BUILD THE WHOLE PLANT WITH LINE EXTENDERS

WHY NOT?

When the majority of us think about line extenders, we tend to envision a series or cascade of two to three units following a bridger output. In larger systems there is no question (or will we suggest to the contrary) that this is a must approach. The integrity of the trunk *must be maintained.* In older systems, with multiple pressure taps and/or directional taps without seized center conductors, the idea of keeping the feeder lines as autonomous as possible from the trunk line was (and is) a good idea.

But. . .what about the new, now being designed, small(er) system; the system with five to ten miles of distribution plant. On the one hand we have ever spiraling costs associated with increasing cable and hardware costs, increasing amplifier costs and last but hardly least the gradual erosion of the labor base costs to install a mile of *plant.* Today we have high-quality (i.e. high isolation) directional taps with seized center conductors. We also have higher quality (i.e. better cross mod rated) line extender amplifiers. Perhaps it is time for small(er) system builders to give *serious reconsideration* to designing a plant with a tapped trunk (or all feeder) approach.

THE ECONOMICS

Naturally we are interested in this approach only if it will save money for initial capital outlay and not affect the quality of the service to our subscribers. If it will do both *there may well be a number of small towns of 250 to 2,000 population* badly in need of cable. If we use this approach we can install CATV, *but* if we are *forced* to use accepted trunk *plus* feeder techniques the economics will not allow a CATV system to be built.

The advantages to this approach are as follows:

(1) No feeder lines paralleling trunk lines (eliminates expensive double cabling);
(2) No expensive (relative to line extenders) trunk amplifiers;
(3) No expensive (relative to line extenders) bridger amplifiers;
(4) No overlashed cable (why not simply use integrated messenger cable?);
(5) A minimum of capital tied up in spare, standby amplifiers or modules, since all (line extender) units use the same type of module;
(6) Reduced maintenance costs (simple system) and lower system complexity (i.e. one set of numbers for the entire plant, not one set for the trunk and one set for the feeders).

So much for the advantages. Naturally there are some *disadvantages* also.

(1) Possible disruption of service for the entire plant beyond a certain point if an amplifier quits or connector pulls (or a tap fails, although this should be rare with today's high quality taps);
(2) Possible picture degradation due to unterminated drop lines or feedback

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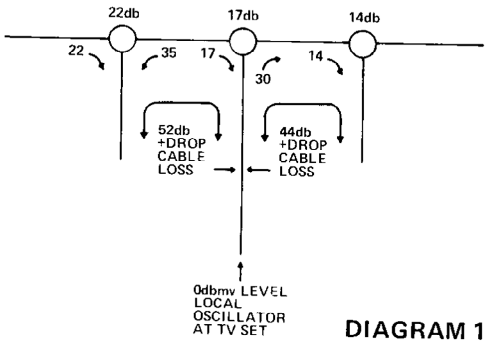

DIAGRAM 1

through the drop from a runaway local oscillator in a TV receiver;

(3) Possible amplifier-additive degradation due to line level changes;

(4) Possible trouble with cross modulation because we must run the line extender at a fairly high output level to facilitate *efficient tapping* procedures.

As for savings, it should be readily apparent that if you can eliminate the trunk cable and trunk (plus bridger) amplifiers, you have saved several thousand dollars even in a small system.

The key, or at least one important key, is the *quality* of today's line extender amplifiers. To establish design criteria for what follows, CATJ looked at the specs for several amplifiers now on the market and developed the following standards for the system designs to follow:

1. *Gain*. . . . . 24-26 db
2. *Cross Mod* at 50 dbmv output for 12 channels. . . . . -57 db
3. *Cross Mod* at 42 dbmv output for 5 db block tilt. . . . -73 db
4. *Cross Mod* at 35 dbmv output for 5 db block tilt. . . . -87db
5. *Noise Figure*. . . . . . . .12 db
6. *AGC*. . . .available as option
7. *Equalizer*. . . .plug in type

If you will check these standards against data sheets now available from a number of manufacturers you will find that *this type of performance is available* from any number of plant equipment manufacturers.

OBJECTION-CONNECTORS

To answer the first objection, it should be obvious that a seized center conductor fitting, properly installed, should all but totally *eliminate the chance* for a connector related outage.

