

WBU-ISOG
INTEROPERABILITY TESTING OF
1080i/720p ENCODERS & DECODERS

TEST PLAN

2/16/05

This document shall describe the policy, procedures, test objectives and methods for the proposed technical evaluation of interoperability among advanced format, (1080i, 720p) encoders and decoders from various manufacturers. An appendix contains the ISOG approved parameter list, detailing the key operational settings.

1.0 Scope

The primary interest is testing direct encoder to decoder operation. The testing will initially bypass modulation and demodulation evaluations, allowing that prior work has resolved issues with DVB standard QPSK modulation and demodulation with regard to the participating manufacturers. The equipment will be interconnected via serial ASI interfaces. A DVB modulator will be available to create a QPSK L-band signal should an individual decoder require it. If time permits a second round of testing may be permitted using modulation and RF interfaces. This will be decided after the completion of the ASI interface testing. Much of that decision will be based on the number of encoders / decoders submitted for evaluation, and the time available from the Test Site Sponsor.

1.1 Interoperability Test Sub Group

A subgroup of broadcasters and carriers, including representatives of Union Technical Committees, has been formed to monitor and address test issues. The Group is led by Mr. Tom Gibbon, representing NHK.

The group will oversee the creation of the Test Plan, the Test Facilities, and will issue a final report.

1.2 Participation by Manufacturers.

WBU-ISOG will invite manufacturers to participate in the interoperability testing program. Manufacturers who accept participation must commit to having one representative accompany their equipment, for the purpose of final setup and operation during the test. The representative must be available for the complete test period. Equipment must be shipped to the site in advance of the test dates, to arrive no later than 2 business days prior to the Test Period, and will be unpacked and placed in the test room by the Test Site Sponsor. After the test, the Sponsor will also re-pack the equipment into their shipping containers and prepare for pickup by a shipping carrier. Manufacturers will be required to ship the equipment to be tested directly to and from the test site, at their expense.

1.3 Test Period

A single test program is planned. The planned dates for the Interoperability test are Monday March 7, 2005 through Friday March 11, 2005. See Section 2 for the estimated schedule. If there are test results or other issues that indicate a follow-up test would be beneficial, or required to complete this effort, the Test Sub Group may arrange another test program.

1.4 Test Site Sponsor

The test site sponsor is Telesat. The test location selected is the Telesat Lab at their headquarters office. Manufacturers will be required to ship the equipment to be tested directly to and from the test site, at their expense.

1.5 Equipment to be tested.

Manufacturers will select which product(s) are to be tested. Each manufacturer will be limited to one encoder and one decoder. Each encoder and decoder will be accompanied by a compliance sheet showing the extent to which the equipment complies with the WBU-ISOG interoperability parameters. Equipment may be submitted for testing even if it is not fully compliant with the WBU-ISOG interoperability parameters.

1.6 Interoperability Test Parameters

Equipment will be tested using each set of the possible parameters listed in the WBU-ISOG interoperability table, see Appendix A. As indicated in the table, tests will be performed at three data rates; 64.509 Mbps, 41.47 Mbps and 20.0 Mbps. Testing will be at a chroma sample of 4:2:2, except where the encoder/decoder only supports 4:2:0.

Tests will be performed without encryption. However, some form of testing with a non-proprietary encryption system may be performed if there is available time in the Test Period, and based on discussions among the Interoperability Test Sub Group, the testing organization and the applicable manufacturers.

1.7 Methods of Evaluation

Three key areas will be examined to validate whether a particular encoder to decoder combination is interoperable. These areas are

1.7.1) Subjective Video Evaluation. Expert viewers will be asked to evaluate for picture integrity, distortions, and any other visible artifacts seen during a 3 - 5 minute test transmission. The same test tape content will be used for all video evaluations. It is sourced in 1080i/59 and will be converted to other formats.

1.7.2) Objective Audio Performance. Frequency response and distortion will be measured with the Audio Precision AP2.

1.7.3) Audio/Video Sync -“Short Term”. A/V Sync will be evaluated over a 10 minute period. This window may be expanded depending on availability of time. Some Encoder/Decoder combinations may exhibit “Long-Term” lip-sync variation, which will not be detected by this test program.

