CIRCUIT DESCRIPTION

6. Digital signal processing LSI CXD1125Q (X25-2932-71 : IC2)

The CXD1125Q is the digital signal processing LSI for the compact disc player, and has the following functions. All the digital signals for reproduction can be processed internally with this one-chip design.

- Bit clock reproduction by an EFM-PLL circuit.
- EFM data demodulation.
- Frame sync signal detection, protection and insertion.
- Powerful error detection and correction.
- Interpolation with average value or by holding the previous value.
- Demodulaiton of sub code signal or error detection of sub code Q.
- Spindle motor CLV servo.
- 8-bit tracking counter.
- CPU interface with a serial bus.
- Sub code Q register.
- D/A interface output.

6–1. Block diagram

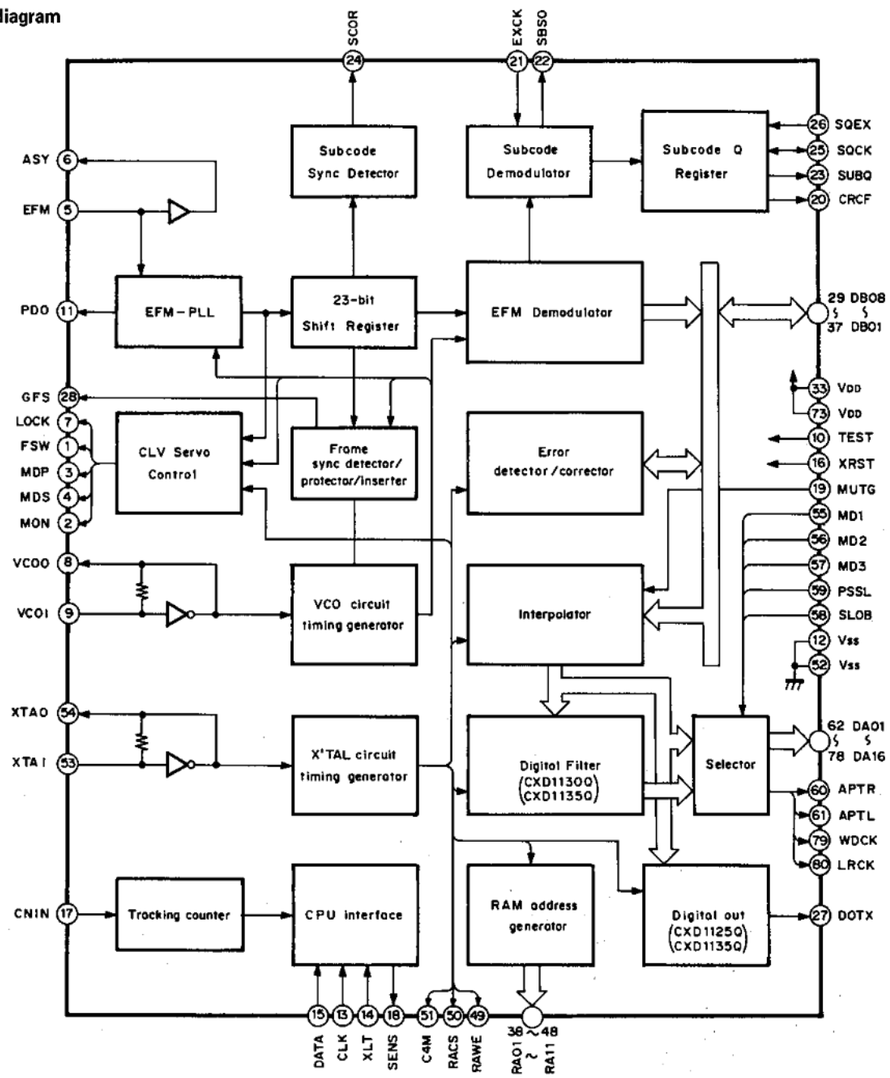


Fig. 6–1

DP-969

CIRCUIT DESCRIPTION

6–2. Explanation of terminals

Terminal No.	Terminal name	I/O	Function
1	FSW	O	Time constant switching output of output filter of spindle motor.
2	MON	O	ON/OFF control output of spindle motor.
3	MDP	O	Drive output of spindle motor. Rough speed control in CLV-S mode and phase control in CLV-P mode.
4	MDS	O	Drive output of spindle motor. Speed control in CLV-P mode.
5	EFM	I	EFM signal input from RF amplifier.
6	ASY	O	Output for controlling the slice level of EFM signal.
7	LOCK	O	Samples the GFS signal with WFCK/16, and outputs "H" when the level is high. When it is "L" for eight times, in arow, outputs "L".
8	VCOO	O	VCO output. f = 8.6436MHz when locked to EFM signal.
9	VCOI	I	VCO input.
10	TEST	I	(0V)
11	PDO	O	Phase comparison output of EFM signal and VCO/2.
12	Vss	–	GND (0V)
13	CLK	I	Serial data transmission clock input from CPU. Data is latched at rising edge of a clock.
14	XLT	I	Latch input from CPU. Data (serial data from CPU) from the 8 bit shift register is latched in each register.
15	DATA	I	Serial data input from CPU.
16	XRST	I	System reset input. Reset at "L".
17	CNIN	I	Input of tracking pulse.
18	SENSE	O	Output of internal status in correspondence to the address.
19	MUTG	I	Muting input. In the case where ATTM of internal register A is "L". normal status when MUTG is "L" or soundless state when it is "H".
20	CRCF	O	Output of result of CRC check of sub code Q.
21	EXCK	I	Clock input for sub code serial output.
22	SBSO	O	Sub code Q read-off clock.
23	SUBQ	O	Sub code Q output.
24	SCOR	O	Sub code sync SO + S1 output.
25	WFCK	O	Write Frame Clock output. f = 7.35kHz when the frame sync is locked.
28	CFS	O	Output of display of lock status of frame sync.
29	DB08	I/O	Data terminal of external RAM. DATA 8 (MSB)
30	DB07	I/O	Data terminal of external RAM. DATA 7
31	DB06	I/O	Data terminal of external RAM. DATA 6
32	DB05	I/O	Data terminal of external RAM. DATA 5
33	VDD	–	Power supply (+ 5V)
34	DB04	I/O	Data terminal of external RAM. DATA 4
35	DB03	I/O	Data terminal of external RAM. DATA 3
36	DB02	I/O	Data terminal of external RAM. DATA 2
37	DB01	I/O	Data terminal of external RAM. DATA 1 (LSB)
38	RA01	O	Address output of external RAM. ADDR01 (LSB)
39	RA02	O	Address output of external RAM. ADDR02
40	RA03	O	Address output of external RAM. ADDR03
41	RA04	O	Address output of external RAM. ADDR04
42	RA05	O	Address output of external RAM. ADDR05
43	RA06	O	Address output of external RAM. ADDR06
44	RA07	O	Address output of external RAM. ADDR07
45	RA08	O	Address output of external RAM. ADDR08
46	RA09	O	Address output of external RAM. ADDR09
47	RA10	O	Address output of external RAM. ADDR10
48	RA11	O	Address output of external RAM. ADDR11 (MSB)
49	RAWE	O	Write Enable signal output to external RAM. (active at "L").
50	RACS	O	Chip select signal output to external RAM. (active at "L").

Table 6–1

CIRCUIT DESCRIPTION

Terminal No.	Terminal name	I/O	Function
51	C4M	O	Crystal dividing output. f = 4.2336MHz.
52	Vss	–	GND (0V).
53	XTAI	I	Crystal oscillator input. f = 8.4672MHz or 16.9344MHz depending on the mode selected.
54	XTAO	O	Crystal oscillator output. f = 8.4672MHz or 16.9344MHz depending on the mode selected.
55	MD1	I	Mode select input 1.
56	MD2	I	Mode select input 2.
57	MD3	I	Mode select input 3.
58	SLOB	I	Audio data output code select input. 2's complement output when "L", offset binary output when "H".
59	PSSL	I	Audio data output mode select output. Serial output when "L", parallel output when "H".
60	APTR	O	Aperture compensation control output. "H" when R-ch.
61	APTL	O	Aperture compensation control output. "H" when L-ch.
62	DA01	O	DA01 (parallel audio data LSB) output when PSSL = "H", C1F1 output when PSSL = "L".
63	DA02	O	DA02 output when PSSL = "H", C1F2 output when PSSL = "L".
64	DA03	O	DA03 output when PSSL = "H", C2F1 output when PSSL = "L".
65	DA04	O	DA04 output when PSSL = "H", C2F2 output when PSSL = "L".
66	DA05	O	DA05 output when PSSL = "H", C2FL output when PSSL = "L".
67	DA06	O	DA06 output when PSSL = "H", C2PO output when PSSL = "L".
68	DA07	O	DA07 output when PSSL = "H", RFCK output when PSSL = "L".
69	DA08	O	DA08 output when PSSL = "H", WFCK output when PSSL = "L".
70	DA09	O	DA09 output when PSSL = "H", $\overline{\text{PLCK}}$ output when PSSL = "L".
71	DA10	O	DA10 output when PSSL = "H", UGFS output when PSSL = "L".
72	DA11	O	DA11 output when PSSL = "H", GTOP output when PSSL = "L".
73	VDD	–	Power supply (+ 5V).
74	DA12	O	DA12 output when PSSL = "H", RAOV output when PSSL = "L".
75	DA13	O	DA13 output when PSSL = "H", C4LR output when PSSL = "L".
76	DA14	O	DA14 output when PSSL = "H", $\overline{\text{C21O}}$ output when PSSL = "L".
77	DA15	O	DA15 output when PSSL = "H", C21O output when PSSL = "L".
78	DA16	O	DA16 (parallel audio data MSB) output when PSSL = "H", DATA output when PSSL = "L".
79	WDCK	O	Strobe signal output. 88.2kHz.
80	LRCK	O	Strobe signal output. 44.1kHz.

