CBS RECORDS
PROFESSIONAL SERIES

CBS RECORDS CD-1

STANDARD TEST DISC

1. INTRODUCTION

The CBS Records CD-1 Test Disc is a highly accurate signal source specifically designed for those interested in making a full range of demanding performance measurements on Compact Disc (CD) players. Because of the convenient nature of the CD medium and high quality of the recorded signals, the disc is also suitable for use as a source for testing a variety of audio systems or components, including tape recorders, amplifiers and speakers, All 16-bit digital audio test signals contained in the 21 tracks and over 71 minutes of playing time have been computer generated and transferred in digital form to the CD. The latest knowledge and technology in digital audio engineering has been used to provide a comprehensive set of test signals in a format with user requirements in mind. This arrangement includes all Electronic Industries Association (EIA)-specified test signals, plus CBS Records enhancements which allows the concerned evaluator the ability to obtain even more critical performance data than required by the corresponding EIA measurement standard.

2. GENERAL DESCRIPTION

Table 1 is detailed listing of the contents of the CBS Records CD-1 Test Disc. It provides location and identification of each test signal by means of Track Number (TNO), Index. Code, Channel, Frequency, Level, and Timing. The general purpose of the various signals on the disc are also indicated in the table. The timing is further divided into player time (P- Time) from the start of signal on the indicated track, duration of the signal, and elapsed time from the beginning of the disc (A-Time). Timing is designated in minutes and seconds (min:sec), and all signals start on full minute boundaries to allow easy identification and access even on the simplest of CD players. With the exception of track 12, all signals have been recorded without empahsis.

All waveforms are computer generated, and the recorded digital signal format meets applicable IEC standards (a two's complement representation). Sinewaves have been generated from full scale (O dB) prototypes, with a maximum peak value equal to 7FFF hexadecimal (32 767) and a minimum peak value equal to 8001 hexadecimal (-32 767) before sampling and quantization (rounding to the nearest least significant bit, LBS).

With the exception of tracks 2 and 3 which are used to measure channel separation, the recorded signals on both channels are identical. On tracks 2 and 3, digital zero (silence) has been recorded on the channel without signal.

All tracks begin with 2 seconds of silence before the start of signal. All test signals end with 1 second of silence, which is included in the time indicated by duration. The frequency sweep signal includes an additional 1 second of silence at the end of the signal, also included in duration.

3. IMPORTANT DETAILS AND FEATURES

SETUP AND TRADITIONAL TESTS (TRACKS 1-10, 14, 15) — The choice of test frequencies and levels were made with practical considerations and a desire for maximum measurement reliability in mind. The more familiar ISO (266-1975) test frequencies are recorded on the first few tracks where basic checks and system setup are most often performed. Frequencies relatively prime to the sample frequency (44.1 kHz) have been chosen where maximum accuracy and reliability of the indicated measurement are likely to be required. This choice of test frequency avoids the undesirable condidtion that only a few quantum codes out of the 65 536 possible in a 16-bit representation may be generated when the ratio of the sample frequency to the signal frequency is equal to an integer. Thus the frequencies indicated in Table 1 for tracks 6 through 10 inclusive, track 18 and track 19 are the prime values closest to the nominal test frequencies of 4, 8, 16, 32, 63, 125, 250, 500. 1k, 2k, 4k, 8k, 10k, 12.5k, 16k, 18k, and 20 kHz.

SWEEP FREQUENCY RESPONSE (TRACK 11) — On this track a digitally-generated, continuously-varying, full scale sweep signal covering the frequency range from 5 Hz to 22.05 kHz has been recorded. It begins with a 1-kHz trigger tone of 5.25 seconds duration. The actual sweep starts immediately after the trigger and continues for 60.75 seconds. Two seconds of silence follows the last non-zero sample value. The trigger time, the actual sweep time, and the 2 seconds of digital zero have been included in the duration as listed in Table 1. The rate of sweep has been selected to synchronize with standard 50 second per 3 decade frequency paper (for example, Bruel & Kjaer Type QP1143).

DE-EMPHASIS ERROR (TRACK 12) — A series of signals have been recorded with the standard CD pre-emphasis of 50/15 microseconds. These computer-generated sine waves will play back at a constant level of -20 dB on a player having an ideal de-emphasis circuit. No other signals on disc have been generated with emphasis.

