

**LC7872E****CD Graphics Decoder**

## Overview

The LC7872E is a CMOS LSI that integrates in a single chip the signal processing functions required for compact disk graphics (CD-G) decoding. The LC7872E accepts the subcode R to W signals output by a CD-DSP chip such as the Sanyo LC786X series, LC7862XE series or LC7863XE series and performs de-interleaving, error detection and correction, graphics instruction processing and image processing.

## Functions

- Built-in RGB encoder allows a CD-G decoder to be implemented in just two chips: the LC7872E and an external 64-kword × 4-bit DRAM
- Interpolation and protection for the CD subcode synchronization signals as well as de-interleaving, error detection and correction for the R to W signals.
- Two crystal oscillator systems, one for NTSC and one for PAL are provided and can be switched easily using the control pin provided. The standard clock and all required internal timings can be generated by connecting a 14.31818 MHz crystal for NTSC and/or a 17.734476 MHz crystal for PAL.
- The LC7872E performs CD graphics instruction processing and drawing processing and controls the image display.
- Composition video 8-bit D/A converter output provided
- Superimposition support
- Microprocessor interface provided to support set upgrades.
- Define transparency support
- Color bar output function

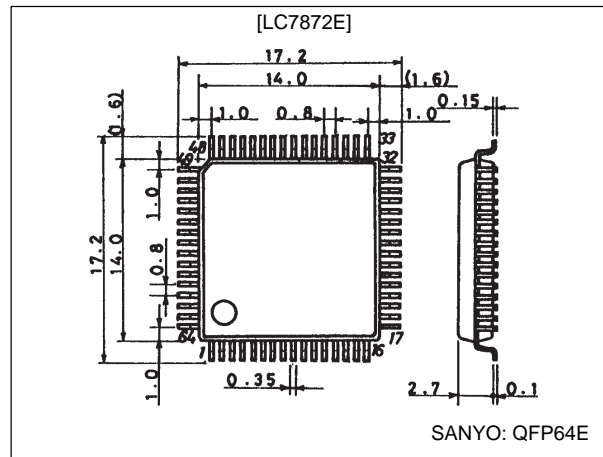
- CCB is a trademark of SANYO ELECTRIC CO., LTD.
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## Features

- A CD-G decoder can be implemented with just two chips: a controller is not required.
- Silicon gate CMOS structure for low power operation
- Single 5 V power supply
- 64-pin QFP (QIP) package

## Package Dimensions

unit: mm

**3159-QFP64E**

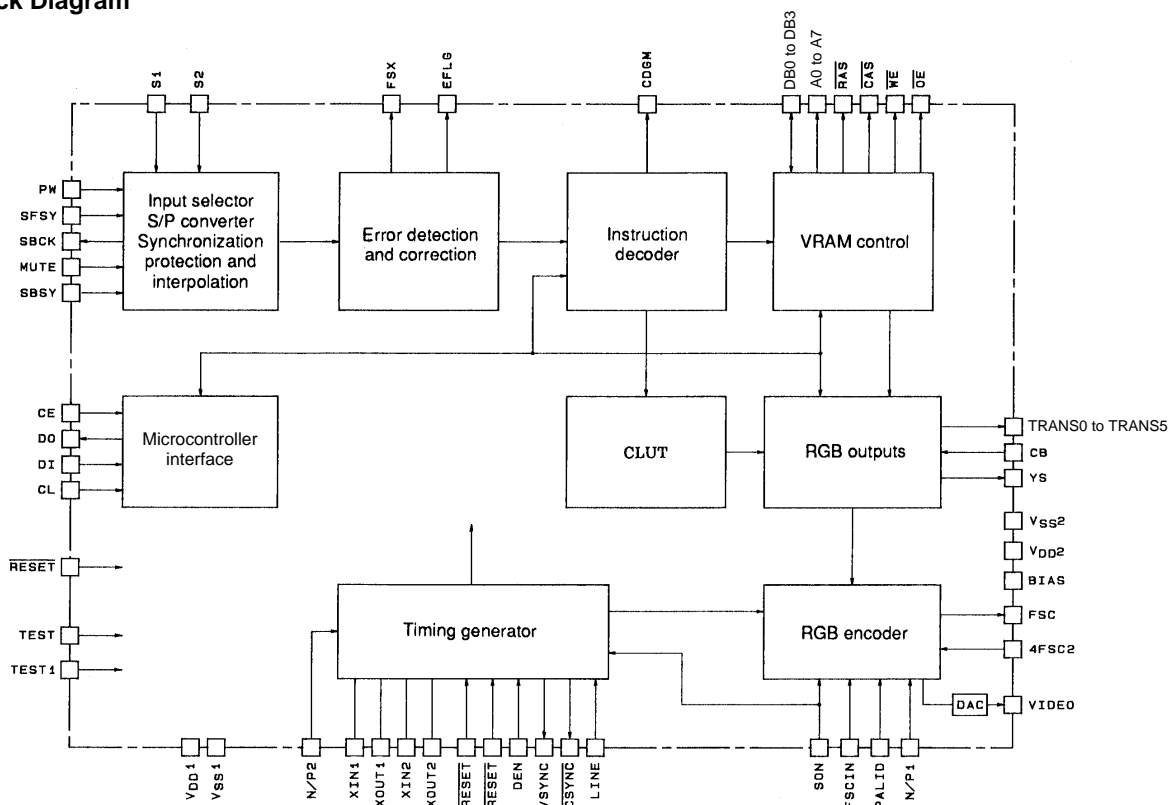
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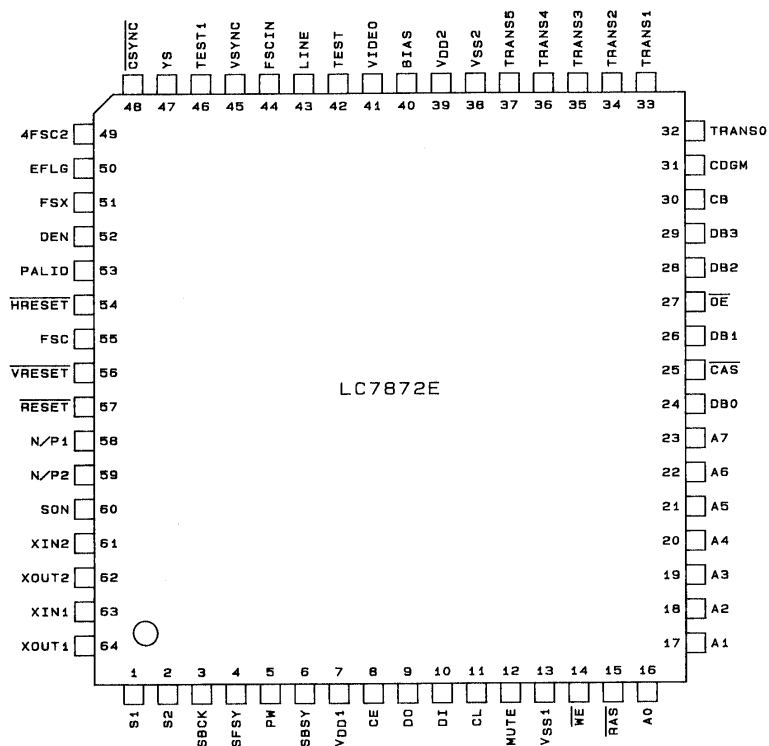
# LC7872E

