RURAL DISTRIBUTION SYSTEMS:
A NEW TECHNIQUE FOR SMALL SYSTEM TRUNKING

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Abstract

There is a requirement for the cable television industry to provide service to areas outside the basic body of the system. In many cases, small systems are actually comprised of many small systems interconnected by what is commonly called supertrunk, express trunk or simply dead trunk runs. This report will not eliminate these situations but will attempt to describe a new technique for providing high performance, low cost cable service to sparsely populated areas.

Introduction

Two of the limiting factors that have prevented cable operators from providing service to remote (rural) sections of their franchise areas have been economics and performance. In many cases, desired performance to these remote areas could be provided, but the cost of doing so is prohibitive. Microwave links could provide the performance desired if there was a subscriber base to warrant the expense. Supertrunks, consisting of large diameter, low loss cable offer land route alternatives to provide pictures of quality to these areas when using sophisticated high quality amplifiers. Unfortunately, in providing a quality product to these remote areas, performance is sometimes more easy to overcome than the prohibitive costs of installing such system extensions. A means to serve remote extensions without compromising performance and being economically feasible should be of interest to many operators and certainly could be considered a new technique.

Discussion

"Mini-trunk" carries the stigma, in the minds of many operators, of something cheap and inferior. This may be the greatest obstacle to generating interest in a mini-trunk amplifier. In this discussion of mini-trunks and their applications, costs should be thought of as inexpensive or reasonable in price, but the system described here is definitely not cheap or inferior.

When C-COR Electronics, Inc., developed their current line of distribution amplifiers, the latest gold bonded trunk hybrids available were used. These gold bonded trunk hybrids produce the highest output now available. The die (transistor) is the output device which largely determines the output capability of the amplifier. This output capability is the most important single electrical characteristic of an amplifier. While one may manipulate the specifications describing output of an amplifier, the facts are that the die (transistor) determines the output. The gold metallization used in these hybrids gives higher reliability than earlier aluminum bonded types, and these newer hybrids were designed for trunk amplifiers.

C-COR utilized different combinations of these gold bonded trunk hybrids in order to provide a line of amplifiers which have 44 dB and 29 dB gain utilizing two hybrids. This use of two trunk hybrids within these amplifiers allows for a definite application for use as mini-trunk amplifiers. The immediate application for such amplifiers is for sparsely populated areas where a full sized trunk station is not economically justifiable but where high performance is still required. The emphasis is not on reduced performance but rather on reduced amplifier expense.

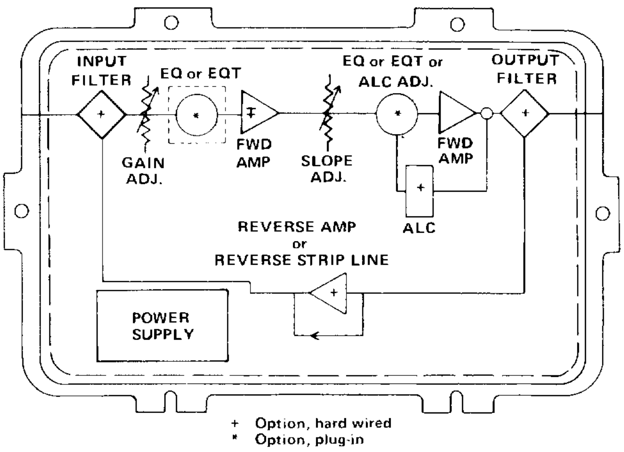
The following provides some typical amplifier list prices for cost comparison of a twenty (20) trunk amplifier cascade.

	List Price
Trunk station w/ALC (22 dB spacing)	$ 885.00
Mini-trunk (D-443) w/thermal level control (22 dB spacing)	339.00
20 amplifier cascade of full sized trunk stations	17,700.00
20 amplifier cascade consisting of 16 mini-trunks and 4 full sized trunk stations	8,964.00

Using list pricing for the amplifier cascade, the utilization of mini-trunks with a full sized trunk station at every fifth (5th) location will result in amplifier costs of approximately 1/2 of the costs resulting from a similar cascade consisting of all full sized trunk stations. Naturally, discounts available and the amount of distribution required along the cascade will result in variations in the total pricing.