OBJECTION-AMPLIFIERS

Anyone currently using recent vintage plant line extenders is already impressed with their reliability. It simply should not be a problem. And when there is an outage, the modular "snap-in" design of today's line extenders should facilitate quick service restoration.

OBJECTION-TAP DISCONTINUITIES

By utilizing today's high quality directional taps or couplers from plant service lines to the home drop, ghosting caused by non-terminated drops and local oscillator feed back should be not less than 40 db down (plus the natural loss of the drop cable). Running the numbers Diagram 1 is a depiction of three taps in a system with the television set connected to the middle DT and a local oscillator radiation *output* of 0 dbmv.

Notice that the level at the 22 db tap is down 52 db and at the 14 db DT the undesired oscillator is down 44 db. In both cases this is adequately down to meet FCC specs (1).

OBJECTION - LEVEL STABILITY

Line extenders are available today with AGC for approximately $20.00 more than with manual gain. If each and every line extender AGC'd by the AGC system, levels should be constant at the end of a 10 amplifier cascade within 2 db without any need for seasonal adjustments.

(1 - Section 76.605 (a) (11) states "Terminal isolation provided each subscriber shall be not less than 18 db, but in any event shall be sufficient to prevent reflections caused by open-circuited or short-circuited subscriber terminals". Section 76.605 (a) (10) states "The ratio of visual signal level to the rms amplitude of any coherent (such as a receiver local oscillator) disturbance shall be not less than 46 db".)

CROSS MODULATION COMBINING DERATE: FOR DISSIMILAR AMPLIFIERS

DIFFERENCE IN dB	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0	6.02	5.97	5.92	5.87	5.82	5.77	5.73	5.68	5.63	5.58
1.0	5.53	5.49	5.44	5.39	5.35	5.30	5.26	5.21	5.17	5.12
2.0	5.08	5.03	4.99	4.94	4.90	4.86	4.82	4.78	4.73	4.69
3.0	4.65	4.61	4.57	4.53	4.49	4.45	4.41	4.37	4.33	4.29
4.0	4.25	4.21	4.17	4.13	4.10	4.06	4.02	3.98	3.95	3.91
5.0	3.88	3.84	3.80	3.77	3.73	3.70	3.66	3.63	3.60	3.56
6.0	3.53	3.50	3.46	3.43	3.40	3.36	3.33	3.30	3.27	3.24
7.0	3.21	3.18	3.15	3.12	3.09	3.06	3.03	3.00	2.97	2.94
8.0	2.91	2.88	2.86	2.83	2.80	2.77	2.74	2.72	2.69	2.66
9.0	2.64	2.61	2.59	2.56	2.53	2.51	2.48	2.46	2.44	2.41
10.0	2.39	2.36	2.34	2.32	2.29	2.27	2.25	2.22	2.20	2.18
11.0	2.16	2.13	2.11	2.09	2.07	2.05	2.03	2.01	1.99	1.97
12.0	1.95	1.93	1.91	1.89	1.87	1.85	1.83	1.81	1.79	1.77
13.0	1.75	1.74	1.72	1.70	1.68	1.67	1.65	1.63	1.61	1.60
14.0	1.58	1.56	1.55	1.53	1.51	1.50	1.48	1.47	1.45	1.44
15.0	1.42	1.41	1.39	1.38	1.36	1.35	1.33	1.32	1.31	1.29
16.0	1.28	1.26	1.25	1.24	1.22	1.21	1.20	1.19	1.17	1.16
17.0	1.15	1.14	1.12	1.11	1.10	1.09	1.08	1.06	1.05	1.04
18.0	1.03	1.02	1.01	1.00	0.99	0.98	0.96	0.95	0.94	0.93
19.0	0.92	0.91	0.90	0.89	0.88	0.87	0.86	0.86	0.85	0.84
20.0	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.77	0.76	0.75
21.0	0.74	0.73	0.73	0.72	0.71	0.70	0.69	0.69	0.68	0.67
22.0	0.66	0.66	0.65	0.64	0.64	0.63	0.62	0.61	0.61	0.60
23.0	0.59	0.59	0.58	0.57	0.57	0.56	0.56	0.55	0.54	0.54
24.0	0.53	0.53	0.52	0.51	0.51	0.50	0.50	0.49	0.49	0.48
25.0	0.48	0.47	0.46	0.46	0.45	0.45	0.44	0.44	0.43	0.43
26.0	0.42	0.42	0.42	0.41	0.41	0.40	0.40	0.39	0.35	0.38
27.0	0.38	0.38	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.34
28.0	0.34	0.34	0.33	0.33	0.32	0.32	0.32	0.31	0.31	0.31
29.0	0.30	0.30	0.30	0.29	0.29	0.29	0.28	0.28	0.28	0.27
30.0	0.27	0.27	0.26	0.26	0.26	0.26	0.25	0.25	0.25	0.24
31.0	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.22	0.22	0.22
32.0	0.22	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.19
33.0	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.17
34.0	0.17	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.15
35.0	0.15	0.15	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.14
36.0	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.12
37.0	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11
38.0	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10
39.0	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
40.0	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