1.8 Communication of Test Results

The results of the first round of tests will be communicated to the Interoperability Test Sub Group and to the manufacturers on-site. Depending upon the availability of the Test Site and the necessary equipment, manufacturers will have a limited opportunity to modify equipment and to request a re-test of the modified equipment.

After any second round of testing, the results of the first and second rounds of testing will be communicated to WBU-ISOG and the manufacturers. WBU-ISOG will release the results to the public.

2.0 Test Procedures

2.1 Test Configuration.

Refer to Figure 1. ISOG-WBU Test Configuration. The following is a detailed description of the test setup;

A Doremi V1-UHD will provide a source video stream. This will be a 3 - 5 minute test loop for subjective evaluation. We plan to provide the three image formats to be evaluated; 1080i/59, 720p/59, and 1080i/50.

The Doremi will directly feed the Encoder with HD-SDI.

Two audio sources shall be made available to the encoder. For direct MPEG audio testing two digital AES/EBU feeds shall be provided by an Audio Precision AP2 Audio Analyzer. The unit can supply both Unbalanced and Balanced signals. For evaluation of Dolby E pass through the Audio Precision shall feed a Dolby DP571 Audio Encoder. The output of this encoder is unbalanced AES/EBU only. During the tests we shall manually connect the two audio inputs as necessary. Each Encoder to be tested is expected to have at least two (stereo) audio inputs.

The output of the MPEG Encoder shall be a serial ASI stream. This will be fed to a Leitch DA to split the ASI signal into direct feeds to each MPEG Decoder, and to provide a feed to a Tektronix MTS300.

The MTS300 will be used to evaluate the ASI signal content and integrity. If any problems occur with decoding this tool will be available to provide a wide range of information about the encoded DVB formatted stream.

The HD-SDI outputs of the MPEG decoders will be connected to individual D-to-A converters and then fed to an Analog Component Router. This will permit easy distribution of signals for picture monitors as shown.

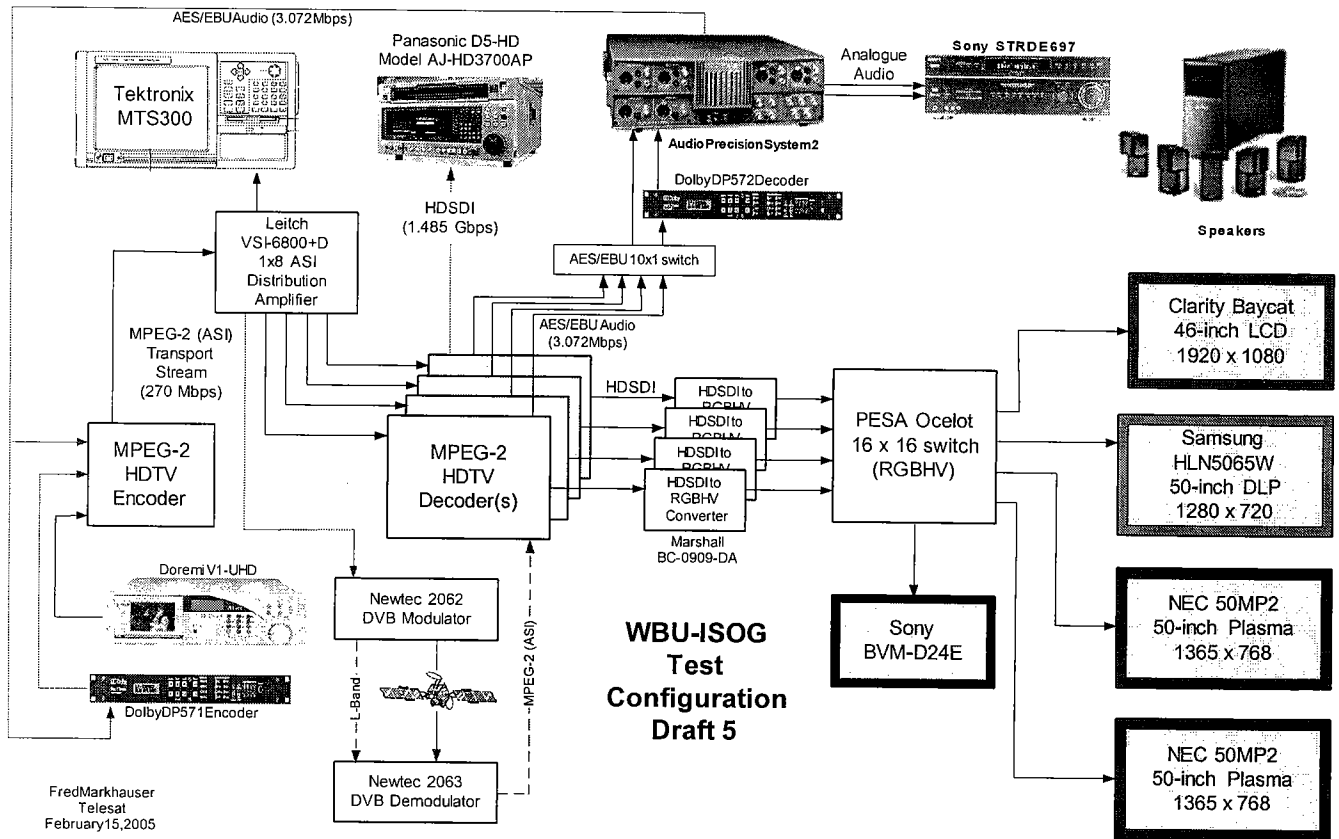
The monitors will be viewed by select expert viewers, to subjectively determine picture performance, as a means to qualify the level of interoperability.

