Fiber Optic CATV Transportation using combined PCM and VSB-AM Transmission
-ABSTRACT-

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1. Introduction

Fiber optic CATV transportation is achieving higher performances standards and lower cost with the utilization of the latest break throughs in VSB-AM and PCM technological. Studies have shown that VSB-AM fiber optic transmission provides an economical means for the transportation of high count CATV channels. Fiber Optic CATV transporation using VSB-AM trunk distribution in conjunction with PCM super trunking can provide a cost effective method of distributing high quality CATV signal to a large distribution area.

To support this hypothesis Sumitomo investigated the technical aspects of this transportation concept.

This paper summarizes the following experimental tests;

1. Multi-drop distributions of baseband PCM video signals from PCM fiber optic backbone.
2. Long distant PCM transmission of high quality video signals through multiple PCM repeaters.
3. End of line performance of a cascaded PCM, VSB-AM, and coaxial CATV transportation network.

We are also proposing high count base band video signal distribution using PCM equipment operating at 1.2 Gbps and 2.4 Gbps providing un-compressed transmission of high channel capacity per fiber distribution.

2. Features Of The PCM And VSB-AM Distribution Network

2-1. PCM Network

PCM transmission equipment time division multiplexes baseband video and audio signals. This technology provides:

(1). Repeater less transmission exceeding 50 km.

(2). Branching capability of optical signals through the use of optical couplers

(3). High transmission quality of video signals (60 dB weighted), independent of transmission distance and the number of repeaters.

(4.) Small size and lower consumption through the use of GaAs-LSI technologies.

(5). Easy installation and alignment.

2-2. VSB-AM Network

Optical VSB-AM transmission equipment intensity modulates multiple television channels. This technology provides:

(1). Direct modulatation, compatible with existing coax CATV distribution signals

(2). High performance over a wide bandwidth, up to 550 Mhz

(3). Easy installation and alignment. Configuartuions include strand mount, rack mount and pole mount equipment.

3. PCM and VSB-AM Equipment

3.1. PCM Equipment

Table 1 PCM Video Transmission Equipment

ITEMS		PCM 400 Mbps	PCM 1.2 Gbps	PCM 2.4 Gbps
Total bit rate		400 Mbps	1.2 Gbps	2.4 Gbps
Optical loss budget		25 dB	23 dB	20 dB
Optical devices		1,300nm, 1,550 nm LD and InGaAs PD		
Video	Number of Channels	4 chs 8 chs (WDM)	12 chs 24 chs (WDM)	24 chs 48 chs (WDM)
	Frequency response	20 Hz ~ 4.2 MHz ±0.5 dB, 4.2 MHz ~ 4.8 MHz +0.5/-1.0 dB (BTSC)		
	Coding	8 bits composite coding		
	DG/DP	<3 %, 1.3 °		
	S/N weighted	>56 dB	>60 dB	
Audio	Number of channels	8 chs 16 chs (WDM)	24 chs 48 chs (WDM)	48 chs 96 chs (WDM)
	Frequency response	20 Hz ~ 18 kHz ±0.5 dB 18 kHz ~ 20 kHz ±1.0 dB		
	Coding	16 bits linear coding		
	S/N	>60 dB		
Data channel (Option)		30 Mbps	60 Mbps	60 Mbps
Size		(W)435 mm (H)221.5 mm (D)500 mm	Video, (W)483mm (H)355mm (D)330mm Audio (Two sets of), (W)483mm (H)177mm (D)330mm	
Environment		0° C~ 40° C		

3.2. VSB-AM Equipment

Table 2 VSB-AM Transmission Equipment

Bandwidth	50 MHz ~ 550 MHz
Number of channels	40 Channels
Optical loss budget	11 dB
C/N	51 dB
CSO	60 dB
CTB	65 dB
XM	60 dB
Size(Rack-mount type)	480mm(W), 99mm(H), 350mm(D)
Environment	0° C ~ 40° C

4. PCM Repeater Performance and Multi-Drop Distribution

The large link budget and optical repeater configurations associated with PCM transmission systems affords the opportunity for multiple drops access from the primary signal transmission path.