Notes:

C1F1 :
C1F2 : } Error correction status monitor output for C1 decode.

C2F1 :
C2F2 : } Error correction status monitor output for C2 decode.

C2PO : C2 pointer signal.

C2FL : Correction status output. Goes "H" when the currently corrected C2 series data cannot be corrected.

RFCK : Read frame clock output. 7.35MHz when locked to the crystal line.

WFCK : Write frame clock output. 7.35MHz when locked to the crystal line.

$\overline{\text{PLCK}}$: VCO/2 output. f = 4.3218MHz when locked to the EFM signal.

UGFS : Non-protected frame sync pattern output.

GTOP : Frame sync protect status display output.

RAOV : ±4 frame jitter absorption RAM overflow and underflow display output.

C4LR : Strobe signal. 176.4kHz.

$\overline{\text{C21O}}$: C21O invert output.

C21O : Bit clock output. 2.1168MHz.

DATA : Audio signal serial data output.

Table 6–1

CIRCUIT DESCRIPTION

6–3. Explanation of functions

- **CPU interface**

1) Data input

Each register may be set by input of 4 bit address, and 4 bit data from LSB in the timing that is shown in Fig. 6–2 to three terminals, XLT, CLK and DATA. The address and data of each terminal are as shown in Table 6–2, and their functions are as follows. The contents of each register become entirely 0 when XRST = "L".

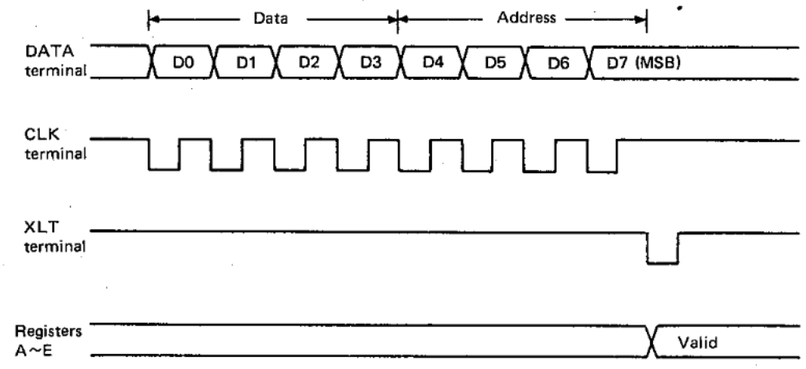


Fig. 6–2 Timing chart for data input

2) Registers

○ Register 9 – New function control

Controls the new functions added to the CX23035.

D3 : ZCMT Switches the zero cross mute function ON/OFF. Details are described in **"Interpolation and Mute, Attenuate"**.

D2 : HZPD One of the defect countermeasures. Switches ON/OFF the function which makes the PD0 pin a high impedance (Z) for a maximum of 0.55ms from the rising edge of GFS. Details are described in **"Countermeasures to defects"**.

D1 : NCLV Switches between the old CLV-P servo and the new CLV-P servo by comparison with newly added base counter. Details are described in **"CLV servo control"**.

D0 : CRCQ Switches ON/OFF the function which outputs the CRCF data to the SUBQ pin from the rising edge of SCOR to the trailing edge of SQCK. Details are described in **"5) Subcode output"**.

○ Register A – Sync. protection, attenuator control

D3 : GSEM
D2 : GSEL
D1 : WSEL } Provided for switching frame synk. protection characteristics in correspondence to the time of playback and time of access. Details will be described in the paragraph of **"EFM demodulation"**.

D0 : ATTM Used for attenuating audio signals by 12dB, and the details will be described in the paragraph of **"D/A interface"**.

○ Registers B and C – Counter set, more significant 4 bits (register C) and less significant 4 bits (register B)

these registers are used for setting the tracking count value. the data of registers B and C are preset in the counter through the 4 bit buffer register assigned by address. Accordingly, when data of either register B or C is input, the contents of both registers are preset in the counter simultaneously as 8 bit data (either buffer register is of "OLD" data.)

D3 : DIV The dividing ratio of RFCK and WFCK in CLV-P mode is fixed, and the phase is compared with RFCK/4 or WFCK/4 respectively, regardless of the status of D3, then output from the MDP pin.

○ Register D-CLV control

D3 : DIV Used for setting the frequency dividing ratio of RFCK, WFCK in the CLV-P mode. When D3 = 0,, phase comparison of RFCK/4 and WFCK/4 is made, and when D3 = 1, phase comparison of RFCK/8 and WFCK/8 is made, and output is made out of MDP terminal in each case.

D2 : T_B Used for determining the period of bottom hold in the CLV-S and CLV-H modes.
Bottom hold is made in the period of RFCK /32 when D2 = 0 or in the period of RFCK/16 when D2 = 1.

D1 : Tp Used for setting the period of peak hold in the CLV-S mode. Peak hold is made in the period of RFCK/4 when D1 = 0 or in the period of RFCK/2 when D1 = 1.

D0 : GAIN Used for setting the gain of MDP terminal output in the CLV-S and CLV-H modes. It is –12dB (time of 3/4 out of the period of RFCK/2 is of high impedance) when D0 = 0 or is 0dB when D0 = 1.

CIRCUIT DESCRIPTION

○ Register E-CLV mode

It is as shown in Table 6–2.

The details of each mode will be described in the paragraph of CLV servo control.

Register name	Command	Address D7~D4	Data D3	D2	D1	D0	SENSE terminal
9*1	New function control	1001	ZCMT	HZPD	NCLV	CRCQ	Z
A*2	Sync protection, attenuator control	1010	GSEM	GSEL	WSEL	ATTM	Z
B	Counter set, Less significant 4 bits	1011	Tc3	Tc2	Tc1	Tc0	$\overline{\text{COMPLETE}}$
C	Counter set, More significant 4 bits	1100	Tc7	Tc6	Tc5	Tc4	$\overline{\text{COUNT}}$
D*3	CLV control	1101	DIV	T_B	T_P	GAIN	Z
E*4	CLV mode	1110		CLV mode			$\overline{Pw \geqq 64}$

*1 **Register 9**

		Dn = 0	Dn = 1
ZCMT	D3	Zero-cross MUTE off	Zero-cross MUTE on
HZPD	D2	PDC pin is always active	PDC pin is "Z" at the trailing edge of GFS
NCLV	D1	CLV-P servo for the frame sync signal	CLV-P servo for the base counter
CRCQ	D0	CRCF is not superimposed on SUBQ	SUBQ = CRCF at the raising edge of SCOR

*2 **Register A**

GSEM	GSEL	Frame
0	0	2
0	1	4
1	0	8
1	1	13

WSEL	Clock
0	±3
1	±7

ATTM	MUTG terminal	dB
0	0	0
0	1	−∞
1	0	−12
1	1	−12

*3 **Register D**

DIV	D3	0	RFCK/4 & WFCK/4	Phase comparison frequency in CLV-P mode
		1	RFCK/8 & WFCK/8	
T_B	D2	0	RFCK/32	Bottom hold period in CLV-S, CLV-H mode
		1	RFCK/16	
T_P	D1	0	RFCK/4	Peak hold frequency in CLV-S mode
		1	RFCK/2	
GAIN	D0	0	−12dB	Gain at MDP terminal in CLV-S, CLV-H mode
		1	0dB	

*4 **Register E**

Mode	D3~D0	MDP terminal	MDS terminal	FSW terminal	MON terminal
STOP	0000	L	Z	L	L
KICK	1000	H	Z	L	H
BRAKE	1010	L	Z	L	H
CLV-S	1110	CLV-S	Z	L	H
CLV-H	1100	CLV-H	Z	L	H
CLV-P	1111	CLV-P	CLV-P	Z	H
CLV-A	0110	CLV-S or CLV-P	Z or CLV-P	L or Z	H

Z : High impedance

Table 6–2 List of registers

CIRCUIT DESCRIPTION

3) Trakcing counter

This counter is provided for facilitating track jump. Load the number of tracks to be jumped in register B and C. Count of CNIN pulses is started at raising edge of XLT after it was loaded in either register B or C.

When n (n = 256 is meant when register B = register C = 0) is loaded in registers and the address is set at "B", a signal ($\overline{\text{COMPLETE}}$) that is of HIGH level up to "n" pulses and is of LOW level after "n" pulses is output of SENSE terminal. When the address is set at "C", signal ($\overline{\text{COUNT}}$) of CNIN/2n (Hz) is output.

The tracking counter timing chart is shown in Fig. 6–3.