A Panasonic AJ-HD3700AP will be available to record MPEG Decoder outputs to document any visible anomalies detected by the expert viewers. This is being done to permit the manufacturers to have a tape recording of any interoperability problems. A recording will not be made if no artifacts of any kind are detected, and the particular combination of Encoder/Decoder is judged compatible.

For audio performance the Audio Precision AP2 will be used to generate audio signals for the purpose of automatically measuring frequency response and THD of the subject Encoder/Decoder pair.

[For those Decoders with analog audio outputs, these signals will also be fed to the Analog Router. The router will then feed an Audio amplifier for subjective audio evaluation.]

Figure 1.



2.2 Test Procedure

The following test program shall be followed:

1. The equipment shall be unpacked, installed in the test room, either on tables or in racks, and will be connected and powered by the Test Sponsor.
2. All Encoders and Decoders for evaluation will be operated by their respective representatives.
3. Thirty-six Encoder setups (1-18 at 4:2:2 and 19-36 at 4:2:0) have been derived from the ISOG-WBU parameter table; see Appendix A for the Table. Each setup has been defined as a Test Sequences. See the Test Sequence Table in Section 3 below.
4. Each Encoder in turn shall be configured through the 1-18 (4:2:2) or 19-36 (4:2:0) different Test Sequences. Any Sequence may be skipped if the Encoder is not capable of operation. As each Sequence is confirmed on the Encoder by the Test Sponsor, all Decoders capable of operation will be evaluated and the results recorded. Sequences may be skipped if the Encoder under test is not capable of operation with a particular Sequence.
3. For documentation, a Master Test Table will be created. For each individual measurement of each Test Sequence, an Encoder/Decoder combination Test Record entry shall be defined. An example Master Test Table is shown in Section 3.
4. The Test Sequence comprises 4 audio configurations which will be measured at the Bit Rate of 41.47 Mb/s only. It is assumed that audio performance at this one rate can predict the performance of audio at the other two bit rates. Testing at the High and Low rates shall be limited to Video only. Audio testing (at the Mid rate) will be run separately from the Video testing. Complete audio testing shall be performed only at 1080i/59 with brief confirmation testing at 1080i/50 and 720p/50.

2.3 Testing Methods & Ratings

For each Test Record, 3 data points are entered; the following defines the Test & Test Criteria:

2.3.1 Subjective Video Evaluation

The expert viewer will watch the Decoder output while the Video test loop plays. At the end the following code will be applied:

Code	Classification	Subjective Video Observations
V0	No decode function	No video, or video unstable.
V1	No visible impairments video is useable	No loss of resolution, no macro-block errors, no motion artifacts.
V2	Visible artifacts, but video is useable	Slightly annoying picture artifacts, but no severe blocking errors, or other discontinuous video aberrations.
V3	Visible artifacts, video is unusable	Video is locked and continuous, but with annoying artifacts; such as regular macro-block errors, frame drops, and other discontinuous picture breakups.

An encoder/decoder pair with a code of V1 or V2 shall be considered interoperable.