Figure 1 illustrates a block diagram of the mini-trunk amplifier. It should be noted that accessibility of the interstage location for equalization and control is a real advantage, especially when coupled with the low noise figure of the amplifiers. The interstage equalizer plug-in position can be used to provide maximum carrier-to-noise ratio when operating with tilted outputs. The use of thermal equalizers, both interstage and at the input of the 28 dB gain mini-trunk, can thermally compensate for 22 dB of cable at the highest frequency. With the 44 dB gain unit, the thermal equalizers at the input and interstage locations will compensate for approximately 34 dB of cable at the highest frequency. The spacing of the mini-trunk is determined by selecting the appropriate equalizers for the desired system bandwidth.

FIGURE 1



Thermal level control for short cascades can be accomplished by seasonal balancing of the amplifier or by interspersing closed loop pilot controlled ALC trunk stations at strategic locations along the cascade. The use of thermal plug-in equalizers within the mini-trunk will compensate for the spacing between amplifiers over the temperature range from 0 to 120° F with better than $\pm$ .75 dB flatness from 50 MHz to the highest frequency. If standard closed loop pilot controlled ALC trunk stations are used at, say, every fourth location, an economical trunk cascade with excellent level control can be realized. A typical trunk cascade is illustrated in Figure 2.

FIGURE 2

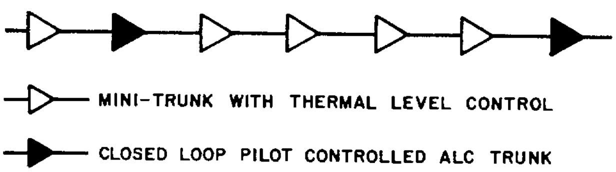


Figure 3 lists the individual specifications for standard type trunk amplifiers. A comparison of the standard type trunk with the mini-trunk shows that the mini-trunk actually has some performance advantages over the standard units, especially with the 22 dB spaced unit. Even with the 34 dB spaced unit, there is substantial improvement over standard units with third order performance.

The 22 dB spaced mini-trunk has system application for extended cascades which have channel loading up to 30 channels. The 34 dB spaced mini-trunk is generally recommended for shorter cascades with 12 to 20 channel loading. The decision on which mini-trunk should be used must ultimately be decided by the individual user as is the case with any amplifier selection process. Bandwidth, channel loading, distance to be traversed and performance desired at the system extremes must be considered. There will be situations in which either of the mini-trunks could be used. Where such a situation exists, many could choose to use the 34 dB spaced unit on the basis that fewer amplifiers increases system reliability. The amplifier selection, however, must be based on realistic requirements, considering both present and anticipated future needs.

Figure 4 lists some typical system performance numbers using cascades of mini-trunk and standard trunk stations. Distribution performance has been included to show system performances. The distribution performance has been calculated on the basis of using the trunk cascade, plus one distribution (Bridger) amplifier and two extenders in cascade. Trunk cascades are included in Figure 4 for comparative performance information. The comparison shows that either standard or mini-trunk stations can be used with negligible differences. By installing closed loop pilot controlled ALC trunk stations at every fourth or fifth trunk station, the resultant trunk run would have excellent level control and excellent performance - plus at a substantial savings over conventional cascades where all full sized trunk stations are not required.

Summary

While the goals for cable systems are fairly rigid in some instances, there is flexibility in the ways to approach those goals. Generally, performance within a system should not be greatly compromised since the object of providing service to remote areas is to gain subscribers and the subscribers will judge for themselves whether cable television is worth paying for. The approaches to getting to the subscriber areas are variable, at least with respect to amplifiers to be utilized and costs involved in purchasing those amplifiers. Every reader of this paper might not agree with the approach discussed here, but we have suggested an approach which is more economical, provides excellent performance and is an option which we believe is worth considering. Other utilization considerations might be to use the mini-trunk within the main body of the system where relatively short secondary trunk runs eminate from the primary trunks. The uses of mini-trunks are as varied as the imaginations of the operators. Perhaps the initial foremost consideration is that it could save cable operators real dollars. In this day, that alone makes the system discussed here well worth considering.