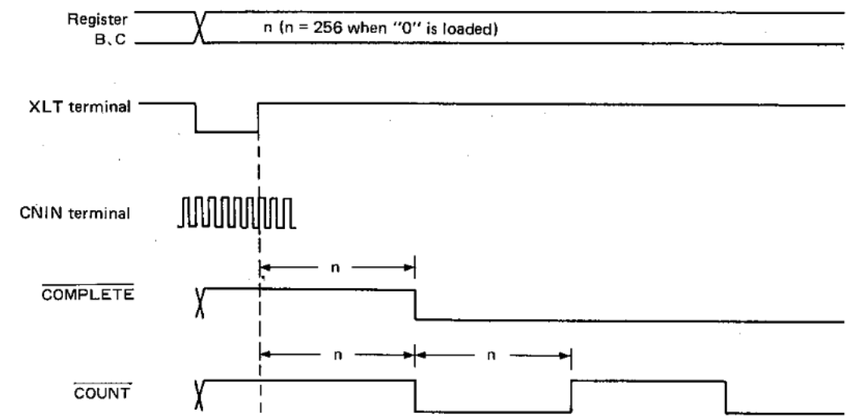


Fig. 6–3 Tracking counter timing chart

4) SENSE

The following signals are output from SENSE terminal depending on the address of D7~D4.

1. $\overline{\text{COMPLETE}}$: Address is "B"; Shown in Fig. 6–3.
2. $\overline{\text{COUNT}}$: Address is "C"; Shown in Fig. 6–3.
3. $\overline{\text{PW} \geqq 64}$: Address is "E"; this signal is of LOW level when the pulse width after bottom hold is over 63, and is of HIGH level otherwise. It is used for detection of a drop in the speed of the spindle motor after braking and so on.

Note : Address setting is determined only by the data that corresponds to D4~D7 which can be input from DATA terminal shown in Fig. 6–2.

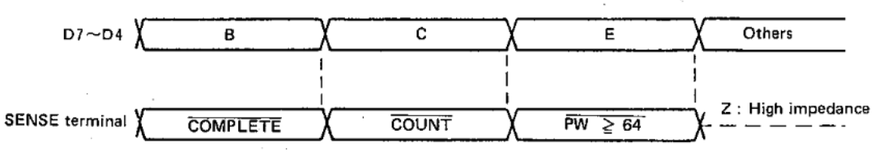


Fig. 6–4 Timing chart of SENSE terminal

CIRCUIT DESCRIPTION

5) Sub code output

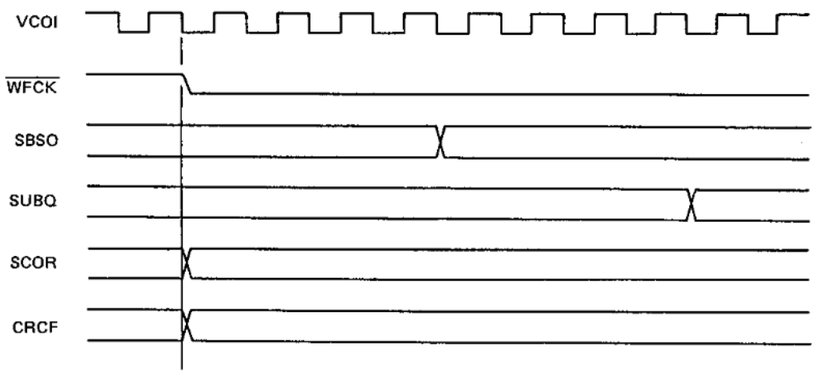
Sub codes P~W loaded in the 8 bit shift register are output out of SBSO terminal in accordance with the clock input through EXCK terminal. when SCOR terminal is "H", S0 · S1 signal is output.

Sub code Q is as follows, depending on the SQEX pin status.

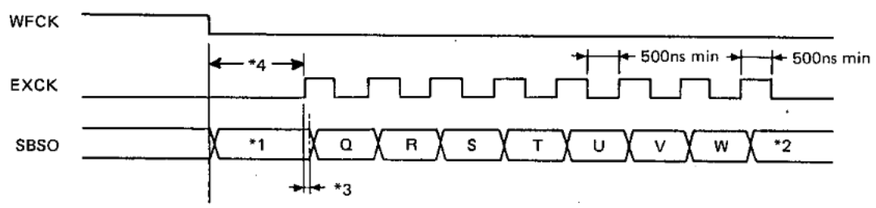
(i) When the SQEX pin is "L", sub code Q is output from the SUBQ pin in synchronism with the WFCK signal in the same way as for the CX23035. The $\overline{WFCK}$ is also output from the SQCK pin.

(ii) When the SQEX pin is "H", sub code Q is output from the SUBQ pin in synchronism with the external clock (as from the microprocessor). Two 80-bit shift registers, for reading and writing, are incorporated, and while the microprocessor reads, the new sub code Q is written to another register. The microprocessor is interrupted from the outside at the rising edge of the SCOR pin, and after checking the CRCF flag (output to the CRCF pin, or the SUBQ pin when the CRCQ flag is "1"), the CRCF is checked. If CRCF = "H", a shift lock is output and the new sub code Q is read. After the LSB side is replaced with the MSB side by a unit of 4 bits, the data is stored in register. As the microprocessor serially inputs from the LSB first, replacing the 4 bits of data is unnecessary.

(a) Timing of SBSO, SUBQ, SCOR, CRCF



(b) Timing of SBSO, EXCK



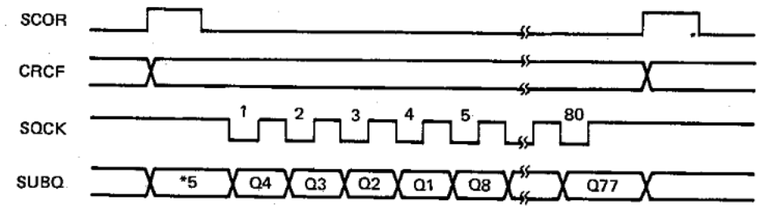
*1 : Sub code P is output when SCOR is 0.
S0 · S1 is output when SCOR is 1.
*2 : SBSO is 0 when 8 or more pulses are input to EXCK.
*3 : 4T ~ 6T if the period of VCO is expressed as T.
*4 : Make EXCK low for 10μs from the rising edge of WFCK.
One time period of T = 8.6436MHz.

Fig. 6–5 (1) Timing chart of sub code outputs

CIRCUIT DESCRIPTION

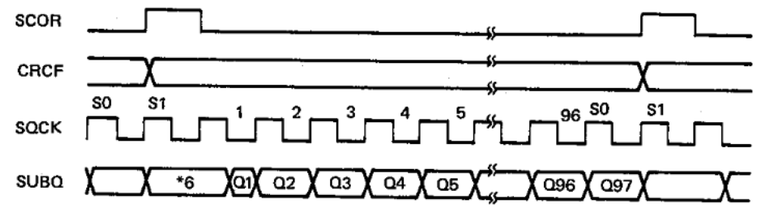
(c) Timing of SCOR, CRCF, SQCK, SUBQ

SQEX= "H" level



*5 : CRCF when CRCQ flag is "1", undefined when "0".

SQEX= "L" level



*6 : CRCF when CRCQ flag is "1", Q98,Q1 when "0".

Fig. 6–5 (2) Timing chart of sub code outputs

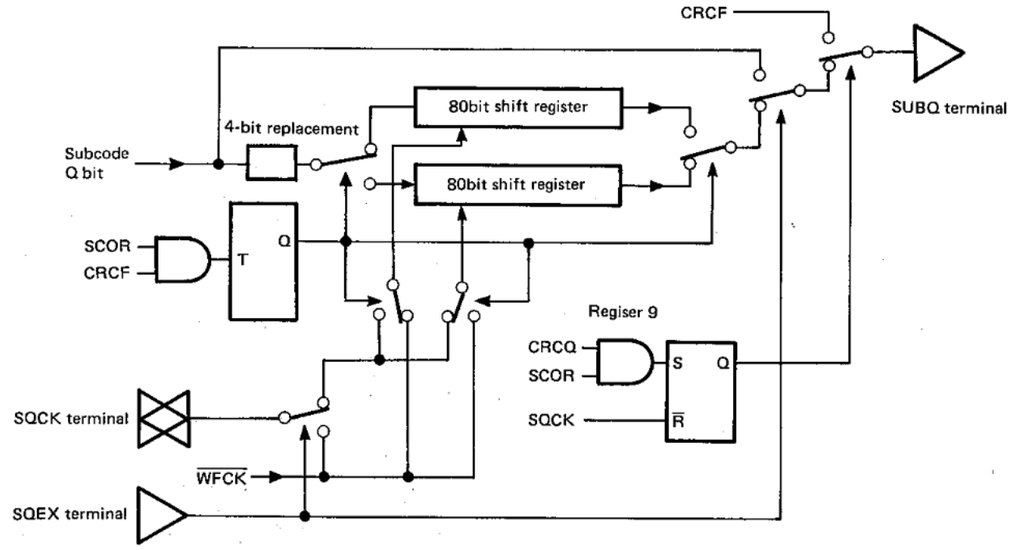


Fig. 6–6

CIRCUIT DESCRIPTION

- **EFM demodulation**

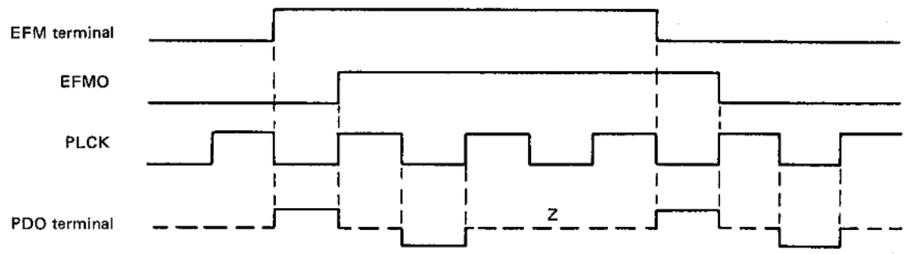
1) Playback of bit clock by EFM-PLL circuit

The EFM signal read out of the optical block contains a clock component of 2.16MHz. Therefore, it is possible to take out a bit clock (PLCK) of 4.32MHz synchronized with this clock by the EFM-PLL circuit.