An encoder/decoder pair with a code of V0 or V3 shall be considered not interoperable. [However, if an encoder/decoder pair has a code of V3 and if the encoder/decoder pair by the same manufacturer has a code of V3, the problem may be the result of encoder caused artifacts, rather than the result of a strict interoperability problem.]

This table may be adjusted at the start of testing to accommodate the differences in evaluating interoperability against the need to clearly note usability of the link provided by each encoder/decoder combination. Thus, additional data may be collected about the observations made, including where artifacts may be strictly encoder related or not.

2.3.2 Audio Performance Evaluation

The Audio Precision AP2 audio analyzer will be used to perform an automatic frequency response and THD measurement. The frequency range is 20 Hz-20 KHz. The results will be coded as follows:

Code	AP2 Audio Measurements
A0	Audio not decoded, or is intermittent
A1	Frequency response within +/- 3 dB, THD measures < 1%
A2	Frequency response outside +/- 3 dB, THD measures <1%
A3	Frequency response within +/- 3 dB, THD measures >1%
A4	Frequency response outside +/- 3 dB, THD measures >1%
A5	Audio continuous, but out of specification (3 dB/1%)

For Audio, only A0 and A5 present an unusable situation.

2.3.3 Audio/Video Synchronization (Lip-Sync)

A special Lip-Sync test sequence will be played by the Doremi, and with an oscilloscope, using the technique described in Appendix B. With this procedure objective lip-sync will be measured. The manufacturer may adjust the Decoder to minimize the measurement. The results will be coded as follows:

Code	A/V Sync Measurements
L1	A/V Sync below 5 mS, stable during test period
L2	A/V Sync between 5 mS – 30 mS, stable during test period
L3	A/V Sync over 30 mS, stable during test period
L4	A/V Sync variable during test period.

3.0 Test Plan Tables

3.1 Test Sequence Table

The following Table describes the individual Test Sequences. Each numbered sequence will be run for each Encoder.

Test Sequence #	Chroma Format	Video Format	Total Data Rate	Audio Format
1	4:2:2	1080i/59	64.509 Mb/s	None
2	4:2:2	1080i/59	41.470 Mb/s	2 CH PCM
3	4:2:2	1080i/59	41.470 Mb/s	2 CH MPEG
4	4:2:2	1080i/59	41.470 Mb/s	4 CH MPEG
5	4:2:2	1080i/59	41.470 Mb/s	8 CH DOLBY E
6	4:2:2	1080i/59	20.000 Mb/s	None
7	4:2:2	1080i/50	64.509 Mb/s	None
8	4:2:2	1080i/50	41.470 Mb/s	2 CH PCM
9	4:2:2	1080i/50	41.470 Mb/s	2 CH MPEG
10	4:2:2	1080i/50	41.470 Mb/s	4 CH MPEG
11	4:2:2	1080i/50	41.470 Mb/s	8 CH DOLBY E
12	4:2:2	1080i/50	20.000 Mb/s	None
13	4:2:2	720p/59	64.509 Mb/s	None
14	4:2:2	720p/59	41.470 Mb/s	2 CH PCM
15	4:2:2	720p/59	41.470 Mb/s	2 CH MPEG
16	4:2:2	720p/59	41.470 Mb/s	4 CH MPEG
17	4:2:2	720p/59	41.470 Mb/s	8 CH DOLBY E
18	4:2:2	720p/59	20.000 Mb/s	None

Test Sequence #	Chroma Format	Video Format	Total Data Rate	Audio Format
19	4:2:0	1080i/59	64.509 Mb/s	None
20	4:2:0	1080i/59	41.470 Mb/s	2 CH PCM
21	4:2:0	1080i/59	41.470 Mb/s	2 CH MPEG
22	4:2:0	1080i/59	41.470 Mb/s	4 CH MPEG
23	4:2:0	1080i/59	41.470 Mb/s	8 CH DOLBY E
24	4:2:0	1080i/59	20.000 Mb/s	None
25	4:2:0	1080i/50	64.509 Mb/s	None
26	4:2:0	1080i/50	41.470 Mb/s	2 CH PCM
27	4:2:0	1080i/50	41.470 Mb/s	2 CH MPEG
28	4:2:0	1080i/50	41.470 Mb/s	4 CH MPEG
29	4:2:0	1080i/50	41.470 Mb/s	8 CH DOLBY E
30	4:2:0	1080i/50	20.000 Mb/s	None
31	4:2:0	720p/59	64.509 Mb/s	None
32	4:2:0	720p/59	41.470 Mb/s	2 CH PCM
33	4:2:0	720p/59	41.470 Mb/s	2 CH MPEG
34	4:2:0	720p/59	41.470 Mb/s	4 CH MPEG
35	4:2:0	720p/59	41.470 Mb/s	8 CH DOLBY E
36	4:2:0	720p/59	20.000 Mb/s	None

