

# Design and Fabrication of CATV Optical Fiber Deep Node

董志鴻、林漢年

E-mail: 9315060@mail.dyu.edu.tw

## ABSTRACT

ABSTRACT In order to provide the CATV(Cable Television) subscribers' demands on ever increasing bandwidth and service quality of the currently implemented HFC(Hybrid Fiber Coax) network architecture, we proposes a new optical node architecture — Optical Fiber Deep Node - to extend the fiber delivery distance of HFC network in this thesis. With this concept, the fiber network can reach much deeper to the subscribers' ends and also reduce the number of the line extender amplifiers built within the coaxial cable network. We can therefore achieve the optimal architecture of increasing transmission bandwidth, improving system performance and reliability, and reducing the network maintenance cost. In the thesis, we will first introduce the HFC network fundamental, and then emphasize what the advantage and feasibility of this new Optical-Fiber-Deep-Node's architecture over standard HFC network architecture by comparing their differences. Furthermore, we will also explore the theory, design and fabricating technologies of the embedded active devices (such as photo detector, RF amplifier) and passive devices (such as PAD, equalizer and diplex filter) that strongly affect the system performance.

Keywords : CATV ; HFC ; Optical Node ; Line Extender Amplifier ; Photo Detector ; RF Amplifier ; PAD ; Equalizer ; Diplex Filter

## Table of Contents

目錄 封面內頁 簽名頁 授權書 . . . . .	iii	中文摘要 . . . . .	iv
. . . . .	iv	英文摘要 . . . . .	v
. . . . .	vi	誌謝 . . . . .	vii
. . . . .	vi	圖目錄 . . . . .	vii
. . . . .	x	表目錄 . . . . .	x
. . . . .	xiii	第一章 緒論 1.1 混合光纖同軸電纜網路介紹 . . . . .	1
. . . . .	2	1.2 被動混合光纖同軸電纜網路 . . . . .	1
. . . . .	2	1.3 研究動機 . . . . .	5
. . . . .	7	第二章 基本理論 2.1 光通訊基本原理簡介 . . . . .	7
. . . . .	11	2.2 光纖通訊的主要特徵及優點 . . . . .	9
. . . . .	17	2.3 訊號功率 . . . . .	13
. . . . .	17	2.4 增益、插入損失、反射損失及隔離度 . . . . .	13
. . . . .	17	2.5 雜訊 . . . . .	17
. . . . .	17	2.5.1 雜訊的種類 . . . . .	17
. . . . .	17	2.5.2 雜訊指數 . . . . .	20
. . . . .	22	2.6 載波雜訊比 . . . . .	24
. . . . .	34	2.7 同調干擾和串調變 . . . . .	24
. . . . .	34	第三章 光接收模組設計與製作 3.1 簡介 . . . . .	34
. . . . .	37	3.2 光接收模組的架構與規格 . . . . .	37
. . . . .	39	3.3 電路架構說明 . . . . .	39
. . . . .	39	3.3.1 檢光模組 . . . . .	39
. . . . .	39	3.3.2 第一級射頻放大器 . . . . .	40
. . . . .	40	3.3.3 溫度補償線路 . . . . .	40
. . . . .	40	3.3.4 等化器(Equalizer) . . . . .	43
. . . . .	46	3.3.5 插拔式衰減器 . . . . .	46
. . . . .	46	3.3.6 推挽式混合CATV放大模組 . . . . .	50
. . . . .	51	3.3.7 高通濾波器 . . . . .	51
. . . . .	51	3.3.8 方向耦合器 . . . . .	53
. . . . .	54	3.4 功能架構比較 . . . . .	54
. . . . .	54	第四章 射頻輸出放大模組設計與製作 4.1 簡介 . . . . .	56
. . . . .	56	4.2 射頻輸出放大模組的架構與規格 . . . . .	56
. . . . .	56	4.3 電路架構說明 . . . . .	58
. . . . .	59	4.3.1 衰減器(PAD) . . . . .	59
. . . . .	59	4.3.2 等化器(EQ) . . . . .	59
. . . . .	60	4.3.3 預置放大器與後級放大器 . . . . .	61
. . . . .	62	4.3.4 溫補償元件(TH) . . . . .	61
. . . . .	62	4.3.5 功率分配器 . . . . .	64
. . . . .	64	4.3.6 雙向濾波器 . . . . .	64
. . . . .	64	4.4 與傳統光接收機的射頻輸出放大模組比較 . . . . .	67
. . . . .	67	第五章 特性量測 5.1 光接收模組的量測與討論 . . . . .	70
. . . . .	74	5.2 射頻輸出放大模組的量測與討論 . . . . .	70
. . . . .	74	5.3 整體光接收機的量測與討論 . . . . .	79
. . . . .	82	第六章 結論 . . . . .	82
. . . . .	82	參考文獻 . . . . .	85
. . . . .	87	附錄A 檢光模組2609B規格 . . . . .	87
. . . . .	87	附錄B 射頻放大IC RF2317規格 . . . . .	89
. . . . .	89	附錄C 有線電視系統傳輸用同軸電纜損失值參考表 . . . . .	91
. . . . .	91	附錄D Motorola公司推挽式混合CATV放大模組MHW8272A 規格 . . . . .	93
. . . . .	93	附錄E Motorola公司功率倍增式混合CATV放大模組 MHW9187規格 . . . . .	93
. . . . .	94		