At each edge of EFM signal, phase comparison is made with PLCK, which is 1/2 of VCO, is made and output is made by TRI STATE out of PDO terminal. The mean value of PDO terminal is about 1/2 VDD if synchronized, but the mean value drops when VCO becomes higher. On the other hand, the mean value increases when VCO becomes less.

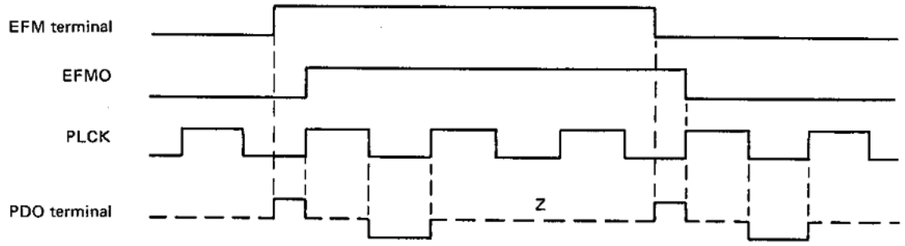
The timing charts of EFM terminal, EFMO, PLCK and PDO are shown in Fig. 6–7.

(a) When EFM signal and VCO are synchronized



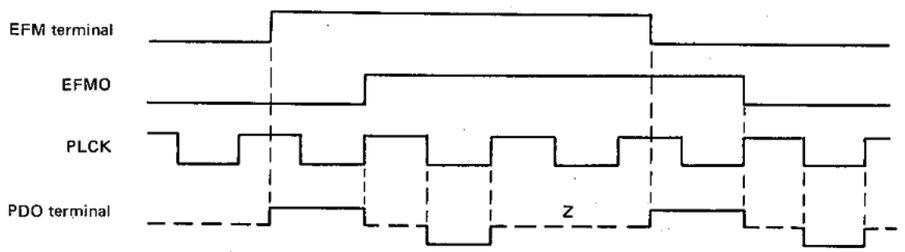
Z : High impedance

(b) When VCO is higher than EFM signal



Z : High impedance

(c) When VCO is less than EFM signal



Z : High impedance

Fig. 6–7 Timing charts of EFM-PLL circuit

CIRCUIT DESCRIPTION

2) Detection, protection and interpolation of frame synchronizing signals

There are cases during recording where the same pattern is detected in the data due to the influence of drop-out and jitter, even if a pattern that is same as the synchronizing signal will not appear.

On the other hand, there also are cases where original frame synchronizing signal is not detected. Therefore, protection and interpolation are required besides detection.

The edge portion only of EFM signal (EFMO) latched with PLCK is converted to "1" and the rest to "0", and then input is to a 23 bit shift register and a frame synchronizing signal is detected.

In order to protect a frame synchronizing signal, a window is provided and the same patterns outside of this window are removed. This width can be selected with WSEL. If no frame synchronizing signal is located in this window, interpolation is made with a signal produced by 588-mal counter (4.3218MHz/588 = 7.35kHz)

A 4 bit counter for counting the number of these frames to be interpolated is provided, and when its count reaches the level selected with GSEL, GSEM, the window is ignored and the 4 bit counter is reset with the next frame synchronizing signal. the GTOP terminal is of "H" while this operation is performed. Further, GFS terminal is of "H" when the frame synchronizing signal generated by the 588-mal counter for making interpolation is synchronized with the frame synchronizing signal from the disc.

The frame synchronizing signal before passage through the window or the wondow is output out of UGFS (DA05 terminal at the time when PSSL = L.)

WSEL	Window width
0	±3 clock
1	±7 clock

GSEM	GSEL	Number of frames to be interpolated	UGFS (PSSL = "L")
0	0	2 frames	Window
0	1	4 frames	Window
1	0	8 frames	Frame synchronizing signal before passage through window.
1	1	13 frames	Window

The timing for write request signal (WREQ), Write Frame Clock (WFCK), etc. is generated based on the protected and interpolated frame synchronizing signal.

3) EFM demodulation

14 bit data is taken out of the 23 bit shift register and is demodulated to 8 bit data through 14 → 8 conversion circuit composed of array logics. Then a write request (WREQ) signal is output to the RAM interface block, and the data is then output to the data bus (DB08~DB01) terminals) of the RAM in accordance with the OENB signal transmitted from said block.

- **Sub code demodulation**

1) Sub code demodulation

synchronizing signals S0, S1 of 14 bit sub codes are detected out of the 23 bit shift register, and sampling is made in the timing that is synchronized with WFCK.

After delay of S0 by one frame, S0 + S1 is output out of SCOR terminal and S0 · S1 is output out of SBSO terminal (only when SCOR = H.)

Data (P~W) of sub codes only is input to the register in the timing synchronized with WFCK after EFM demodulation; and sub code Q is output out of SUBQ terminal, and at the same time, it is loaded in the 8 bit shift register and is output out of SBSO terminal in correspondence to a clock from EXCK terminal.

The detials of this timing will be shown in the paragraph of CPU interface.

2) Sub code Q error detection

The CRC sub code result is output from the CRCF pin in synchronism with the SCOR pin. It goes "L" when an error is detected. At the same time as the CRCQ flag is "1", the CRCF flag is output from the SUBQ pin during the time from the rising edge of the SCOR pin to the trailing edge of the SUBQ pin. This timing is detialed in **"CPU interface"**.

CIRCUIT DESCRIPTION

- **RAM interface (generation of external RAM address)**

1) Request from EFM demodulation block (Write RAM request)

When one symbol of demodulation is complete in the EFM demodulation block, the EFM demodulation block requests to write data to the external RAM to the RAM interface block. This request is WREQ signal. This block gives priority orders to requests from other blocks and processes these requests.

When EFM write request is received, an address is generated to the RAM and Write Enable state is produced. Furthermore, a data output instruction is issued against the EFM demodulation block. This instruction is OENB signal.

Clocks of PLL system are used for EFM block and for requests (WREQ) from EFM block, but clocks of X'Tal system are used for processing thereafter.

2) Request from D/A converter output circuit (Read to D/A request)

This is a de-interleaved data request issued out of the timing generator in this block. This request is of the highest priority among all requests, and addresses of three types are generated against this request.

This request is generated once every 24 periods based on the period of system clock C212 (8.4672MHz/4). The data output out of the RAM is C2 pointer first, less significant 8 bits out of 16 bits and finally more significant 8 bits.

3) Request from error correction block (C1/C2 correction, pointer R/W)

The error correction block requests the data located on the system (C1/C2) to be corrected. Furthermore, there is a request to rewrite incorrect data to correct data. In addition, there is a request for pointer R/W which indicates reliability of data.

These requests are made by the 8 bit data directed to the RAM interface block from the error correction block. The requests from the error correction unit are of the lowest priority among requests of three types. After acceptance of a request, data from RAM is directed to the 3rd clock of C212.

The data of acceptance of a request is output to the error correction block as a PREN signal. This block generates the address of the requested data, and controls R/W of the RAM at the same time.

4) Address generation

The data after EFM demodulation is data subjected to interleave processing. This interleave processing is subjected to data lag by the unit of a frame. Data of 108 frames are required for de-interleave. In other words, for obtaining one frame of audio data played in a certain length of time, data of 108 frames after EFM demodulation are required. Further, the system data of C1/C2 is of the system in the process of application of interleave, and therefore, is included in 108 frames.

Data in practice are generated continuously. That is, de-interleave should be updated by the unit of a frame. Therefore, Read/Write base counters are required. This base counter performs counting by the unit of a frame.

The writer base counter is used only at the time of EFM data writer. The address directed to the external RAM is determined by the relative lag value to EFM demodulation data and their number of frames.

5) Priority of address generation request

The system control block determines priority of address generation requests made to the RAM interface block.

The priority order is as follows beginning with higher priority.

1. Read to D/A request
2. Write to RAM request
3. C1/C2 request

The number of times of requests is as follows.

1. Requests of 12 times in the frame section
   The number of times of address generation to it is 36 times.
2. Requests of 32 times in the frame section
   The number of times of address generation to it is 32 times.
3. Maximum number of times of request (C1 Double error correction, C2 pointer copy)
   Read R/W 64 times, Pointe R/W 65 times in one frame section
   The number of times of address generation to it is 129 times.