3.2 Master Test Table

The following table format will be used to record the results of the interoperability tests. (A version will be created once all Encoders and Decoders are known)

Test Rec #	Encoder	Test Seq #	Decoder	Video Test Code	Audio Test Code	A/V Sync Test Code
1	TANDBERG E5782	1	TIERNAN TDR6	V-	A-	L-
2	TANDBERG E5782	2	TIERNAN TDR6			
3	TANDBERG E5782	3	TIERNAN TDR6			
4	TANDBERG E5782	4	TIERNAN TDR6			
5	TANDBERG E5782	5	TIERNAN TDR6			
6	TANDBERG E5782	6	TIERNAN TDR6			
		7				
		8				

**APPENDIX A: WBU-ISOG BASIC TEST PARAMETERS FOR EXISTING
MPEG-2 1080i/720p CODEC INTEROPERABILITY
FOR CONTRIBUTION FEEDS FOR PROGRAM EXCHANGE**

VIDEO					
Image Format	1080i/59.94/50				
	720p/59.94				
Compression	MPEG 2 ¹				
Chroma	4:2:2 (preferred) ²				
	4:2:0				
GOP	IBBP length = 15 ³				
AUDIO	Essence Interface	Compression	Bit rates	Service	Output
	2 audios	PCM (SMPTE 302M 2002)	1.92 Mbps (20 bit mode)	Audio 1	AES/EBU Group 1
	2 audios	MPEG Layer 2 (within MPEG-2)	384 Kbps	Audio 1	AES/EBU Group 1
	4 audios	MPEG Layer 2 (within MPEG-2)	768 Kbps	Audio 1 Audio 2	AES/EBU Group 1 AES/EBU Group 2
	8 audios ⁴	Dolby E ⁵ (Outboard Encoding)	1.92 Mbps (20 bit mode)	Audio 1	AES/EBU Group 1
DATA RATE ^{6,7}					
	Low transmission rate: 20-30 Mbps				
	Standard transmission rate: 38-42 Mbps (DS-3 compatible)				
	High transmission rate: 60-100 Mbps				
OTHER					
Encryption	Codecs should support non-proprietary encryption, such as BISS.				

¹ The WBU-ISOG parameters are based on an MPEG-2 environment, on existing equipment, and existing transmission practices of broadcasters. It should be noted that while the present interoperability tests are for MPEG 2 codecs now in use, WBU broadcasters will probably employ more advanced compression systems such as MPEG 4 in the future. As new compression schemes or equipment become available in practical equipment and are used for contribution feeds, new interoperability parameters may be specified.

² 4:2:2 is the preferred chroma format for 1080i/720p contribution feeds. Because there may be times when a contribution feed is restricted to 4:2:0, e.g., bandwidth restrictions, 4:2:0 is included as a parameter for interoperability. In principle, 4:2:2 equipment should also accept 4:2:0 to comply with backward compatibility requirements of MPEG 2 levels and profiles.

³ Either the codec should be pre-selected to N=15 or the codec should have the option of N=15, and support an open GOP structure.

⁴ Dolby E 20-bit mode limited to 8 channels.

⁵ Codec should be set to Dolby E passthrough.

⁶ Decoder should recognize the PID identified in the MPEG transport layer (automatically or manually) for both audio and video.

⁷ A data rate for each transport range should be selected for test purposes, e.g. Low: 20 Mbps; Standard: 41.47 Mbps (for QPSK Satellite); High: 64.509 Mbps.