## Block Diagram



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## Pin Assignment



Top view

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## LC7872E

### Specifications

#### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$ , $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{DD\text{ max}}$		$V_{SS} - 0.3$ to $+7.0$	V
Maximum input voltage	$V_{IN\text{ max}}$		$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Maximum output voltage	$V_{OUT\text{ max}}$		$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Allowable power dissipation	$P_d\text{ max}$		300	mW
Operating temperature	$T_{opr}$		$-30$ to $+85$	$^\circ\text{C}$
Storage temperature	$T_{stg}$		$-40$ to $+125$	$^\circ\text{C}$

#### Allowable Operating Ranges at $T_a = 25^\circ\text{C}$ , $V_{SS} = 0\text{ V}$

Parameter	Symbol	Conditions	min	typ	max	Unit	
Supply voltage	$V_{DD}$	$V_{DD1}$ , $V_{DD2}$	4.5		5.5	V	
Input high level voltage	$V_{IH(1)}$	RESET	$0.7 V_{DD}$		$V_{DD}$	V	
	$V_{IH(2)}$	SFSY, PW, SBSY, CE, DI, CL, MUTE, DB0 to DB3, PALID, HRESET, VRESET, N/P1, N/P2, SON	2.2		$V_{DD}$	V	
	$V_{IH(3)}$	S1, S2, CB, TEST, TEST1, LINE, DEN	$0.8 V_{DD}$		$V_{DD}$	V	
Input low level voltage	$V_{IL(1)}$	RESET	$V_{SS}$		$0.3 V_{DD}$	V	
	$V_{IL(2)}$	SFSY, PW, SBSY, CE, DI, CL, MUTE, DB0 to DB3, PALID, HRESET, VRESET, N/P1, N/P2, SON	$V_{SS}$		0.8	V	
	$V_{IL(3)}$	S1, S2, CB, TEST, TEST1, LINE, DEN	$V_{SS}$		$0.2 V_{DD}$	V	
High level clock pulse width	$t_{\phi H}$	CL: Figure 1	400			ns	
Low level clock pulse width	$t_{\phi L}$	CL: Figure 1	400			ns	
Data setup time	$t_{DS}$	CL, DI: Figure 1	200			ns	
Data hold time	$t_{DH}$	CL, DI: Figure 1	200			ns	
CE wait time	$t_{CP}$	CE, CL: Figure 1	400			ns	
CE setup time	$t_{CS}$	CE, CL: Figure 1	400			ns	
CE hold time	$t_{CH}$	CE, CL: Figure 1	400			ns	
DO setup time	$t_{DOS}$	CL, DO: Figure 1	130		300	ns	
Input frequency	$f_{in(1)}$	XIN1		14.31818		MHz	
	$f_{in(2)}$	XIN2		17.734476		MHz	
	$f_{in(3)}$	4FSC2	NTSC mode		14.31818		MHz
			PAL mode		17.734476		MHz
	$f_{in(4)}$	FSCIN	NTSC mode		3.58		MHz
PAL mode				4.43		MHz	
Input amplitude	$V_{IN}$	XIN1, XIN2, 4FSC2, FSCIN: sine wave, capacitive coupling	0.3		5	V <sub>p-p</sub>	
Reset pulse width	$t_{WRES}$	RESET	400			ns	

#### Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{SS} = 0\text{ V}$ , $V_{DD} = 5\text{ V}$

Parameter	Symbol	Conditions	min	typ	max	Unit
Current drain	$I_{DD(1)}$	$V_{DD1}$		24	40	mA
	$I_{DD(2)}$	$V_{DD2}$		12	20	mA
Input high level current	$I_{IH(1)}$	S1, S2, SFSY, PW, SBSY, CE, DI, CL, MUTE, LINE, HRESET, VRESET, N/P1, N/P2, RESET, SON: $V_{IN} = V_{DD}$			5	$\mu\text{A}$
	$I_{IH(2)}$	CB, TEST, TEST1, DEN: $V_{IN} = V_{DD}$	30	100	200	$\mu\text{A}$
Input low level current	$V_{IL(1)}$	S1, S2, SFSY, PW, SBSY, CE, DI, CL, MUTE, LINE, HRESET, VRESET, N/P1, N/P2, RESET, SON: $V_{IN} = V_{SS}$	-5			$\mu\text{A}$
	$V_{IL(2)}$	PALID: $V_{IN} = V_{SS}$	-200	-100	-30	$\mu\text{A}$
Output high level voltage	$V_{OH}$	SBCK, WE, RAS, CAS, OE, A0 to A7, DB0 to DB3, CDGM, TRANS0 to TRANS5, VSYNC, YS, CSYNC, EFLG, FSX, FSC: $I_O = -0.5\text{ mA}$	$V_{DD} - 1$		$V_{DD}$	V

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Parameter	Symbol	Conditions	min	typ	max	Unit
Output low level voltage	$V_{OL(1)}$	SBCK, $\overline{WE}$ , $\overline{RAS}$ , $\overline{CAS}$ , $\overline{OE}$ , A0 to A7, DB0 to DB3, CDGM, TRANS0 to TRANS5, VSYNC, YS, CSYNC, EFLG, FSX, FSC: $I_O = 2 \text{ mA}$	$V_{SS}$		0.4	V
	$V_{OL(2)}$	DO: $I_O = 5 \text{ mA}$	$V_{SS}$		0.75	V
Output off leakage current	$I_{OFF}$	DO, DB0 to DB3	-5		+5	$\mu\text{A}$
Built-in feedback resistance	$R_X$	XIN1, XIN2, 4FSC2, FSCIN		1		$\text{M}\Omega$
8-bit D/A converter reference voltage	$V_{REF}$	VIDEO	2.40	2.45	2.50	V
8-bit D/A converter output resistance	$R_{DA}$	VIDEO		300		$\Omega$
8-bit D/A converter output level	$V_{DAC}$	VIDEO: Figure 9				
Random read/write cycle time	$t_{RC}$	Figures 2 and 3	250			ns
Page mode cycle time	$t_{PC}$	Figures 4 and 5	130			ns
RAS access time	$t_{RAC}$	Figure 2			210	ns
CAS access time	$t_{CAC}$	Figures 2 and 4			10	ns
Output turn-off delay time	$t_{OFF}$	Figures 2 and 4			20	ns
RAS precharge time	$t_{RP}$	Figures 2, 3, 4, 5 and 6	100			ns
RAS pulse width	$t_{RAS}$	Figures 2, 3 and 6	120			ns
RAS pulse width (page mode)	$t_{RASP}$	Figures 4 and 5			18000	ns
RAS hold time	$t_{RSH}$	Figures 2, 3, 4 and 5	60			ns
CAS hold time	$t_{CSH}$	Figures 2 and 3	120			ns
CAS pulse width	$t_{CAS}$	Figures 2, 3, 4 and 5	60			ns
CAS precharge time	$t_{CPN}$	Figure 6	50			ns
CAS precharge time (page mode)	$t_{CP}$	Figures 4 and 5	50			ns
Row address setup time	$t_{ASR}$	Figures 2, 3, 4 and 5	100			ns
Row address hold time	$t_{RAH}$	Figures 2, 3, 4 and 5	50			ns
Column address setup time	$t_{ASC}$	Figures 2, 3, 4 and 5	0			ns
Column address hold time	$t_{CAH}$	Figures 2, 3, 4 and 5	50			ns
Read command setup time	$t_{RCS}$	Figure 2	150			ns
Read command hold time (referenced to CAS)	$t_{RCH}$	Figure 2	120			ns
Read command hold time (referenced to RAS)	$t_{RRH}$	Figure 2	120			ns
Write command setup time	$t_{WCS}$	Figure 3	100			ns
Write command hold time	$t_{WCH}$	Figure 3	50			ns
Write command pulse width	$t_{WP}$	Figure 3	150			ns
Write data setup time	$t_{DS}$	Figure 3	100			ns
Write data hold time	$t_{DH}$	Figure 3	100			ns
CAS setup time (CAS before RAS)	$t_{CSR}$	Figure 6	50			ns
CAS hold time (CAS before RAS)	$t_{CHR}$	Figure 6	50			ns
RAS precharge · CAS active time	$t_{RPC}$	Figure 6	50			ns
Video setup time	$t_{VS}$	Superimposition: Figure 7	20		25	ns
SBCK output delay time	$t_{SD}$	NTSC mode: Figure 8	4.74		5.03	$\mu\text{s}$
		PAL mode:	4.79		5.08	$\mu\text{s}$
SBCK cycle frequency	$f_{SC}$	NTSC mode: Figure 8		224		kHz
		PAL mode:		222		kHz
PW setup time	$t_{PWS}$	Figure 8	100			ns