INTERMODULATION DISTORTION (TRACK 13) — On this track composite signals are provided for the purposes of

measuring intermodulation made by SMPTE (60 Hz + 7 kHz at a level ration of 4:1 respectively) and TWIN TONE (CCIF, 11 kHz + 12 kHz at a level ratio of 1:1) methods. In generating both signals the positive peak value of the waveform was set equal to full scale.

SQUARE WAVE (TRACK 16) — On this track a full-scale square wave has been recorded for the purposes of measuring phase linearity of the channel by means of observing waveform asymmetry. The signal consists of 44 samples at positive full scale, followed by 44 samples at negative full scale. The frequency of the square wave is an exact submultiple of the sample frequency and is 1002.2727 ... Hz (44 100/44 Hz). The signal has not been prefiltered prior to recording and therefore contains all its components up to the Nyquist Frequency (half the sample frequency).

IMPULSE AND POLARITY (TRACK 17) — On this track a positive impulse and a negative impulse has been recorded for the purposes of measuring output signal polarity, and to provide the user with the capability of performing impulses-derived frequency response and phase. The test pattern is as follows: a) digital zero for the first 15 seconds; b) a single positive full scale digital value (positive impulse); c) a period consisting of 30 seconds of digital zero; d) a single negative full scale value (negative impulse); and finally e) a section of 15 seconds of digital zero completes the pattern.

LINEARITY (TRACK 18) — Traditional linearity and distortion measurements as a function of level can be perfromed with this track. At low signal levels where only a few quantum codes are generated and the measurement of digital to analog converter (DAC) accuracy is most important, consideration must also be given to specifying the exact level at which the test signal has been generated. Thus the decibel values in the low signal region of track 18 have been chosen so that the signal peaks correspond to integer multiples of 1 LSB, or in other words exact fractions of full scale. (For example, the peak value of the—70.31 dB signal is 10 LSB.) Because the signals on this track have not been dithered before quantizing, the level of the fundamental will naturally differ slightly from the values as listed in Table 1. (see Track 19)

LINEARITY WITH DITHER (TRACK 19) — On track 19 a series of low level signals from about —70 dB down to —100 dB have been recorded with added dither for the purpose of measuring linearity and distortion without the effects of correlated quantizing noise. The last signal at —100 dB has a dual purpose in that it demonstrates the

ability of digital systems and the CD in particular to accurately reproduce signals below the least significant bit when a proper dither signal has been added. Measurements with these signals may be compared with those of track 14 for the undithered case. The dither used is based on a random variable which has a uniform probability density function with limits of ½ LSB and —½ LSB. The signal at —90.31 dB has been recorded for twice the time of the other signals to allow narrow band spectral measurements with improved resolution or reduced statistical variance. The CBS Records CD-1 Test Disc contains the dithered signals at test levels of —70.31 dB and —80.77 dB, which are enhancements to those test levels specified by the EIA. These additional distortion-free test signals allow evaluation of player or audio system performance at levels approaching the background noise of normal listening environments, and closer to the residual noise level of typical good quality cassette systems. The levels have also been chosen to be compatible with the amplitude range covered by track 21 which evaluates monotonicity.

4. EXPANDED FEATURES

FADE TO NOISE WITH DITHER (TRACK 20) — On this track the disc contains a fade into noise to allow the user to subjectively evaluate player performance with a signal whose envelope varies continuously from —60 dB down to —120 dB over a period of 30 seconds. The test signal has been dithered using a triangluar probability density function, which has been derived by taking the convolution of two uniform probability density functions described above for Track 19. This technique provides the same linearity as the dither used for the signals in track 19, but also removes any noise modulation which might be audible. A small overall increase in the noise level does result. In this way subjective evaluations can be performed without confusing signal artifacts with player performance. For the convenience of the listener this track has been placed following all other high level signals.

MONOTONICITY (TRACK 21) — On this track a special square wave signal has been recorded to allow the user to observe player monotonicity. The peak of the waveform starts at digital zero and increases by 1 LSB after every 5 cycles, to a maximum of 10 LSB. The frequency of the square wave is 1102.5 Hz, exactly 44 100/40 Hz. While low frequency noise and lack of player response toward DC will alter the envelope of the waveform, the averaged step should always increase on the positive side and decrease on the negative side. Ideally the steps should be equal in size. The lack of uniformity in step size contributes to

distortion in reproduced waveforms. The dithered signals from track 19 which also covers the same 10 LSB in peak amplitude, can be used in conjunction with the monotonicity test to help identify the origin of distortion components. For purposes of external synchronization the waveform has a repetition rate of 20.045 Hz.