**WBU-ISOG BASIC TEST PARAMETERS FOR EXISTING
MPEG-2 1080i/720p CODEC INTEROPERABILITY
FOR CONTRIBUTION FEEDS FOR PROGRAM EXCHANGE
BACKGROUND AND EXPLANATION**

Based on the operating experience of WBU-ISOG broadcasters, WBU-ISOG has concluded that there are significant codec interoperability problems that need to be resolved for 1080i (Rec. ITU-R BT.709-5) / 720p (Rec. ITU-R BT.1543) contribution feeds. In an attempt to resolve these issues, WBU-ISOG has adopted basic 1080i/720p codec contribution network parameters. WBU-ISOG's goal is that all MPEG 1080i/720p codecs will have the capability to be configured to any set of the WBU-ISOG parameters and, when so configured, any 1080i/720p decoder will be able to successfully decode the signal from any 1080i/720p encoder. From an operations perspective, this goal would ensure that if a broadcaster configures an encoder to a set of parameters listed in the WBU-ISOG table and communicates those parameters to the receiving site, the broadcaster will have confidence that its contribution feed will be successfully received regardless of the manufacturer and model of the decoder. To achieve WBU-ISOG's goal, WBU-ISOG will sponsor 1080i/720p codec interoperability tests based on the WBU-ISOG 1080i/720p codec interoperability parameters for contribution feeds.

The WBU-ISOG 1080i/720p codec interoperability parameters are based on an MPEG-2 environment. WBU-ISOG may in the future prepare interoperability parameters for the 'advanced compression' environment. Contribution network equipment for the advanced compression environment is not yet commonly available.

The WBU-ISOG 1080i/720p codec interoperability parameters do not set new standards, but are based on existing standards that have been previously adopted in the broadcast industry.

The WBU-ISOG 1080i/720p codec interoperability parameters are adopted for contribution feeds only. Parameters for 1080i/720p codec interoperability for distribution would likely be different.

The WBU-ISOG 1080i/720p codec interoperability parameters are basic parameters. WBU-ISOG expects that broadcasters will have occasions to use different parameters for various 1080i/720p contribution feeds and expects that codec manufacturers will design their codecs to meet those needs. The basic parameters are premised on technology commonly available today and on the parameters that broadcasters typically use for the contribution feeds that are not transmitted over broadcaster-controlled closed networks. If, for example, 720p/50 transmission equipment becomes commonly available and some broadcasters begin to use such 720p/50 codecs for international contribution feeds in advance of the present interoperability test, WBU-ISOG will add 720p/50 as a parameter. As technology and operational practices develop and evolve, future interoperability tests can be organized and held as desired by the WBU broadcasters and as requested by the WBU-ISOG membership.

APPENDIX B. LIP SYNC MEASUREMENT TECHNIQUE

Manual Procedure for Lip-Sync Measurement Of HDTV Transmission Systems

Introduction

The source of the lip-sync signal is an audio/video tape that contains 50% white flat field and tone followed by silence and black video. The duty cycle of the white field and tone is 0.5 seconds followed by 2.5 seconds of silence and black. For high definition lip-sync source material, CBS has prepared a D5 1920 x 1080/59.94 fields-per-second, 8 channel and 4 channel tape with the same test signal/duty cycle. If a high definition audio/video server is available, it is recommended that the tape be dubbed into the server and placed in the loop mode for multiple tests.

The audio/video lip-sync measurement should be made using a dual trace scope. If a storage scope is available, this aids in viewing the waveforms due to the long sweep intervals. We recommend that a Tektronix Model TDS-3054, or equivalent 4 channel digital storage oscilloscope be used when available.

Since most high definition plants today are all digital it is necessary to have a high definition digital-to-analog converter that converts SMPTE 292 (1.5 Gbps) to Y,Pb,Pr. Most HD waveform monitors have a built-in D/A converter that can be used for this purpose. The Y channel of the D-to-A converter should be connected to Channel 1 of the dual trace scope and terminated in 75 Ohms. The audio should go through an AES digital-to-analog converter and be connected to Channel 2 of the dual trace scope.