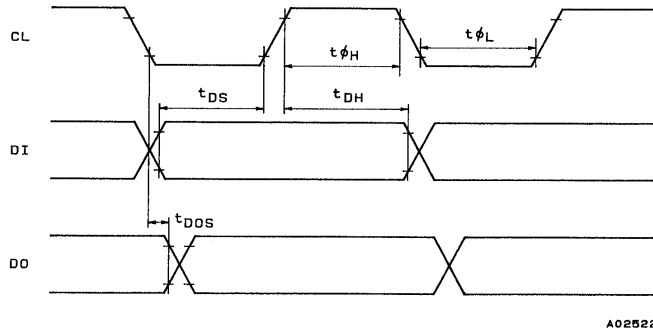
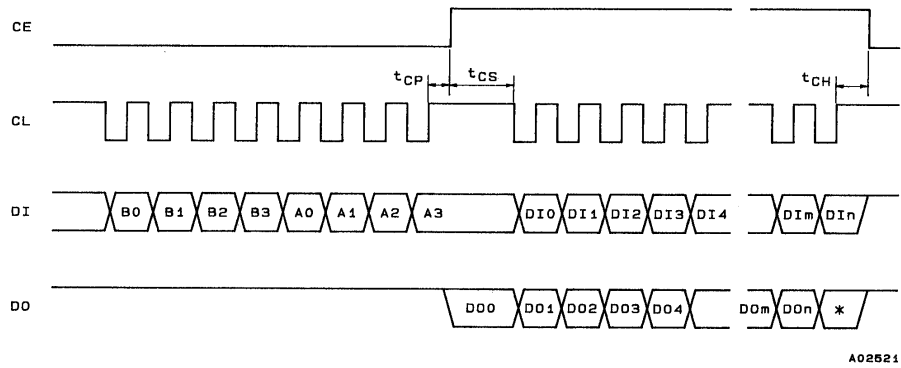


Figure 1 Microcontroller Interface Timing

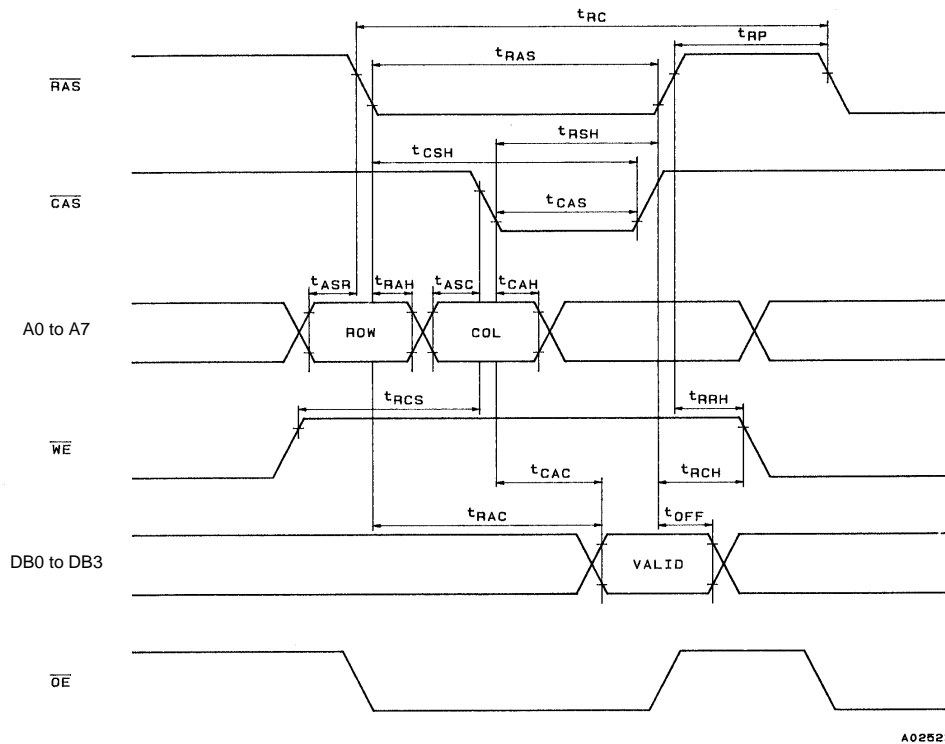
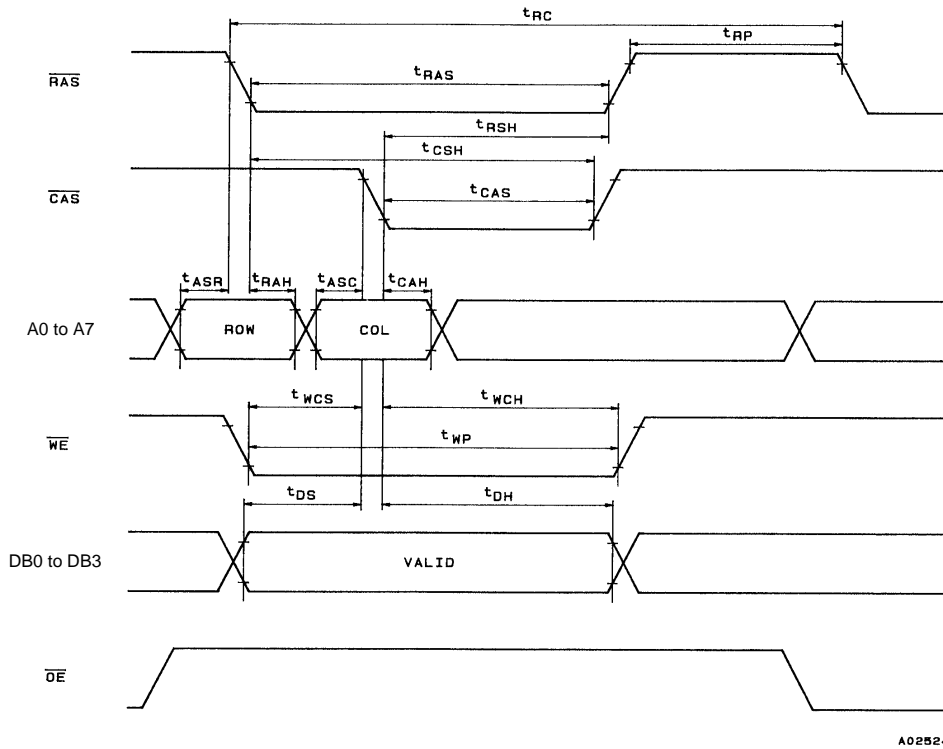
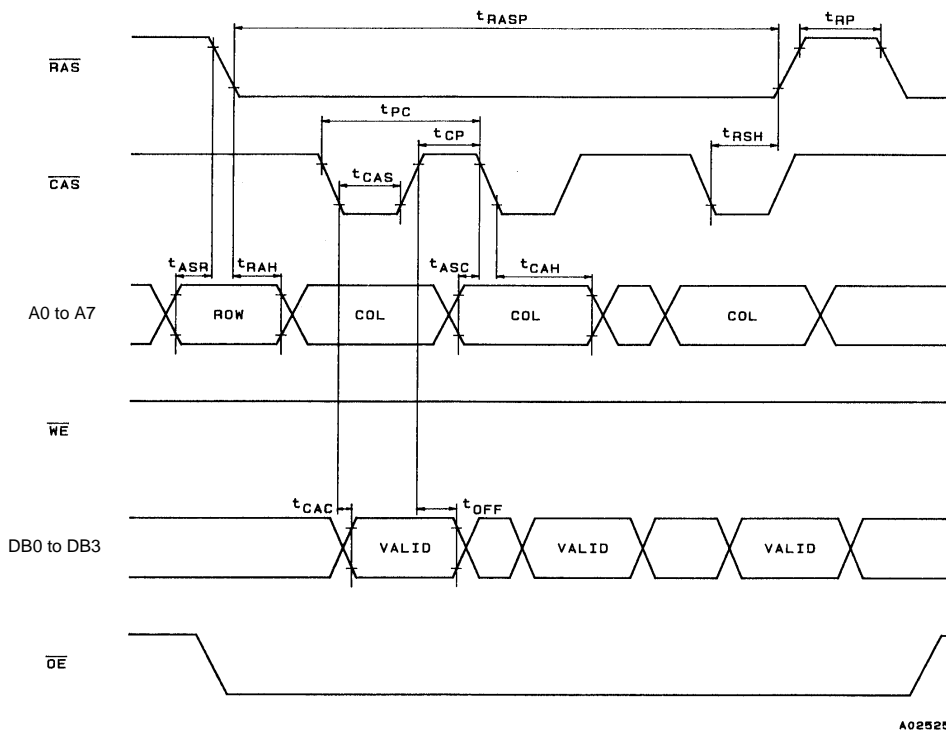