288 C212 (clocks) are included in a frame, and the number of times of operation of the RAM in it is 197 times at maximum. In the system control block, against request 1, the timing of its occurrence is reserved in advance. Requests 2, 3 are not accepted in this timing. When requests 2, 3 are generated simultaneously, priority is given to request 2, and if a requestis generated during execution of either request, priority is given to the job in execution.

CIRCUIT DESCRIPTION

6) Jitter margin

The EFM demodulation data is synchronized with data's playback system (PLL) as described earlier. Accordingly, it includes disturbance (wow, flutter, etc.) of disc rotation servo, etc. It is loaded to the external RAM. As the data taken out of the RAM is synmchronized with the clock of X'Tal system, this RAM is subjected to time axis correction.

However, the limit of time axis correction is determined by the capacity of the RAM. In this system, other data is destroyed when read/write frames are spaced apart by ±5 frames. In such a status how the playback sound is cannot be guaranteed. The base counter monitor is provided in order to avoid it.

In other words, when the difference between read base counter and write base counter exceeds ±4 frames, the write base counter is set in the value of the read base counter. As a result, there is no case where data without error correction is output to the D/A.

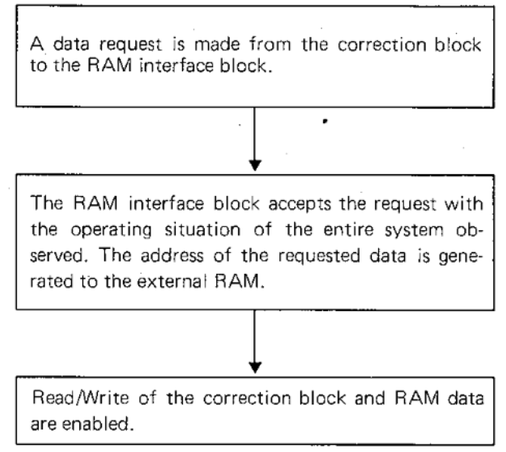
The RAOV signal is of "H" for one frame (WFCK) section when the difference between base counters exceeded ±4 frames.

- **Error correction**

1) The error correction block makes correction up to double errors with each of C1 correction and C2 correction.
2) This system adopts a unique pointer erasure method in order to minimize erroneous correction. Accordingly, the external 16k RAM stores these pointer data in addition to audio data.
3) The pointer generated in C1 correction is called C1 pointer and the pointer generated in C2 correction is called C2 pointer.
4) When the data of C1 system is judged as reliable, a C1 pointer is set in this system.
5) During C2 correction, whether correction is to be made or not to be made and whether the data is reliable or unreliable are judged from the error location, locations and number of C1 pointers obtained through computation. A C2 pointer is set against an unreliable word (16 bits).
6) The word in which a C2 pointer was set is subjected to previous value hold or mean value interpolation when it is output out of this LSI.
7) Terminal C2FL becomes "H" when one or more C1 pointers are set in the data included in the C2 system at the time of C2 correction. C2FL is reset to "L" when a period of minimum 472ns after deactivation of terminal RFCK. C2FL is the AND of C2F1 and C2F2.

Note : 472ns : One period of 2.1168MHz

8) The flow of data with the external RAM is as follows.



9) When PSSL is set at "L", a signal that is capable of monitoring error correction is output. C1F1, C1F2, C2F2 output to DA01~DA04 are these monitor signals. This signal is reset to "L" when a period of minimum 472 ns has elapsed since deactivation of RFCK.

The levels and meanings of these signals at the time of deactivaiton of RFCK are as follows.

C1F1	C1F2	C1 correction status
0	0	No Error
1	0	Single error correction
0	1	Double error correction
1	1	Irretrievable error

C2F1	C2F2	C2FL	C2 correction status
0	0	0	No Error
1	0	0	Single error correction
0	1	0	Double error correction
1	1	1	Irretrievable error

CIRCUIT DESCRIPTION

- **CLV servo control**

The spindle motor revolution is controlled with one selected out of the following seven modes in accordance with a command from the CPU. CLV is the abbreviation of Constant Linear Velocity. The output is composed of MDP terminal for controlling synchronization of velocity and phase, MDS terminal for controlling synchronization of velocity, FSW terminal for making selection of filter constant and MON terminal for controlling motor ON/OFF.

1) STOP : Register E = 0000'B (B means binary)
Mode for stopping the spindle motor.
MDP = FSW = MON = "L", MDS = "Z"

2) KICK : Register E = 1000'B
Mode for running the spindle motor in forward direction.
MDP = MON = "H", MDS = "Z", FSW = "L".

3) BRAKE: Register E = 1010'B
Mode for running the spindle motor in reverse direction.
MDP = FSW = "L", MDS = "Z", MON = "H".

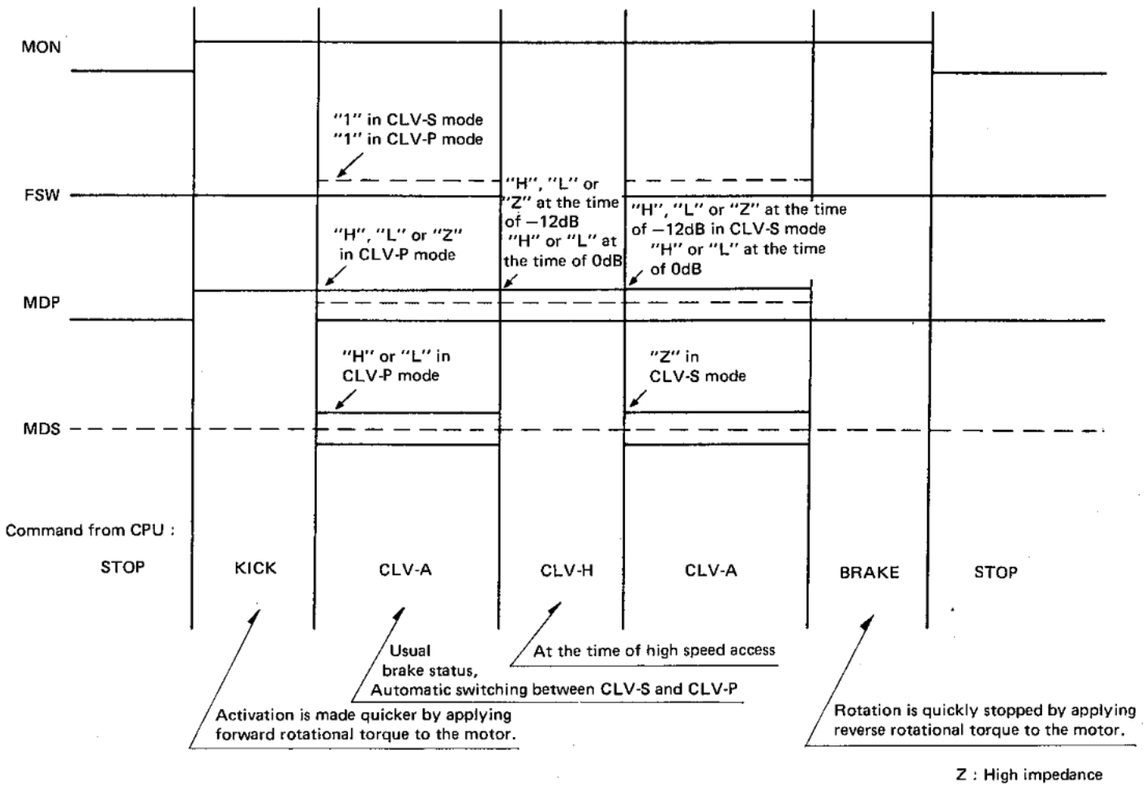


Fig. 6–8 Typical control of spindle motor

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CIRCUIT DESCRIPTION

4) CLV-S : Register E = 1100'B
Rough servo mode used at the time of start of rotation, at the time of track jump and also when the EFM-PLL circuit is unlocked due to another reason. When the period of VCO's oscillation frequency 8.6436MHz is expressed as "T", the pulse width of a frame synchronizing signal is "22T" during specified revolution, and it is the maximum pulse width in a period of RFCK. In practive, however, there are pulses having widths over "22T" due to drop-off of EFM signal due to other reasons, and the frame synchronizing signal cannot be correctly detected unless such pulses are removed. Therefore, the maximum value (peak) of the pulse width of EFM signal is detected (called peak hold) in the period of RFCK/2 or RFCK/4, than the minimum value in this peak is detected (called bottom hold) in the period of RFCK/16 or RFCK/32, and this value is used as the frame synchronizing signal. "L" is produced out of MDS terminal while the frame synchronizing signal is "21T" or less, "Z" when it is "22T", or "H" when it is "23T" or more.
Either 0dB or 12dB can be selected as its gain.
MDS = "Z", FSW = "L", MON = "H".

5) CLV-P: Register E = 1111'B
PLL servo mode.
When the NCLV of register 9 is "0", the phase of the WFCK/4 signal and the phase of the RFCK/4 signal are compared and output to the MDP pin. When NCLV = "1", 1/4 of the base counter frame frequencies at the Write side and the Read side are phase-compared and output to the MDP pin. It goes "H" when WFCK is slow, "L" when it is fast, and is "Z" when synchronized. If the 8.4672/2MHz period is T, and the time when WFCK is "H" is tHW, then the MDS pin outputs a signal which goes "H" during the time from the trailing edge of WFCK to the time represented by (tHW−279T) X 32, and then goes "L" until the next trailing edge of WFCK.
MDS $\leqq$ "H" when tHW = 279T,
MDS = "L" when tHW $\geqq$ 279T.
The MDS pin varies between 32T and 544T, in 32T steps, when 280T $\leqq$ tHW $\leqq$ 296T. For example, when synchronized (rotating at the standard speed), that is when tHW = 288T, a 7.35kHz signal, with a duty cycle of 50% is output.
FSW = "Z", MON = "H".