The dual trace scope should be configured as follows:

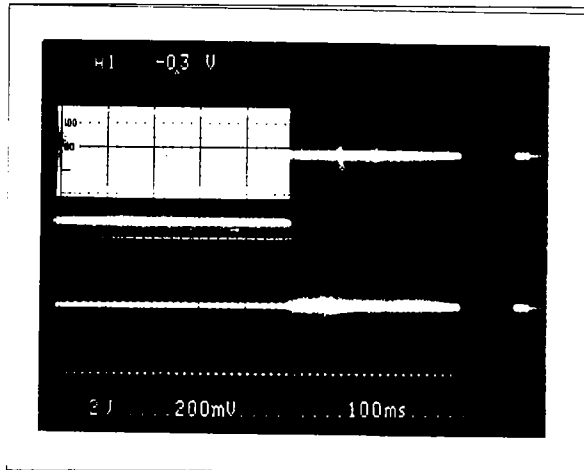
Channel 1	0.5 volts per division
Channel 2	adjusted to provide 2 vertical divisions on the screen

Horizontal	
Sweep	100ms
Trigger Set	Normal Channel 2

Use the X10 magnifier for greater magnification of the waveforms.

The following Figures show typical trace displays when the measurement is being properly made:

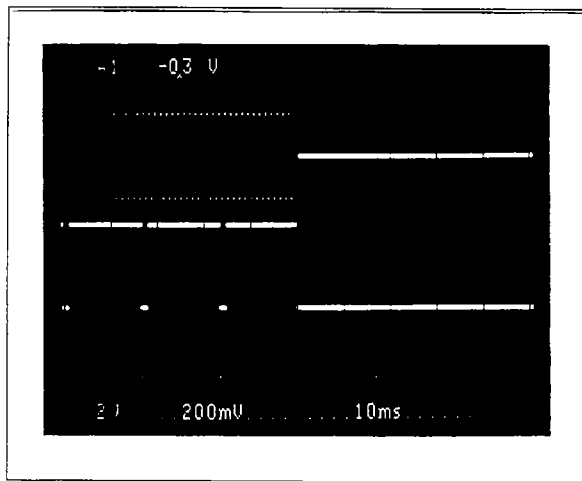
Typical Lip Sync dual trace scope display with 0 millisecond audio/ video offset



Ch-1 audio tone
(trigger source)

Ch-2 Y- video

Horizontal 100 msec /division



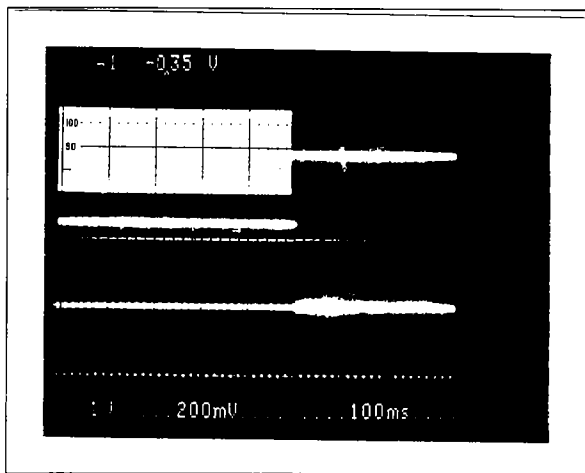
Ch-1 audio tone
(trigger source)

Ch-2 Y- video

X10 magnifier: Horizontal 10 msec /division

Typical Lip sync dual trace scope.doc

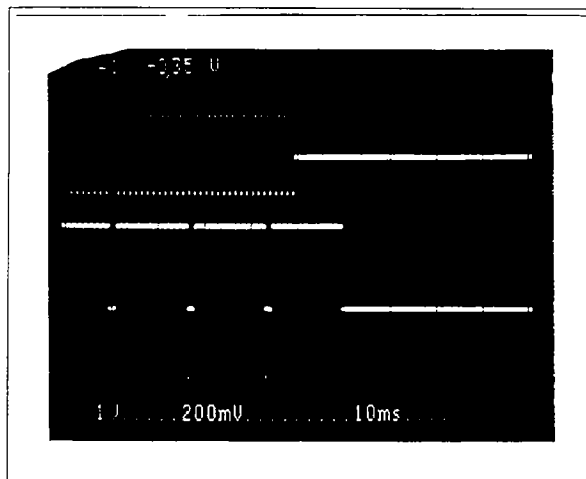
Typical Lip Sync dual trace scope display with 10 millisecond audio/ video offset



Horizontal 100 msec /division

Ch-1 audio tone
(trigger source)

Ch-2 Y- video



X10 magnifier: Horizontal 10 msec /division

Ch-1 audio tone
(trigger source)

Ch-2 Y- video

Typical Lip sync dual trace scope.doc