Figure 2 DRAM Read Cycle



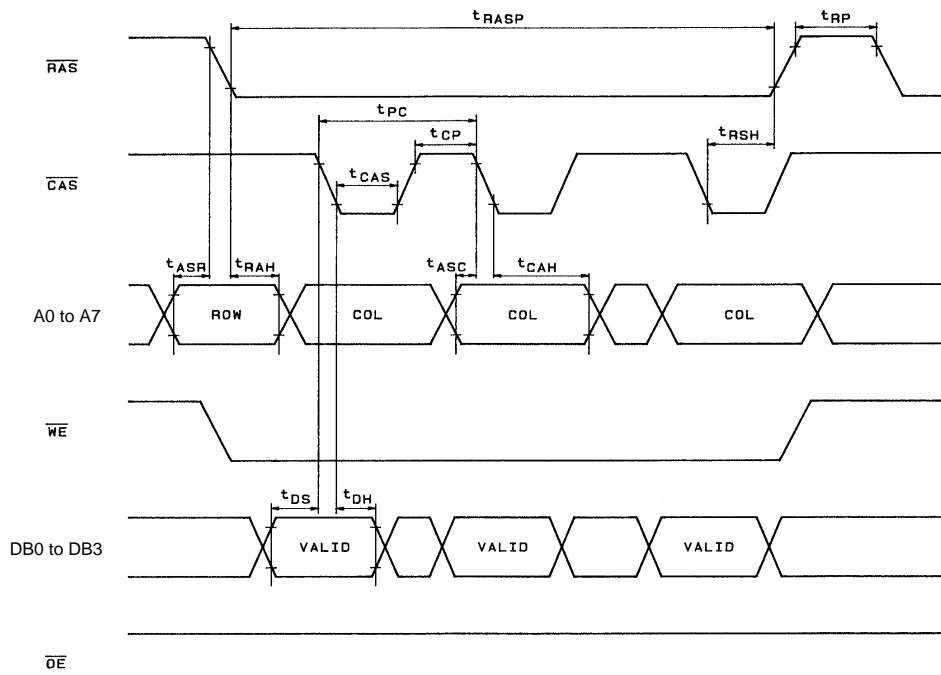
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Figure 3 DRAM Early Write Cycle



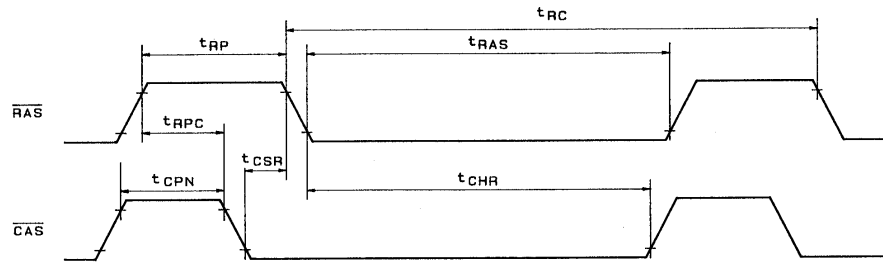
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Figure 4 DRAM Page Mode Read Cycle



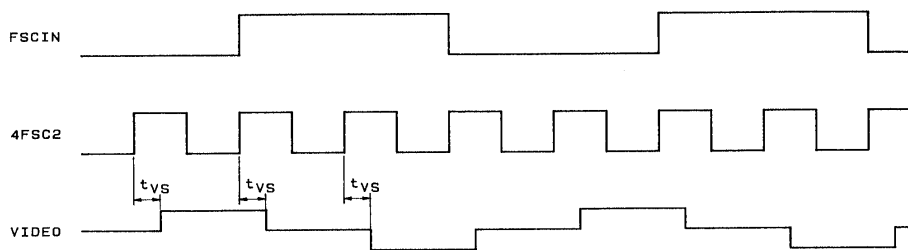
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Figure 5 DRAM Page Mode Write Cycle



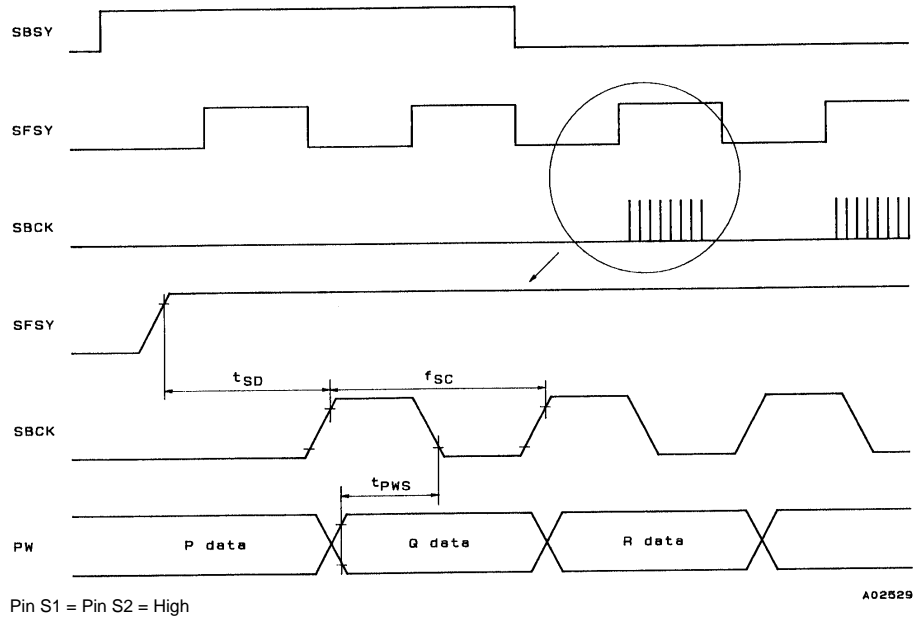
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Figure 6 DRAM  $\overline{\text{CAS}}$  before  $\overline{\text{RAS}}$  Refresh Cycle