5. ACKNOWLEDGEMENT

The test signals and timing contained in tracks 1 through 18, the last two signals of track 19 have been organized and specified by the CD Player Measurments Subcommittee of the Electronic Industries Association (EIA) for testing of DC players. With the exception of the timing on some tracks, the EIA-specified signals include all those specified in the Electronic Industries Association of Japan (EIAJ) Standard CP-308. The CBS Records CD-1 Test Disc further provides four test signals uniquely arranged for even more rigorous testing of linearity, subjective assessment, and player monotonicity as described in the above text and identified in Table 1 by the ★.

CAUTION

This test disc contains many signals at maximum level. The user must exercise care and return the gain of the system to an appropriate level after testing with low level signals. Equipment or hearing damage may result from not observing this precaution.

TABLE 1. CBS RECORDS CD-1 TEST DISC CONTENTS

TRACK (TNO)	INDEX	CHANNEL	FREQUENCY (HZ)	LEVEL (dB)	P-TIMING (BEGINNING) (min:sec)	DURATION (min:sec)	A-TIME (BEGINNING) (min:sec)	PURPOSE OF TEST
	00				−0:02		0:00	Reference Level set
1	01	L,R	1k	0	0:00	2:08	0:02	
2	00				−0:02		2:10	Left Separation
	01	L	1k	0	0:00	1:00	2:12	
	02	L	125	0	1:00	1:00	3:12	
	03	L	4k	0	2:00	1:00	4:12	
	04	L	10k	0	3:00	1:00	5:12	
	05	L	16k	0	4:00	1:00	6:12	
3	00				−0:02		7:12	Right Separation
	01	R	1k	0	0:00	1:00	7:14	
	02	R	125	0	1:00	1:00	8:14	
	03	R	4k	0	2:00	1:00	9:14	
	04	R	10k	0	3:00	1:00	10:14	
	05	R	16k	0	4:00	1:00	11:14	
4	00				−0:02		12:14	Output Noise, S/N
	01	L,R	- - -	−∞	0:00	2:00	12:16	
5	00				−0:02		14:16	Dynamic Range
	01	L,R	1k	−60	0:00	2:00	14:18	
6	00				−0:02		16:18	Frequency Response,
	01	L,R	4	0	0:00	1:00	16:20	Distortion, Phase
	02	L,R	8	0	1:00	1:00	17:20	Difference Between
	03	L,R	17	0	2:00	1:00	18:20	Channels
	04	L,R	31	0	3:00	1:00	19:20	
7	00				−0:02		20:20	
	01	L,R	61	0	0:00	1:00	20:22	
	02	L,R	127	0	1:00	1:00	21:22	
	03	L,R	251	0	2:00	1:00	22:22	
	04	L,R	499	0	3:00	1:00	23:22	

TRACK (TNO)	INDEX	CHANNEL	FREQUENCY (HZ)	LEVEL (dB)	P-TIMING (BEGINNING) (min:sec)	DURATION (min:sec)	A-TIME (BEGINNING) (min:sec)	PURPOSE OF TEST
8	00				−0:02		24:22	Frequency Response,
	01	L,R	997	0	0:00	1:00	24:24	Distortion, Phase
	02	L,R	1 999	0	1:00	1:00	25:24	Difference Between
	03	L,R	4 001	0	2:00	1:00	26:24	Channels
	04	L,R	7 993	0	3:00	1:00	27:24	
9	00				−0:02		28:24	
	01	L,R	10 007	0	0:00	1:00	28:26	
	02	L,R	12 503	0	1:00	1:00	29:26	
	03	L,R	16 001	0	2:00	1:00	30:26	
	04	L,R	17 989	0	3:00	1:00	31:26	
10	00				−0:02		32:26	As above; also for
	01	L,R	19 997	0	0:00	2:00	32:28	measuring Pitch Error
11	00				−0:02		34:28	Sweep Frequency
	01	L,R	5 to 22 050	0	0:00	1:08	34:30	test, w/1kHz trigger
12	00				−0:02		35:38	For measuring
	01	L,R	1k	−20	0:00	1:00	35:40	De-emphasis Error
	02	L,R	125	−20	1:00	1:00	36:40	
	03	L,R	4k	−20	2:00	1:00	37:40	
	04	L,R	10k	−20	3:00	1:00	38:40	
	05	L,R	16k	−20	4:00	1:00	39:40	
13	00				−0:02		40:40	IM Distortion, SMPTE
	01	L,R	60+7k	0	0:00	2:00	40:42	and Twin-tone
	02	L,R	11k+12k	0	2:00	2:00	42:42	methods
14	00				−0:02		44:42	Wow and Flutter test
	01	L,R	3 150	0	0:00	3:08	44:44	

