ [mV]}}{Y \text{ [mV]}} \times 100 \text{ [%]}$$



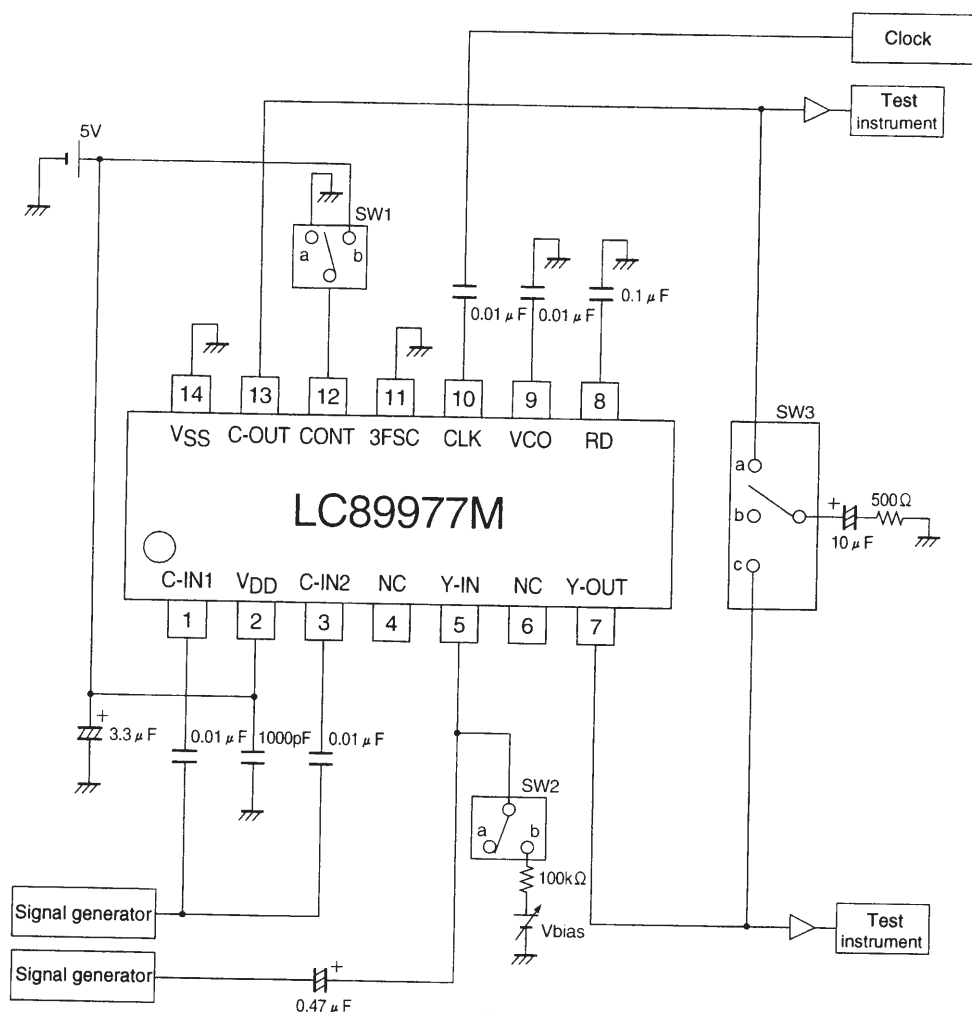
15. Measure the 3fsc (13.3 MHz) and fsc (4.43 MHz) components in the Y-OUT output with no input signal.
16. Measure the noise in the Y-OUT output with no input signal.  
Measure the noise with a noise meter with a 200-kHz low-pass filter, a 5-MHz low-pass filter, and a 4.43-MHz trap filter.
17. Input a 200-kHz, 400-mVp-p sine wave to Y-IN1. Let V1 be the V-OUT output when SW3 is set to the 'c' position, and let V2 be the Y-OUT output when SW3 is set to the 'b' position.

$$Z_{OY} = \frac{V2 \text{ [mVp-p]} - V1 \text{ [mVp-p]}}{V1 \text{ [mVp-p]}} \times 500 \text{ [\Omega]}$$

18. Measure the delay time in the Y-OUT output with respect to the input to Y-IN.

## LC89977M

### Test Circuit



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