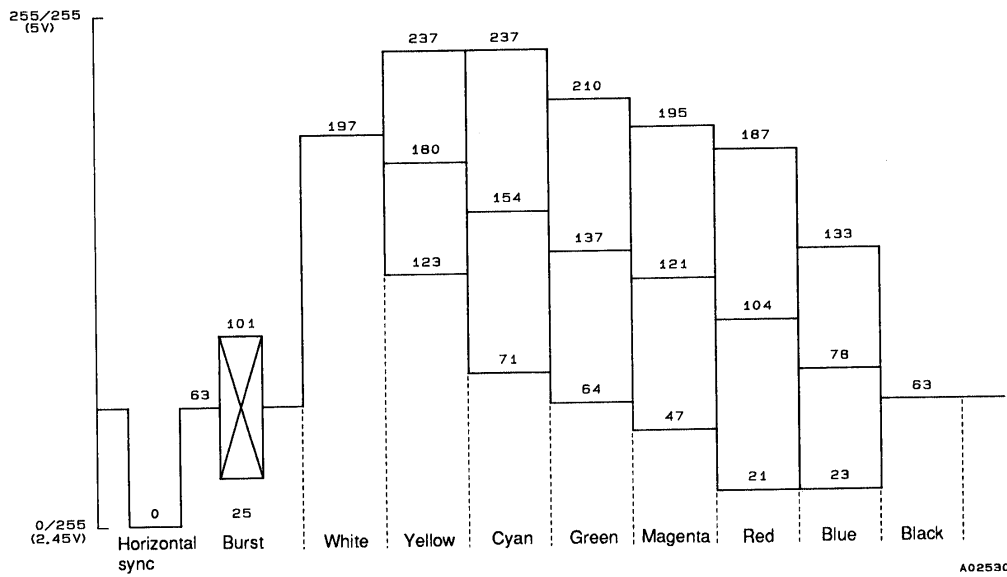
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Figure 7 Phase Relationships in Superimposition Mode



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Figure 8 Subcode Interface



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Figure 9 Composite Video 8-Bit Digital Values (Color Bar Output) at  $V_{DD2} = 5V$



## LC7872E

### Pin Functions

Pin No.	Symbol	I/O	Function	S1	S2	CD DSP
				1	S1	I
2	S2	I	1	0	LC7860K/63	
			1	1	LC7868/69/681	
3	SBCK	O	Subcode R to W readout clock			
4	SFSY	I	Subcode frame synchronization signal			
5	PW	I	Subcode R to W data			
6	SBSY	I	Subcode block synchronization signal			
7	V <sub>DD1</sub>	—	Digital system power supply			
8	CE	I	Serial input or control pin during serial output			
9	DO	O	Serial data output (N-ch open drain)			
10	DI	I	Serial data input			
11	CL	I	Serial data I/O clock			
12	MUTE	I	Control signal that invalidates the subcode data			
13	V <sub>SS1</sub>	—	Digital system ground			
14	$\overline{WE}$	O	DRAM control			
15	$\overline{RAS}$	O	DRAM control			
16	A0	O	DRAM address			
17	A1	O	DRAM address			
18	A2	O	DRAM address			
19	A3	O	DRAM address			
20	A4	O	DRAM address			
21	A5	O	DRAM address			
22	A6	O	DRAM address			
23	A7	O	DRAM address			
24	DB0	I/O	DRAM data			
25	$\overline{CAS}$	O	DRAM control			
26	DB1	I/O	DRAM data			
27	$\overline{OE}$	O	DRAM control			
28	DB2	I/O	DRAM data			
29	DB3	I/O	DRAM data			
30	CB	I	High: color bar output Low: normal mode (pull-down resistor built in)			
31	CDGM	O	Outputs a high level when a CD-G disk detected			
32	TRANS0	O	Transparency digital output			
33	TRANS1	O	Transparency digital output			
34	TRANS2	O	Transparency digital output			
35	TRANS3	O	Transparency digital output			
36	TRANS4	O	Transparency digital output			
37	TRANS5	O	Transparency digital output			
38	V <sub>SS2</sub>	—	Composite video D/A converter ground			
39	V <sub>DD2</sub>	—	Composite video D/A converter power supply			
40	BIAS	O	Ripple exclusion capacitor connection			
41	VIDEO	O	Composite video output (8-bit D/A converter output)			
42	TEST	I	Test pin. Must be tied low in normal operation (pull-down resistor built in)			
43	LINE	I	When pin NP2 is high: High: 263H, Low: 262H When pin NP2 is low: High: 312H, Low: 314H			
44	FSCIN	I	Subcarrier clock input (feedback resistor built in)			
45	VSYNC	O	Vertical synchronization signal output			
46	TEST1	I	Test pin. Must be tied low in normal operation (pull-down resistor built in)			
47	YS	O	Superimposition control output			
48	$\overline{CSYNC}$	O	Composite synchronization signal output			
49	4FSC2	I	Superimposition mode external clock input (feedback resistor built in)			
50	EFLG	O	Error state monitor			

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Pin No.	Symbol	I/O	Function	
51	FSX	O	Error state monitor trigger	
52	DEN	I	Disk information display enable pin	High: BGC Low: Enable (pull-down resistor built in)
53	PALID	I	Superimposition PAL mode external control (pull-up resistor built in)	
54	$\overline{\text{HRESET}}$	I	Horizontal timing external control	
55	FSC	O	Subcarrier clock output	NTSC mode: 3.579545 MHz PAL mode: 4.433619 MHz
56	$\overline{\text{VRESET}}$	I	Vertical timing external control	
57	$\overline{\text{RESET}}$	I	Reset input	
58	N/P1	I	NTSC/PAL selection	High: NTSC Low: PAL (RGB encoder)
59	N/P2	I	NTSC/PAL selection	High: NTSC Low: PAL (CD-G decoder)
60	SON	I	Superimposition on/off	
61	XIN2	I	Crystal oscillator connection 17.734476 MHz (PAL)	
62	XOUT2	O	Crystal oscillator connection 17.734476 MHz (PAL)	
63	XIN1	I	Crystal oscillator connection 14.31818 MHz (NTSC)	
64	XOUT1	O	Crystal oscillator connection 14.31818 MHz (NTSC)	

### CD-G Instructions

The LC7872E supports the following instructions that appear in the R to W subcodes as described in the CD Red Book.

1. MODE = 0, ITEM = 0 ZERO mode
2. MODE = 1, ITEM = 0 LINE GRAPHICS mode
  - Write FONT instruction (4)
  - Write Scroll SCREEN instruction (12)
3. MODE = 1, ITEM = 1 TV-GRAPHICS mode
  - Preset MEMORY instruction (1)
  - Preset BORDER instruction (2)
  - Write FONT FOREGROUND/BACKGROUND instruction (6)
  - Scroll SCREEN with preset instruction (20)
  - Scroll SCREEN with Copy instruction (24)
  - Load CLUT Color-0...7 instruction (30)
  - Load CLUT Color-8...15 instruction (31)
  - EXCLUSIVE-OR FONT instruction (38)
  - Define Color Transparency instruction (28)

**Pin Applications**

1. Crystal Clock Oscillator; XIN1, XOUT1, XIN2, XOUT2, N/P1, N/P2, FSC,  $\overline{\text{CSYNC}}$ , LINE and VSYNC

The LC7872E provides two crystal oscillator systems as follows.