TO USE THIS CHART:

1. DETERMINE THE CROSS MOD LEVEL FOR EACH AMPLIFIER OR GROUP OF AMPLIFIERS WHICH ARE TO BE COMBINED
2. COMPARE THESE LEVELS TO OBTAIN THEIR DIFFERENCE.
3. USE THIS DIFFERENCE FIGURE TO OBTAIN THE DERATE ON THIS CHART.
4. DERATE THE WORST CROSS MOD LEVEL BY THIS DERATE TO OBTAIN A COMBINED CROSS MOD LEVEL.

TABLE ONE - developed from data supplied by Jerrold and Cascade

OBJECTION - CROSS MOD

Before we jump into possible cross mod problems with our ten amplifier cascade of line extenders only, let's go through cross mod derating in a normal CATV system.

First we have our trunk line amplifiers which we derate down to a worst case cross mod situation of -57 db. Then we run our bridger out at a cross mod (down) point of -63 db. This is a difference (57/63) of 6 db between the two. Look at Table 1. For a difference of 6 db we have to subtract 3.53 db from our worst case cross mod (-57 db) which nets us -53.47 db.

Now a typical line extender cascade carried to its extreme is run at -63 db also. Now we combine the -63 db cross mod from the line extenders to the -53.47 db from the

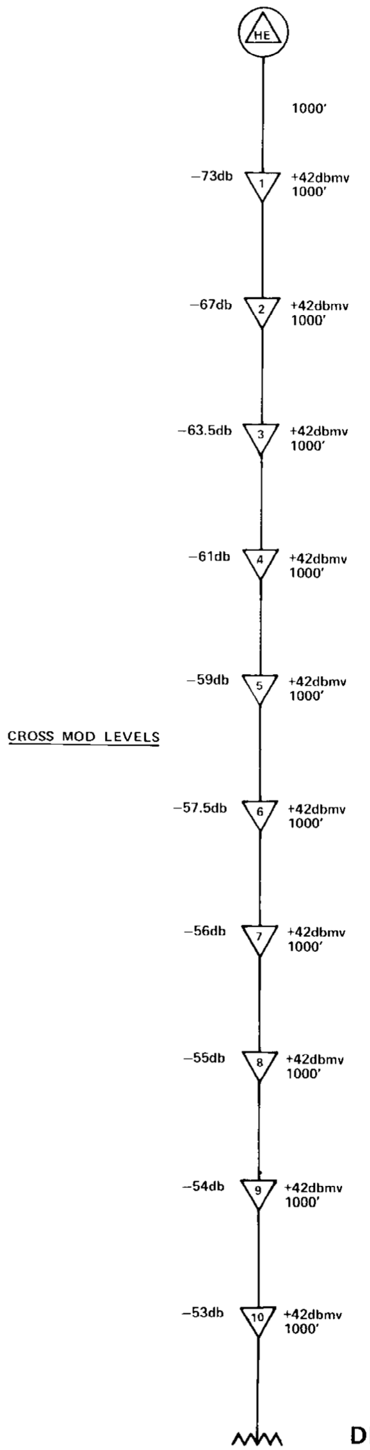

DIAGRAM 2

bridger, and again in Table 1 we find that we need to subtract 2.51 db from the -53.47 which leaves us with -50.96 (call it -51) db.

In a *typical* modern system, with a full cascade run of line extenders, we are actually -51 db for cross mod in a typical (*real-life*) situation.

At the same time, most of the cross mod (and concern for same) is really back in the trunk amplifiers and bridgers anyhow.