## REFERENCES

- 參考文獻 [1] Ernest Tunmann, "HYBRID FIBER-OPTIC COAXIAL NETWORKS," Flatiron Publishing, Inc., First Edition, May 1995.
- [2] 陳克任著, "有線電視通訊寬頻網路主角," 儒林圖書公司, 台北(2001).
- [3] Oleh Sniezko, Tony Werner, Doug Combs and Esteban Sandino, "HFC architecture in the making," CED Magazine, July 1999.
- [4] Aurora Networks, Inc. "Passive HFC Architecture," White Paper, October 2001.
- [5] Donald Sipes and Bob Loveless, "Feature : Deep Fiber Network, A Review of Ready-to-Deploy Architectures," Communications Technology, February 2001.
- [6] 陳盟坤, "適用於光纖通訊之高速雷射二極體驅動電路," 大葉大學碩士論文, 2003.
- [7] Hai-Han Lu, "Directly Modulated Optical Transmitter and Receiver Design with Half-Split-Band Technique," Journal of Technology, Vol. 14, No. 4, pp. 503-510 (1999).
- [8] Djafar K. Mynbaev and Lowell L. Scheiner, "Fiber-Optic Communication Technology," Prentice Hall, 2001.
- [9] Chen, Y. K., Liu, Y. L. and Lee, C. C., "Directly Modulated 1.55um AM-VSB Video EDFA-Repeated Supertrunking System Over 110Km Standard Singlemode Fiber Using Split-band and Wavelength Division Multiplexing Techniques," Electronics Letters, Vol. 33, No. 16, pp. 1400-1410 (1997).
- [10] 林崧銘 編著, "有線電視技術," 全華科技, 二版, 台北(1996).
- [11] 袁帝文, 王岳華, 謝孟翰和王弘毅 編著, "高頻通訊電路設計," 高立圖書, 台北(2002).
- [12] Chris Bowick, "RF Circuit Design," 東南, 台北(1990).
- [13] Donald Raskin and Dean Stoneback, "Broadband Return Systems For Hybrid Fiber/Coax Cable TV Networks," Prentice Hall, 1998.
- [14] PHILIPS BROADBAND NETWORKS, "Broadband Network Reference Guide," July, 1997.
- [15] William Grant, "Cable Television," GWG Associates, Third Edition, 1998.
- [16] Jeffrey L. Thomas, "CABLE TELEVISION Proof-of-Performance," Hewlett-Packard Professional Books (1995).
- [17] MATRIX TEST EQUIPMENT Inc., "SOME NOTES ON COMPOSITE SECOND AND THIRD ORDER INTERMODULATION DISTORTIONS," TECHNICAL NOTES MTN-108, May 9, 2003.
- [18] Winston I. Way, "Broad band Hybrid Fiber/Coax Access System Technologies," Academic Press (1999).
- [19] Philips Semiconductors, "Using a Philips Optical Receiver in CATV Applications," Application Note AN98060, Sep, 1998.
- [20] 益陶電子公司, TAO'S THERMISTOR產品目錄.
- [21] 洪鴻文, "有線電視系統(750MHz)雙向放大器中等化器之設計與製作," 第十四屆全國技術及職業教育研討會論文集, pp. 101-108, 1999年5月.
- [22] JXP Attenuator Catalogue, South Wold Ent., 2001.
- [23] Harmonic Inc. PWRBlazer TM Node, HLN384X Series Catalogue.