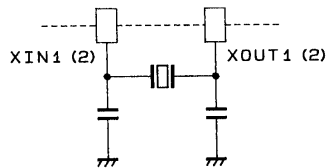
Pins XIN1 and XOUT1 are for use with a 14.31818 MHz crystal oscillator (NTSC)

Pins XIN2 and XOUT2 are for use with a 17.734476 MHz crystal oscillator (PAL)

Crystals can be connected to either crystal system 1 or 2 according to the application, or both systems can be used under the control of pins N/P1 and N/P2 to implement an application that supports both video standards. The N/P1 pin switches the LC7872E RGB encoder block between NTSC and PAL and the N/P2 pin switches the decoder block between NTSC and PAL. The FSC pin outputs a clock that is the crystal oscillator frequency divided by four. The  $\overline{\text{CSYNC}}$  pin is the composite synchronization signal output and VSYNC is the vertical synchronization signal output. The LINE pin switches the number of lines on a screen.

The table below lists the pin states in each mode.

XIN1, XOUT1	XIN2, XOUT2	N/P1	N/P2	Television system	FSC	LINE	$\overline{\text{CSYNC}}$
14.31818 MHz	*	High	High	NTSC/M	3.579545 MHz	H	16.71511323 ms
						L	16.65155767 ms
*	17.734476 MHz	Low	Low	PAL/GBIDH	4.433619 MHz	H	19.96788628 ms
						L	20.09588555 ms
14.30244 MHz	*	Low	High	PAL/M	3.575611 MHz	H	16.73350841 ms
						L	16.6698829 ms



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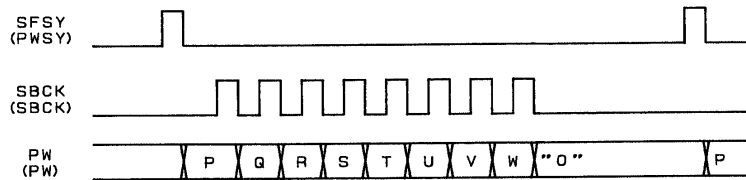
2. Subcode Interface; S1, S2, SBSY, SFSY, PW, SBCK and MUTE

The LC7872E supports three interface modes under the control of pins S1 and S2. When the MUTE pin is set high, SBSY and PW input is disabled and SBCK output stops.

S1	Low	High	High
S2	Low	Low	High
Mode	LC7861N/67 interface	LC7860K/63 interface	LC7868/69/681 interface

The SBCK delivery condition is that SFSY be confirmed to be low about 2.2  $\mu\text{s}$  after the SFSY falling edge in LC7860K/63 interface mode. In the other interface modes, the condition is that SFSY be confirmed to be high and SBSY be confirmed to be low about 2.2  $\mu\text{s}$  after the SFSY rising edge.

- LC7860 interface (Pin names in parentheses are LC7860 pins.)

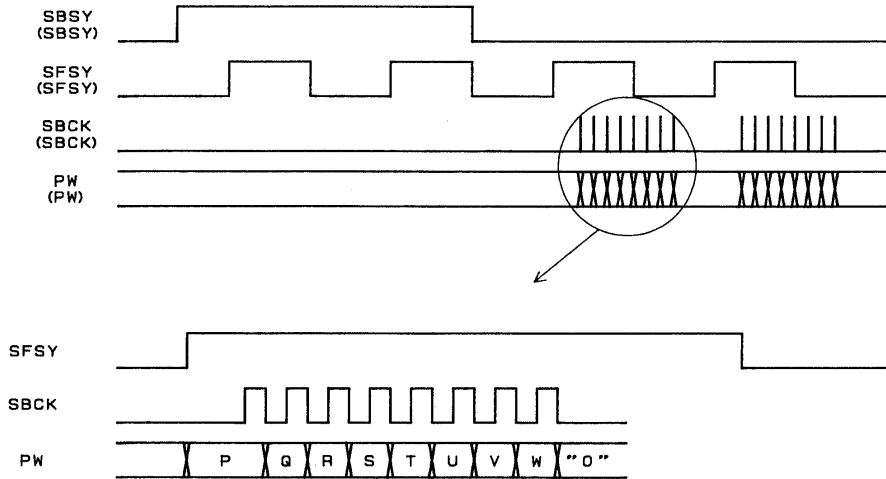


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- Note: 1. PWSY will be high during the S0 and S1 periods.  
2. The SBSY pin must be held low.

## LC7872E

- LC7861N/67 interface (Pin names in parentheses are DSP pins.)



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- LC7868/69/681 interface

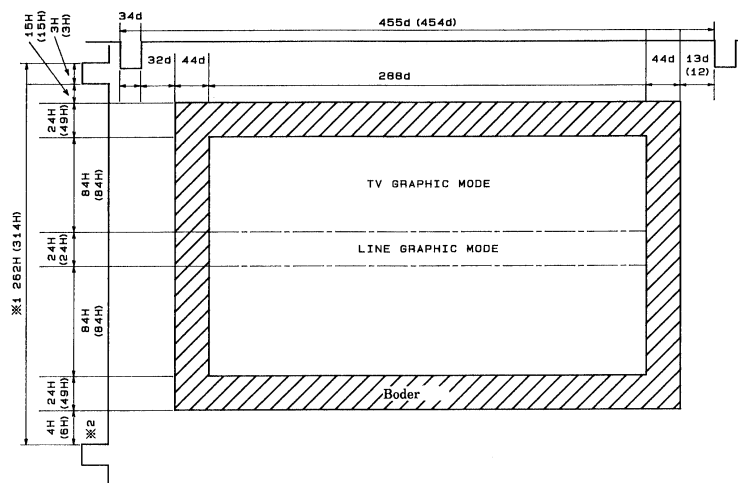
Identical to the LC7861N/67 interface except that the SBCK polarity is reversed (the shift occurs on the rising edge).

### 3. DRAM Interface; A0 to A7, DB0 to DB3, $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , $\overline{\text{WE}}$ , $\overline{\text{OE}}$

The LC7872E uses an external 64-kword  $\times$  4-bit DRAM.

### 4. Display Format; DEN, N/P1, N/P2, $\overline{\text{CSYNC}}$ , $\overline{\text{VRESET}}$ , $\overline{\text{HRESET}}$ , YS, VIDEO, PALID and TRANS0 to TRANS5

- Data to which error detection and correction has been applied is encoded by the RGB encoder and the 8-bit D/A converter output is output from the VIDEO pin. This circuit handles both NTSC and PAL formats and either mode can be specified using the N/P pins. See item 1 for details on the pin states for the NTSC and PAL specifications.
- The 4FSC2, FSCIN, YS,  $\overline{\text{VRESET}}$ ,  $\overline{\text{HRESET}}$ , PALID and TRANS0 to TRANS5 pins are used in superimposition mode. The image may be disrupted if the VRESET and HRESET signals are not synchronized with 4FSC2. The PALID pin is controlled in PAL mode, and is used to match the LC7872E burst signal to the burst component of the external video signal. When this pin is high, the phase of the burst signal changes every horizontal period, and when this pin is low, the phase does not change. The YS pin outputs a control signal used to switch between an external video signal and the LC7872E video signal. The output conditions for this signal are set by the 2N byte command input registers 0, E, F, and G. The pins TRANS0 through TRANS5 output signals according to the define transparency instruction.
- The DEN pin is a display control pin. The internal font data is output when DEN is low and the color data set up in the registers is used when DEN is high. The default state is blue.