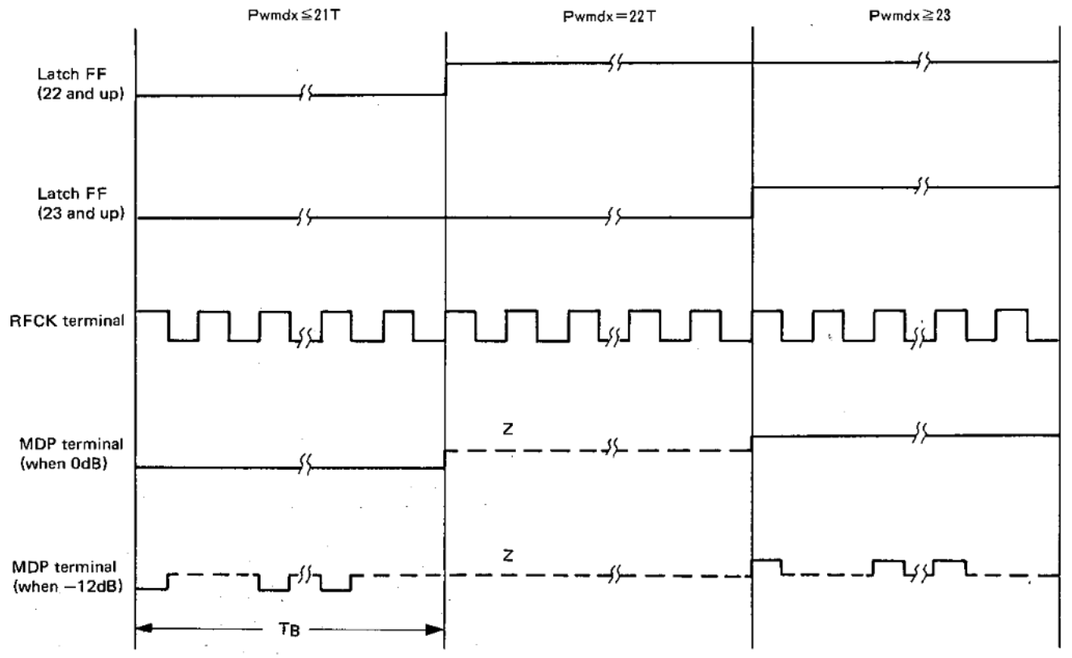


Fig. 6–9 Timing chart in CLV-S, CLV-H mode (1)

CIRCUIT DESCRIPTION

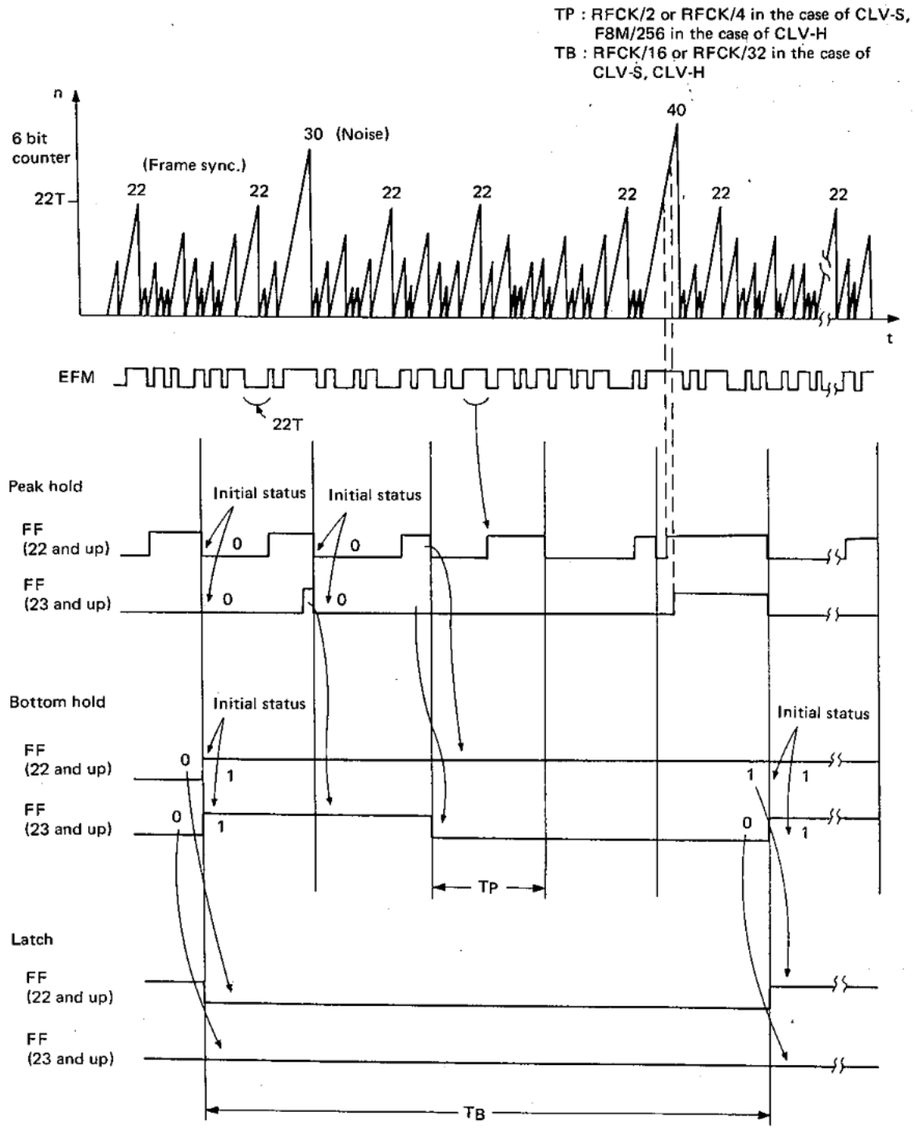
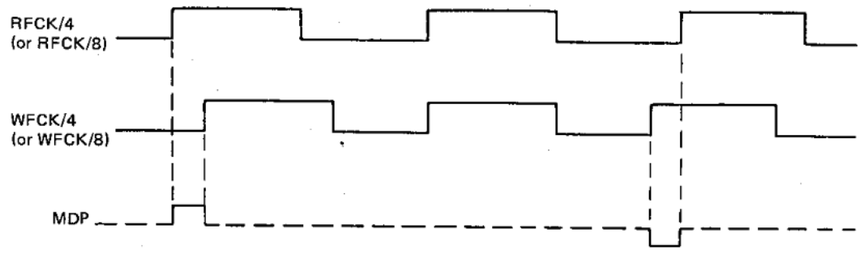


Fig. 6—10 Timing chart in CLV-S, CLV-H mode (2)

CIRCUIT DESCRIPTION

6) CLV-P : Register E = 1111'B
PLL servo mode.
Phase comparison of signals WFCK/4 and RFCK/4 or WFCK/8 and RFCK/8 is made, and output is made out of MDP terminal. "H" when WFCK has delayed, "L" when WFCK is fast, and "Z" when synchronized. When the period of 8.4672/2MHz is expressed at T and the length of time when WFCK is "H" is expressed at tHW, such a signal that is of "H" during (tHW—279T) x 32 with 7.35kHz as a period and that is "L" during the remaining time is produced out of MDS terminal. MDS = "L" when tHW ≦ 279T. MDS = "H" when tHW ≦ 297T. When 280T ≦ tHW ≦ 296T, the MDS terminal changes in 32T steps from 32T to 544T. When synchronized, for instance, that is, when tHW = 288T, a signal of 7.35kHz of DUTY 50% is produced. FSW = "Z", MON = "H".

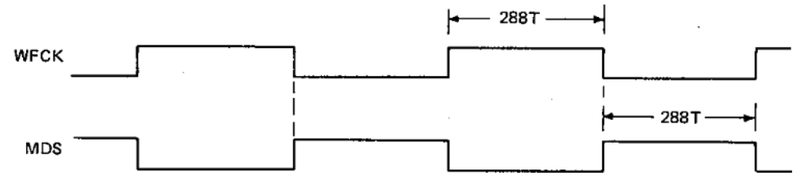
MDP terminal



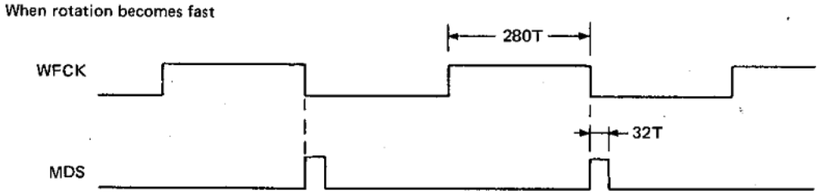
Z : High impedance

MDS terminal (The Period of 4.2336MHz is expressed as "T".)