TRACK (TNO)	INDEX	CHANNEL	FREQUENCY (HZ)	LEVEL (dB)	P-TIMING (BEGINNING) (min:sec)	DURATION (min:sec)	A-TIME (BEGINNING) (min:sec)	PURPOSE OF TEST
15	00				– 0:02		47:52	For measuring Access
	01	L,R	317	0	0:00	1:00	47:54	Time
16	00				– 0:02		48:54	Square Wave test
	01	L,R	1 002.27	0	0:00	1:00	48:56	
17	00				– 0:02		49:56	Impulse and Polarity
	01	L,R	- - -	0	0:00	1:00	49:58	test
18	00				– 0:02		50:58	Level Linearity test
	01	L,R	997	0	0:00	1:00	51:00	
	02	L,R	997	– 1	1:00	1:00	52:00	
	03	L,R	997	– 3	2:00	1:00	53:00	
	04	L,R	997	– 6	3:00	1:00	54:00	
	05	L,R	997	– 10	4:00	1:00	55:00	
	06	L,R	997	– 20	5:00	1:00	56:00	
	07	L,R	997	– 30	6:00	1:00	57:00	
	08	L,R	997	– 39.99	7:00	1:00	58:00	
	09	L,R	997	– 49.97	8:00	1:00	59:00	
	10	L,R	997	– 59.94	9:00	1:00	60:00	
	11	L,R	997	– 70.31	10:00	1:00	61:00	
	12	L,R	997	– 80.77	11:00	1:00	62:00	
	13	L,R	997	– 90.31	12:00	1:00	63:00	
19	00				– 0:02		64:00	Level Linearity with
	*01	L,R	997	– 70.31	0:00	1:00	64:02	Dither test
	*02	L,R	997	– 80.77	1:00	1:00	65:02	
	03	L,R	997	– 90.31	2:00	2:00	66:02	
	04	L,R	997	–100	4:00	1:00	68:02	
20	00				– 0:02		69:02	Fade to Noise
	*01	L,R	500	– 60	0:00	1:00	69:04	with Dither
21	00				– 0:02		70:04	Monotonicity test
	*01	L,R	1 102.5	10 LSB	0:00	1:00	70:06	

CBS RECORDS
CD-1 TEST DISC

FOR MEASURING CD PLAYER PERFORMANCE WITH E.I.A. STANDARD SIGNALS

1 **Reference, L & R,**
O dB, 1 kHz

2 **Left Separation, O dB,**
1K, 125, 4K, 10K, 16K Hz

3 **Right Separation, O dB,**
1K, 125, 4K, 10K, 16K Hz

4 **Signal/Noise, L & R,**
Infinity Zero w/o emphasis

5 **Dynamic Range, L & R,**
1kHz, −60 dB w/o emphasis

6 **Frequency Response,**
L & R, O dB, 4, 8, 17, 31 Hz

7 **61, 127, 251, 499 Hz**

8 **997, 1999, 4001,**
7993 Hz

9 **10 007, 12 503, 16 001,**
17 989 Hz

10 **19 997 Hz**
(Also used for Pitch Error)

11 **Sweep Frequency**
Response,
O dB, 5 Hz −22.05 kHz

12 **De-emphasis Error, L & R,**
1K, 125, 4K, 10K, 16K Hz

13 **Intermodulation Distortion**
(SMPTE, Twin Tone), L & R,
60 Hz + 7 kHz,
11kHz + 12 kHz

14 **Wow & Flutter, L & R,**
O dB, 3150 Hz

15 **Access Time, L & R,**
O dB, 317 Hz

16 **Square Wave, L & R,**
O dB, 1 002.27 Hz

17 **Impulse & Polarity Test,**
O dB, L & R

18 **Linearity, 997 Hz, L & R,**
O dB, −1, −3, −6, −10,
−20, −30, −39.99,
−49.97, −59.94, −70.3l,
−80.77, −90.31 dB

19 **Linearity with Dither,**
997 Hz, L & R,
* −70.31, −80.77,
−90.31, −100 dB

20 **Fade to Noise with Dither,**
L & R,
* −60 dB, 500 Hz

21 **Monotonicity, L & R,**
* 1 102.5 Hz, 10 LSB

* Additional Test Tracks

COMPACT disc DIGITAL AUDIO

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