Diagram 2 shows the actual cross mod (calculated using Table 1) of a derated system for a cascade of ten line extenders running out at +42 dbmv. The important point to notice is that at the 10th line extender the cross mod is only -53 db, or 2 db *better* than would be tolerated in a so-called conventional system. Actually we *could* carry this out to the 12th line extender amplifier and still be at -51.42 db on cross mod.

This works out to 11,000 feet of direct plant (2.083 miles) in plain old every day .412 cable (2.55 db at channel 13). Naturally a man could use more exotic cable, larger cable, etc. and pick up quite a bit of extra mileage *if* the system and costs justified additional runs.

In a real situation where the plant was not all down one straight run (we usually have at least a few side runs involved) you would carefully use directional line taps and splitters and this approach can easily add up to 5 to 8 or 10 miles of total cable plant with nary a bit of trunk involved.

OBJECTION - TOWER DISTANCE

Suppose the tower is a mile (or more) out of town? How can a system afford to use up 50% (or more) of its cascade ability just getting into town?

Diagram 3 shows a cascade of four line extenders used as *"trunk amps"* with 10 db inputs and 35 db outputs spaced at 1,923 feet in .500 cable. After the fourth (trunk) extender we short space at 1,384 feet in .500 cable and go directly *without a bridger* into line extenders running out at +42 dbmv and

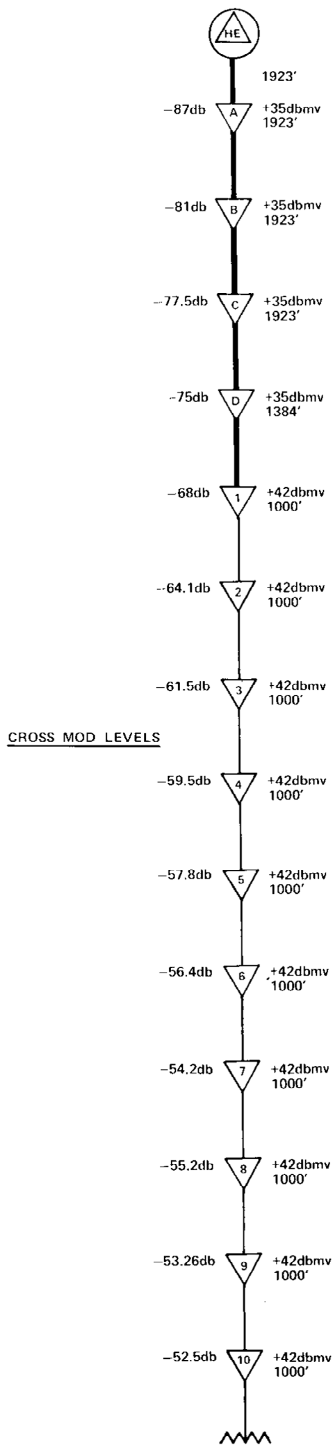

DIAGRAM 3

spaced at 1,000 feet in plain old .412 cable. As you can see in Diagram 3 the cross mod at the first *trunk* is -87 db and after the fourth trunk it has dropped to -75 db. Then each *customer extender* (as opposed to *trunk extender)* is derated per the chart in Table 2 resulting in the cross mod at the tenth customer extender (fourteenth total amplifier of same extender variety) of -52.5 db. This is still well within acceptable limits.

If we look at the problem as being two separate cascades, the first being four deep, Table 1 shows that we must subtract 12 db and we end up with a cross mod of -73 db. In the second cascade of ten extenders we have a derate in 10 amplifiers of 20 db. And that gives us 73-20 or -53 db cross mod. In Table 2 we can also see that for a 20 db difference we have to subtract 0.83 db or 53 - 0.83 which is -52.17 db cross mod. That is very close to our calculations of -52.5 db in Diagram 3.

POWERING PROBLEMS

Most line extenders available today were designed around the Western Electric specs set forth nearly a decade ago when Telco was leasing back systems all over the country. That spec calls for 6 amp *through power handling capacity,* an amount that will keep you well out of trouble.

Different line extenders draw different amounts of current; some are voltage conscious. With a switching regulator type of extender, typical current draw values per line extender are around 250 mA. Other approaches have current draw per amplifier as a function of voltage supplied to the amplifier. One popular series draws approximately 350 mA on 45-60 volts while the same line extender draws 800 mA at 20-26 volts.