(1) When rotating at specified velocity



(2) When rotation becomes fast



(3) When rotation becomes slow

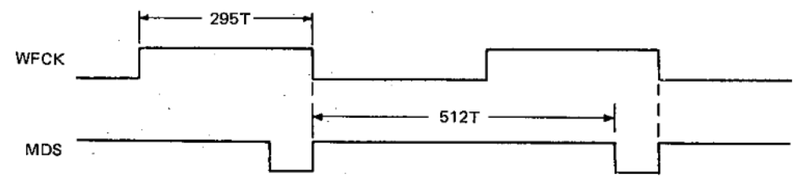


Fig. 6—11 Timing chart in CLV-P mode

CIRCUIT DESCRIPTION

7) CLV-A: Register E = 0110'B

The mode used for normal play status.

The GFS signal ("H" when locked, "L" when unlocked), after frame sync detection, protection and insertion block, is sampled at WFCK/16, and functions in CLV-P mode when the signal is "H". When the "L" signal continues for 8 times, the mode is automatically changed to CLV-S mode. When in the CLV-S mode, setting of the peak hold period, and setting of the period and gain of the bottom hold of the CLV-S and CLV-H are performed in register D, and the selection of each mode is perfomred in register E. The description of these registers are detialed in **"CPU interface"**.

Note: When PSSL = "L", DA07 pin outputs WFCK/4 or WFCK/8 as FCKV, and DA08 outputs EFCK/4 or EFCK/8 as FCKX.

8) CLV-A' : Register E = 0101'B

New auto servo mode added to the CX23035. The difference between CLV-A. and CLV-A is in the rough servo system. With the old rough servo system, the EFM pattern is measured by a crystal and the servo is applied so that the width of the sync pattern is a fixed value, and the rotation speed of the spindle motor is roughly fixed. In this case, if the value is out of the VCO capture range, the VCO never locks with the EFM. With the new rough servo system, a VCO is used for measurement instead of a crystal. If the VCO center is shifted from true center the VCO tends to lock, since the rotation of the spindle motor varies in the same direction.

The new rough servo functions only in CLV-A' mode. The rough servo in CLV-A mode and CLV-S mode is the old rough servo.

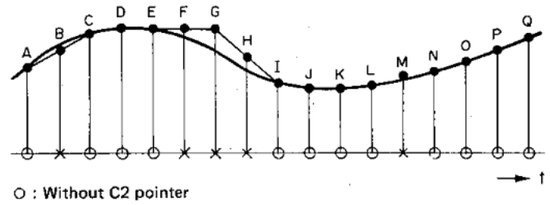
CIRCUIT DESCRIPTION

• Interpolation and D/A converter interface

1) Interpolation circuit block

3 byte data can be obtained with a Read to D/A request. They are C2 pointer, less significant 8 bits and more significant 8 bits. The total 16 bits constitute the data generated per sampling (2's complement.)

The C2 pointer expresses the reliability of this 16 bit data. Therefore, data with C2 pointer is subject to interpolation in this block.



O : Without C2 pointer
X : With C2 pointer

Fig. 6–12

Mean value interpolation

$$B=\frac{1}{2}(A+C)$$

$$H=\frac{1}{2}(E+I)$$: When pointers are continuous

$$M=\frac{1}{2}(L+N)$$

Previous value hold

$$F=G=E$$

16 bit data is alternately output to L-ch and R-ch, R-ch data is output in the section in which LRCK is "L" and L-ch data is output in the section in which LRCK is "H". C2PO signal outputs C2 pointer to the 16 bit data directed to DA01–DA16 (PSSL = H), DA16 (PSSL = L). In other words, it means that the 16 bit data that is output when C2PO is "H" is interpolated data.

2) Explanation of muting and attenuator

In the muting block it is possible to mute (– ∞ dB) or attenuate (–12dB) the audio signal in accordance with the MUTG terminal and ATTM signal of the CPU interface block.

ATTM	MUTG	Attenuation value	Remarks
0	0	0dB	
1	0	–12dB	
0	1	– ∞ dB	See Note
1	1	–12dB	See Note

NOTE : When the MUTG is set to "H" level with the NCLV flag set to "0", the read base counter value is continuously loaded into the write base counter as well as the muting.
Except at CLV-A, CLV-P, CLV-S, or CLV-A' with the NCLV flag set to "1", the base counter is loaded.

CIRCUIT DESCRIPTION

- **Mode setting**

The various kinds of mode can be set by combining the following pins. (Refer to the table below.)

MD1 pin : Mainly for selection of the oscillator clock at the XTAI or XTAO pin.

MD2 pin : Mainly for selection of the digital out function.

MD3 pin : Mainly for selection of the digital filter function.

PSSL pin : Mainly for selection between serial and parallel output.

SLOB pin : Selection between offset binary and 2's complement.

Input terminal					Function						(Note)	Compatible IC	
MD1	MD2	MD3	PSSL	SLOB	8M/16M	DO OFF/ON	DF OFF/ON	P/S	OB/2's	CD ROM/AUDIO		CXD1125	CXD1130
L	L	L	L	L	16M	DO ON	DF ON	Seri	2's	AUDIO			
L	L	L	H	H	↓	↓	↓	Para	OB	↓			
L	L	H	L	L	↓	↓	DF OFF	Seri	2's	↓		○	
L	H	L	L	L	↓	DO OFF	DF ON	↓	↓	↓			○
L	H	L	H	H	↓	↓	↓	Para	OB	↓			○
L	H	H	L	L	↓	↓	DF OFF	Seri	2's	↓		○	○
L	H	H	H	H	↓	↓	↓	Para	OB	↓		○	○
H	L	L	L	L	8M	↓	DF ON	Seri	2's	↓			○
H	L	L	H	H	↓	↓	↓	Para	OB	↓			○
H	L	H	L	L	↓	↓	DF OFF	Seri	2's	↓		○	○
H	L	H	H	H	↓	↓	↓	Para	OB	↓		○	○
H	H	H	L	L	16M	DO ON	↓	Seri	2's	CD ROM		○	
H	H	H	H	L	8M	DO OFF	↓	↓	↓	↓		○	○

(Note)

- 8M/16M : Selection of clock, XTAL or XTAO. 8.4672MHz/16.9344MHz
- DO OFF/ON : Digital out OFF/ON
- DF OFF/ON : Digital filter OFF/ON
- P/S : Parallel output/serial output
- OB/2's : Offset binary/2's complement
- CD ROM/AUDIO : Compatible to CD ROM/Compatible to audio

1) Selection of clock

The oscillator clock for XTAI and XTAO is available at 16.9344MHz and 8.4672MHz. However, when digital out is used, the clock must be set to 16.9344MHz.

2) Selection of digital out (Refer to "D/A interface")

When digital out is set to ON, a signal conforming to the D/A interface format is output from the DOTX pin. When it is set to OFF, the DCTX pin outputs the WFCK signal. In the DP-969, this function is fixed to ON.

3) Selection of digital filter

When the digital filter function is set to ON, the DAC interface signal are all set to double speed.

4) Selection of parallel output/serial output

When the parallel output is selected, DA01 to DA16 pins output the 16-bit parallel data. When the serial output is selected, DA01 to DA16 pin output the following signals respectively.

DA01 → C1F1 : } Error correction status monitor
DA02 → C1F2 : } output at C1 decode.
DA03 → C2F1 : } Error correction status monitor
DA04 → C2F2 : } output at C2 decode.
DA05 → C2FL : Correction status output, C2FL = C2F1·C2F2.

DA06 → C2PO : C2 pointer signal.
DA07 → RFCK : Read frame clock signal, 7.35kHz when locked to the crystal line.
DA08 → WFCK : Write frame clock signal, 7.35kHz when locked.
DA09 → $\overline{\text{PLCK}}$: 1/2 of the divided signal from the VCO pin, 4.3218MHz when locked.
DA10 → UGFS : Non-protect frame sync signal.
DA11 → GTOP : Frame sync protect status display signal.
DA12 → RAOV : Jitter margin over or underflow display signal.
DA13 → C4LR : 4 times the LRCK signal.
DA14 → $\overline{\text{C21O}}$: Bit clock (invert signal of C21O).
DA15 → C21O : Internal system clock (4.2336MHz when DF is ON, 2.1168MHz when CXD1125Q or DF is OFF).
DA16 → DATA : Serial data output (MSB or LSB first output).

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CIRCUIT DESCRIPTION

5) Selection of OFFSET BINARY/2'S COMPLEMENT

When the SLOB pin is "H", an offset binary signal is output, and when it is "L", a 2's complement signal is output.

6) Selection of CD ROM/AUDIO compatibility

When MD1 = MD2 = MD3 = "H", the player is compatible with a CD ROM and outputs the C2 pointer for each byte. At the same time, the average value interpolation and the previous value holding operations are not performed. For example, when there is an error in the upper 8 bits of the 16 bits, only the C2 pointer corresponding to the upper 8 bits goes "H", and the lower 8 bits are processed as the correct data.

- **D/A Interface**

The player incorporates a D/A interface output (digital output) and the digital signal is output from the DOTX pin. The digital signal is output after passing through interpolation, mute and attenuator circuits. The 4 control bits (ID0, ID1, COPY, EMPHASIS) in the C-bit channel status perform a CRC check and are revised only when it's OK.