Note: 1. Becomes 263H (312H) when the LINE pin is high.  
2. Becomes 5H (4H) when the LINE pin is high.

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5. CD Graphics Monitor; CDGM

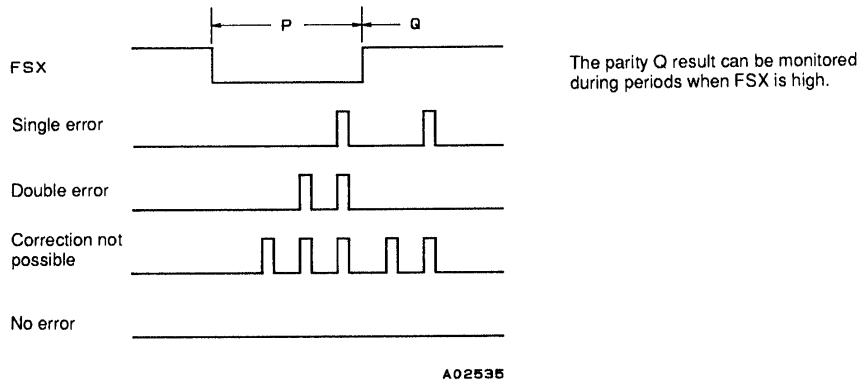
The CDGM pin goes high when the LC7872E receives any CD-G instruction. Since once this pin goes high it remains high as long as power is applied, using this pin requires a reset when the disk is changed.

6. Video Output; VIDEO

A composite video signal is output from the VIDEO pin. The output level of the 8-bit D/A converter is 2.5 Vp-p. Therefore only an external 75 Ω driver is required to acquire a 1 Vp-p rated output.

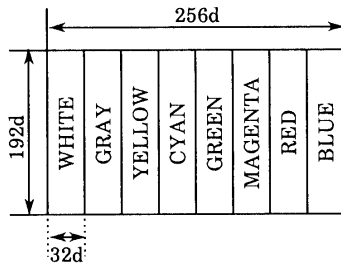
7. Error Flag Output; EFLG and FSX

The result of the error detection process can be monitored from the EFLG pin.



8. Color Bar Output; CB

The VIDEO pin outputs a color bar pattern when the CB pin is set high. The tables below describe this color bar pattern.

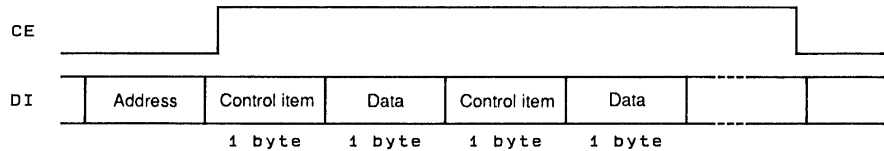


RGB Mixture Ratio (HEX)

Item	R	G	B
WHITE	F	F	F
GRAY	B	B	B
YELLOW	F	F	0
CYAN	0	F	F
GREEN	0	F	0
MAGENTA	F	0	F
RED	F	0	0
BLUE	0	0	F
BORDER (BLACK)	0	0	0

**Microcontroller Interface (CCB Bus)**

1. 2N byte input command



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Address (F4h): lsb [ 0 0 1 0 1 1 1 1 ] msb

Control item: lsb [ 0 - - - A A A A ] msb; Where A A A A is the register number.

Register 0 (mode setting)

Data: lsb [ A B C D E F G H ] msb; Default: [ 0 0 0 0 0 1 1 0 ]

A = VRAM/BG 0: Display the contents of VRAM  
1: Display the background color (BGC)

B = TV/LINE 0: TV graphics mode  
1: Line graphics mode

C = Disk command enable  
0: Only disk commands are accepted.  
1: Disk commands are ignored and only MGC is accepted.

D = Color bar on/off  
0: Off  
1: Color bar on

EFG = Comparison conditions in superimposition mode (only valid when SON = 1)

EF = 00: Comparison not performed.  
01: When the border color is not black, YS is set high (display) for section whose color does not match the border color and is set low (clear) otherwise.  
11: YS is set high for sections that do not match the chroma key color, and is set low otherwise.

G = 0: The whole screen is set low (clear) when the comparison condition does not hold for EF = 00 and EF = 01.

G = 1: The whole screen is set high (display) when the comparison condition does not hold for EF = 00 and EF = 01.

H = INIT 0: Normal  
1: Internal reset

On an internal reset the display screen is set to a blue background screen.

Register 1 (screen position adjustment)

Data: lsb [ H H H H V V V V ] msb; Default: [ 0 0 0 0 0 0 0 0 ]

H = horizontal direction. The value is specified as a two's complement value with left being the positive direction. Position is adjustable in two dot units from -16 to +14 dots from the center.

V = vertical direction. The value is specified as a two's complement value with up being the positive direction. Position is adjustable in two dot units from -16 to +14 dots from the center.

Register 2 (on/off settings for channels 0 to 7)

Data: lsb [ C C C C C C C C ] msb; Default: [ 1 1 0 0 0 0 0 0 ]

C = channel 0 to 7  
0: off  
1: on

Register 3 (on/off settings for channels 8 to 15)

Data: lsb [ C C C C C C C C ] msb; Default: [ 0 0 0 0 0 0 0 0 ]

C = channel 8 to 15

0: off

1: on

Register 4 (BGC R and G setting)

Data: lsb [ R R R R G G G G ] msb; Default: [ 0 0 0 0 0 0 0 0 ]

Register 5 (BGC B setting)

Data: lsb [ B B B B - - - - ] msb; Default: [ 0 1 0 1 - - - - ]

Register 6 (chroma key color R and G settings)

Data: lsb [ R R R R G G G G ] msb; Default: [ 0 0 0 0 0 0 0 0 ]

Register 7 (chroma key color B setting)

Data: lsb [ B B B B - - - - ] msb; Default: [ 0 0 0 0 - - - - ]

Register 8 (burst phase setting, only valid when SON = 1)

Data: lsb [ F F - - - - P ] msb; Default: [ 0 0 - - - - 0 ]

Register 9 (YS and TRANS output timing)

Data: lsb [ T T T - - - - - ] msb; Default: [ 0 0 1 - - - - - ]

T = phase setting. The phase difference between YS and TRANS (the digital output) and the video signal can be set to one of 8 levels from 0 to 7 in units of single 4FSC clock cycles. At a value of 4 the phase is identical to that of the VIDEO pin.

Register 10 (External synchronization on/off, test mode)

Data: lsb [ T T T - - Y S R ] msb; Default: [ 0 0 0 - - 0 0 ]

T = test mode setting

R = 0: Only the display area is moved

1: Motion also includes the border area (only left/right motion supported)

S = 0: Normal

1: Initializes the TLUT contents to all 0.\*

Y = 0: Resets HRESET and VRESET when an external clock is used (SON = 1)

1: Resets VRESET when an external clock is used (SON = 1) (HRESET is not required)

Note: \* In this state the define transparency command will not be accepted. (Return the system to the S = 0 state.)

Register 11 (subtitle scrolling, vertical)

Data: lsb [ V V V V V - - - ] msb; Default: [ 0 0 0 0 0 - - - ]

This setting allows the subtitle screen display position to be scrolled in font height units.