The same approach to directional taps indicates that typically *5-6 amps through current* is specified.

Normally you would locate your power supply near the plant *mid-point* and you will probably run out of voltage (especially with .412 cable) before you run out of current handling ability.

NOISE DERATE	AMPS IN CASCADE	CROSS MOD DERATE	NOISE DERATE	AMPS IN CASCADE	CROSS MOD DERATE	NOISE DERATE	AMPS IN CASCADE	CROSS MOD DERATE	NOISE DERATE	AMPS IN CASCADE	CROSS MOD DERATE
NOISE AND CROSS MODULATION DERATE: CROSS MODULATION DERATE ON 12 CH. SYNCHRONOUS											
0	1	0	12.04	16	24.08	14.91	31	29.83	16.63	46	33.26
3.01	2	6.02	12.30	17	24.60	15.05	32	30.10	16.72	47	33.44
4.77	3	9.54	12.55	18	25.10	15.19	33	30.37	16.81	48	33.62
6.02	4	12.04	12.79	19	25.58	15.32	34	30.63	16.90	49	33.80
6.99	5	13.98	13.01	20	26.02	15.44	35	30.88	16.99	50	33.98
7.78	6	15.56	13.22	21	26.44	15.56	36	31.13	17.08	51	34.15
8.43	7	16.90	13.42	22	26.85	15.68	37	31.36	17.16	52	34.32
9.03	8	18.06	13.62	23	27.23	15.80	38	31.60	17.24	53	34.49
9.54	9	19.08	13.80	24	27.60	15.91	39	31.82	17.32	54	34.65
10.00	10	20.00	13.98	25	27.96	16.02	40	32.04	17.40	55	34.81
10.41	11	20.82	14.15	26	28.30	16.13	41	32.26	17.48	56	34.96
10.79	12	21.58	14.31	27	28.63	16.23	42	32.46	17.56	57	35.12
11.14	13	22.28	14.47	28	28.94	16.34	43	32.67	17.63	58	35.27
11.43	14	22.92	14.92	29	29.25	16.44	44	32.87	17.71	59	35.42
11.76	15	23.52	14.77	30	29.54	16.53	45	33.06	17.78	60	35.56

TABLE TWO developed from data supplied by Jerrold and Cascade

CONCLUSION

CATJ hopes that this kind of "think about it" article *will start you thinking* about how you can save money without cutting important service quality corners in your next small(er) system. Naturally it would be impossible to give a complete plant layout that would suit *your situation* in one "cover it all" feature. By the time you add in (on paper) your own variables, splitters, directional line taps for splitting, your selection of cables, etc. you will be able to calculate your own "tapped trunk" system costs vs. the more conventional trunk and feeder system.

MORE ON ATS-6

It was **intended** and **planned** that a full description of a do-it-yourself earth receiving terminal for the ATS-6 satellite program would be offered in this issue of CATJ.

Between the date the August feature was prepared (mid-July) and the deadline for this issue (mid-August) CATJ has been successful in getting the antenna, preamplifier, and RF to video portion of our receiver unit perking; which is more than we can say for many of the sites installed by Hewlett Packard for the program!

However, we have a problem that we **share** with the sites now in the field. It seems that when the uplink portion of the package was planned, a very unusual amount and type of video **pre-emphasis** (or planned distortion) was built into the package. For whatever reason this pre-emphasis was "built-in", there are a number of technicians and engineers associated with the project who now wish more attention had been given to this phase of the project.

The receivers built by H-P naturally have **de-emphasis** built in to **compensate** for the pre-emphasis at the uplink end. Unfortunately, the de-emphasis networks built into the ground receiving terminals were constructed or designed with 10 and 20% resistors and capacitors, which is another way of saying **"they are not very precise"**.

The end result is a video/sync stability problem at receiving terminals. There is plenty of RF (i.e. received signal level) present and we can verify that. But the end result, badly distorted video, is something else.

It is correctable we are told, and we agree that it should be. But **how** it is going to get corrected and **how fast**, we cannot report.

We are staying close to the people running the project, and out of their way, while they work on the problem. Then, we will pick up this series as promised and continue with detailed plans for the construction of your own CATV system receiving terminal for ATS-6.