	Mini-Trunk With Interstage EQT	Typical Trunk	Mini-Trunk With Interstage EQT	Typical Trunk	Mini-Trunk With Interstage EQT	Typical Trunk
Full Gain (minimum), dB	25	26	25	26	38	37
Bandpass, MHz	40-220	40-220	40-300	40-300	40-220	50-220
Flatness, ± dB	.3	.2	.3	.2	.3	.25
Output Rating @ -57 dBXM (2) dBmV	+53.5	+50.5	+52.0	+48.5	+53.0	+55.0
Typical Operating Conditions Channels, Number of	21	21	30	30	21	21
Spacing, Operational (1), dB	22 @ 220 MHz	22 @ 220	22 @ 300	22 @ 300	34 @ 220	34 @ 220
Operating Levels (4), dBmV Input	Ch 13/Ch 2 10/15	Ch 13/Ch 2 10/16	Ch W/Ch 2 10/17	Ch W/Ch 2 10/17	Ch 13/Ch 2 6/12	Ch 13/Ch 2 6/12
Output	32/26	32/26	32/26	32/25	40/29	40/29
Distortion Charac. @ Typical Operating Levels (8) Cross Mod, (XM) (5), dB	-100	-94	-97	-90	-83	-87
Second Order (2IM) (6) dB	-88	-86	-88	-86	-72	-84
Third Order (3IM) (7) dB	-114	-111	-117	-114	-98	-90
CW Comp Beat (CB) (8) dB	-99	-95	-93	-92	-82	-77
Noise Figure (3), dB	8	9	8	9	8	8
Factory Alignment Cable Loss, dB	11 @ 220 MHz	11 @ 220	11 @ 300	11 @ 300	18 @ 220	34
Flat Loss, dB	14	12	14	12	20	--
Return Loss, Input and Output, dB	18	16	18	16	18	16
Gain Adjust Range, dB	0-10	0-8	0-10	0-8	0-10	0-8
Slope Adjust Range @ Ch 2, dB (pivot at 200 MHz)	-4.0	-3.5	-4.0	-3.5	-4.0	+4.0

Figure 3. Amplifier Specifications

	CNR at Highest Channel	X-M Linear Tilt	2IM 2 CW Carriers	3IM Triple Beat 3 CW Carriers
22 dB Spacing, 50-220 MHz 21 Channels				
20 Mini-trunk Cascade	+48.0	-74.0	-70.5	-88.0
Distribution	+54.0	-61.0	-69.0	-79.0
System	+47.0	-59.0	-66.5	-76.0
20 Standard Trunk Cascade	+47.0	-68.0	+68.5	-85.0
Distribution	+54.0	-61.0	-69.0	-79.0
System	+46.0	-57.0	-65.5	-75.5
22 dB Spacing, 50-300 MHz 30 Channels				
20 Mini-trunk Cascade	+48.0	-71.0	-70.5	-91.0
Distribution	+54.0	-61.0	-69.0	-79.0
System	+47.0	-58.5	-66.5	-77.0
20 Standard Trunk Cascade	+47.0	-64.0	-68.5	-88.0
Distribution	+54.0	-61.0	-69.0	-79.0
System	+46.0	-56.0	+65.5	-76.5
34 dB Spacing, 50-220 MHz 21 Channels				
10 Mini-trunk Cascade	+47.0	-63.0	-57.5	-78.0
Distribution	+54.0	-61.0	-69.0	-79.0
Systems	+46.0	-59.0	-57.0	-75.0
10 Standard Trunk Cascade	+47.0	-67.0	-69.5	-70.0
Distribution	+54.0	-61.0	-69.0	-79.0
Systems	+46.0	-57.5	-66.0	-67.0

Figure 4. System Performance