Figure 1. shows the evaluation system tested, which is composed of ten (10) PCM repeaters and three (3) optical couplers. Table 1 outlines the evaluation results. Test result verify that there is no degradation in picture quality.

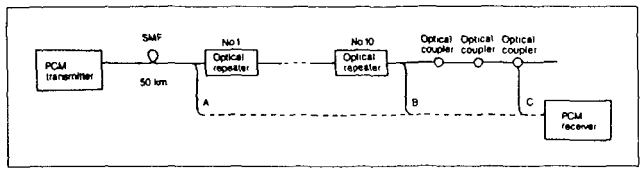

Figure 1. PCM evaluation system composed of PCM repeaters and optical couplers

Table 3. Evaluation results of PCM video signal performance

Test point	Video system				Audio system		
	S/N	DG	DP	Frequency response	S/N	Distortion factor	Frequency response
A After 50 km transmission	53.0	1.0	1.0	±0.30	70.8	0.03	±0.24
B After transmission through 10 optical repeaters	52.8	0.8	0.9	±0.30	72.2	0.03	±0.23
C After transmission through three optical couplers	53.0	0.6	1.0	±0.30	74.0	0.02	±0.23

5. Hybrid CATV System

PCM provides high quality long distant transmission, and VSB-AM provides economical distribution of video signals. The combination of these technologies provides flexibity in the design of fiber optic CATV networks.

Figure 2 is a block diagram representing a hybrid network composed of a, PCM transmitter, ten (10) PCM repeaters, three (3) optical couplers drops, a PCM receiver, VSB-AM transmitter, VSB-AM receiver, and twenty-five (25) coaxial amplifiers. Table 2 outlines the C/N (unweighted) evaluation results for each media of transmission. The end-of-line network performance achieved the minimum desired requirement of a 42 dB C/N.

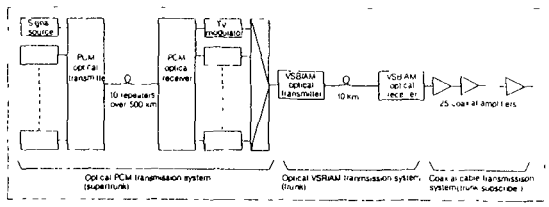

Figure 2. Total CATV system configuration; PCM, VSB-AM, and Coaxial

Table 4 C/N Evaluation results

After PCM transmission (through 10 optical repeaters)		56.9 dB
After VSB-AM transmission (5 dB transmission loss)		51.3 dB
After transmission through coaxial amplifiers	5th step	45.8 dB
	10th step	45.3 dB
	15th step	44.7 dB
	20th step	43.9 dB
	25th step	42.9 dB

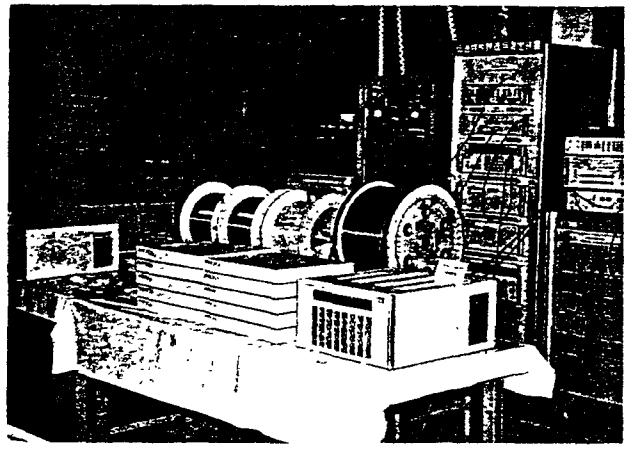

Photo 1 Scene of CATV testsystem