- **Countermeasures to defect**

To counter a defect, the PDC pin is set to "Hi-Z" during the time until GFS goes "H" again after inverting from "H" to "L" or after approx. 0.55ms has elapsed. However, this operation is performed only when the HZPD flag of register 9 is "1". When HZPD = "0", it will never be set to "Hi-Z".

The signal switching between the rough servo in the CLV-A or CLV-A' mode and the PLL servo is output from the LOCK pin. After the GFS signal is sampled at WFCK/16, and when the signal is "1", the LOCK pin goes "H", when a "0" is present 8 times in a row, the LOCK pin goes "L".

This operation is similar to that for the FSW pin. However, while the FSW outputs a fixed signal when not in CLV-A' mode, the LOCK pin always output the above signal.

- **Timing chart**

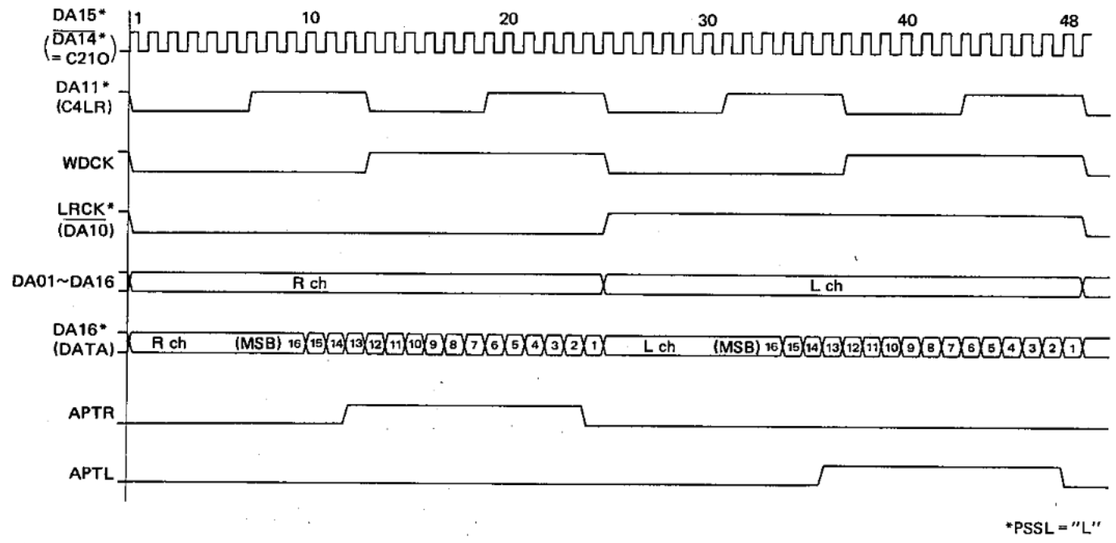
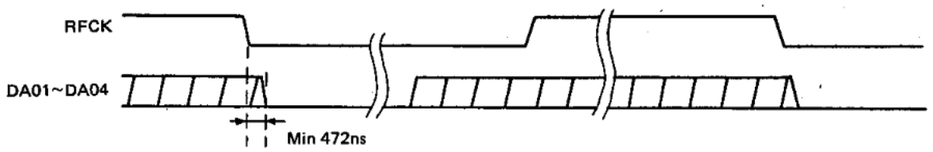
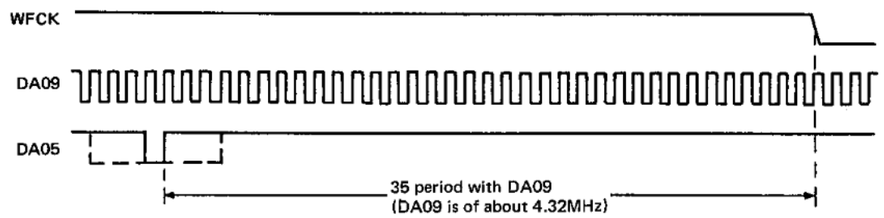


Fig. 6—13 Timing chart of audio output

CIRCUIT DESCRIPTION



* DA01~DA04 (C1F1, C1F2, C2F1, C2F2) are cleared when a period of minimum 472 ns has elapsed since RFCK was deactivated.
* ANDing signal of C2F1 and C2F2 is output out of C2FL termnal.



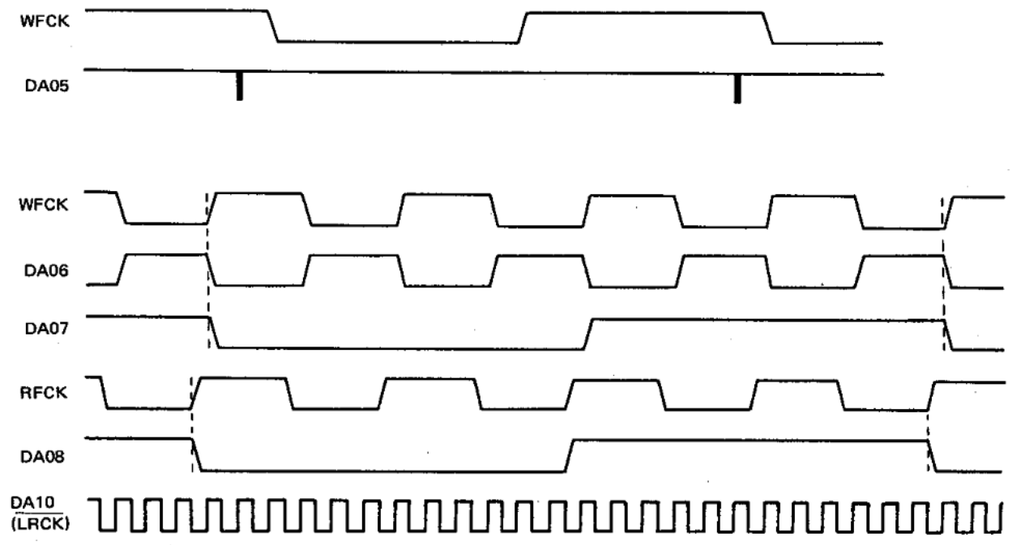


Fig. 6–14 Timing chart of DA01~DA16 output when PSSL = "L"

CIRCUIT DESCRIPTION

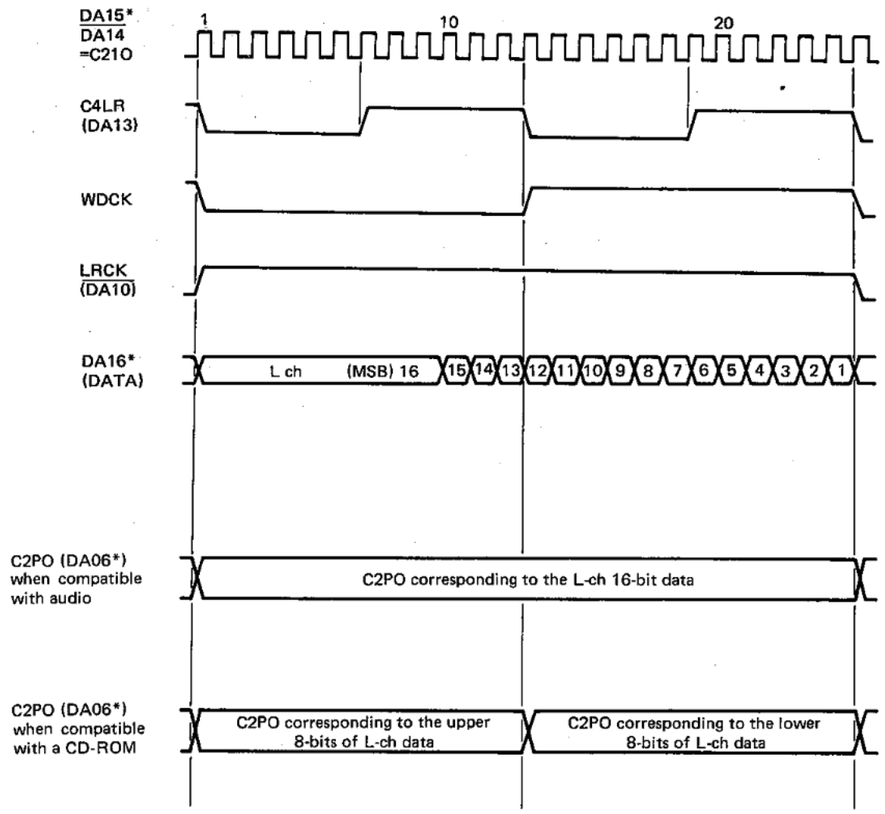


Fig. 6–15 Timing chart of C2PO output (when PSSL = "L")

* RAOV becomes "H" for one frame (synchronized with WFCK) when a jitter that exceeds ±4 frames is generated between RFCK and WFCK.

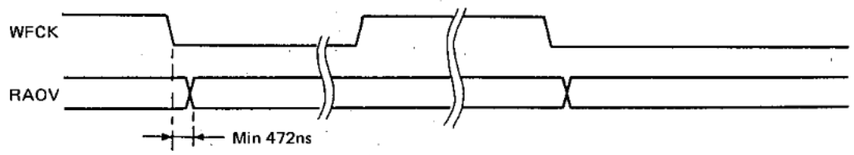


Fig. 6–16 Timing chart of RAOV output