V = vertical (up) scrolling distance (0 to 17 font height units)

Register 12 (subtitle scrolling, horizontal)

Data: lsb [ H H H H H H H - - ] msb; Default: [ 0 0 0 0 0 0 - - ]

This setting allows the subtitle screen display position to be scrolled in font width units.

H = horizontal (left) scrolling distance (0 to 49 font width units)

Register 13 (TRANS setting, only valid when SON = 1)

Data: lsb [ B B B B B B - P ] msb; Default: [ 0 0 0 0 0 0 - 1 ]

P = 1: Enables the TRANS setting.

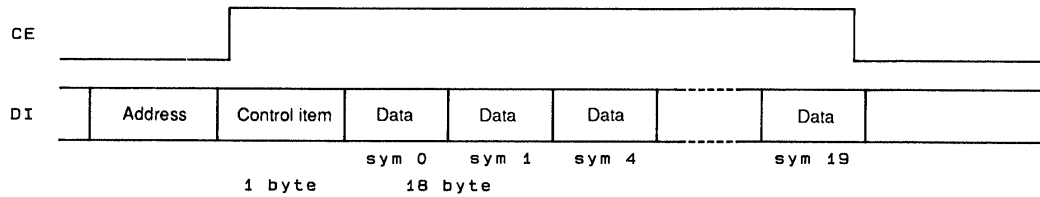
0: Invalid

(The whole screen is displayed and burst goes to the CDG side.)

B = the BGC TRANS value

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### 2. 19-byte input command (MGC write)



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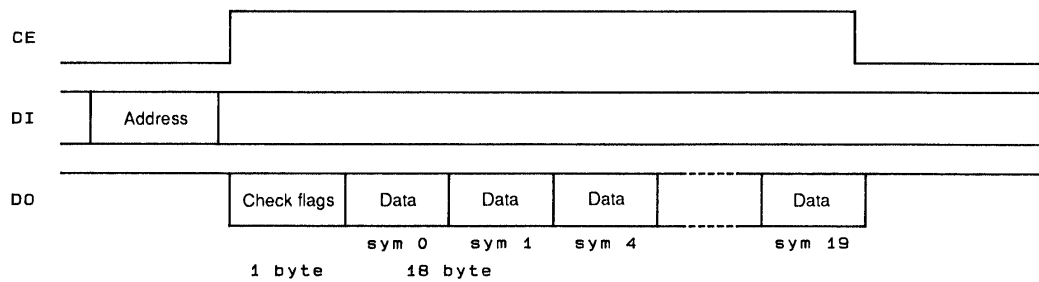
Address (F4h): lsb [ 0 0 1 0 1 1 1 1 ] msb

Control item: lsb [ 1 - - - - - ] msb

Data: lsb [ - - W V U T S R ] msb; R to W is the subcode input.

This command is executed on the CE falling edge.

### 3. 19-byte output command (packed data readout)



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Address (F5h): lsb [ 1 0 1 0 1 1 1 1 ] msb

Check flags: lsb [ A B C D Q Q P P ] msb

Data: lsb [ - - W V U T S R ] msb

A = Set to 1 when the following 18 bytes are guaranteed and furthermore this is the first data item read out. (The readout operation must be completed within 1.1 ms.)

B = 0: Command execution in progress

1: Command wait state

C = VBLANK: Set to 1 during the vertical blanking period

D = Disk identifier flag

0: CD

1: CD-G

Q = QF0 and QF1 (Q error correction flags)

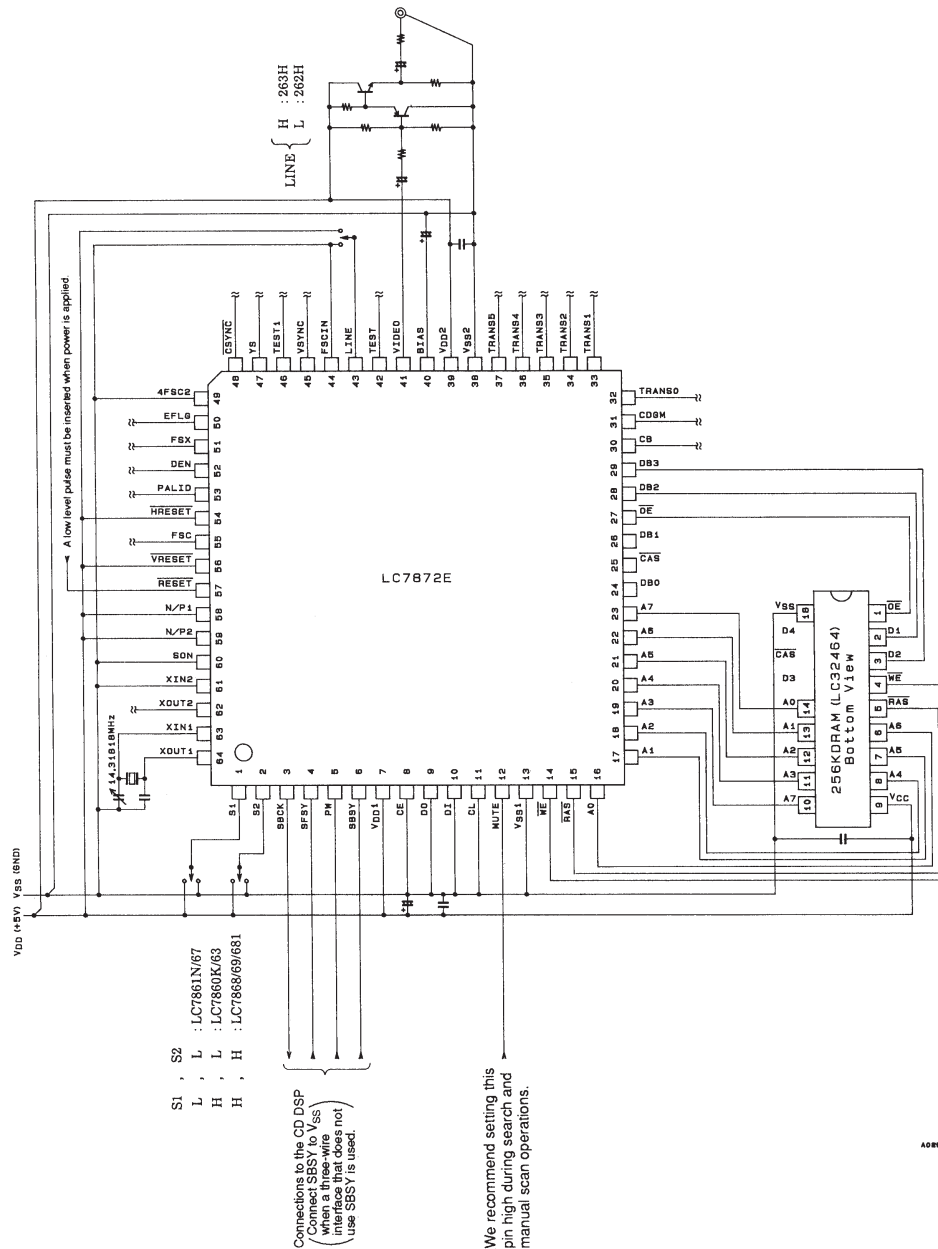
P = PF0 and PF1 (P error correction flags)

Note that when it is not necessary to read out all 19 bytes, the readout can be interrupted at any point in byte units. (In particular, this command can be used to read out only the check flags.)



# LC7872E

## NTSC Application Circuit Using the LC7872E



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