OpTel
The Multi-Family
Telecommunications Specialist

Annex B

“System Design Specifications”

Attached are the RF design specifications for both conventional and interdiction designs. This is a summary of the released specifications. The main additions or changes are:

1. More focus on Multi-Family design and less on conventional R1 cable television design
2. Increased performance and reliability through reduction of amplifiers
3. Anticipated lower cost per passing
4. Cascade rules and operating levels
5. Introduction of GNA amplifier
6. No AGC in underground projects (some exceptions)

This is referenced to Engineering Department Document 9609-E-014, “System Specification for all Video Distribution Systems Design Construction & Operation”.

DESIGN CONCEPTS:

It is very important that our design approach to our OpTel projects is clearly understood by all involved in the design process. We are a high-density Multi-Family business, offering Multi-Family services (voice, video and data). We are not (in most cases) offering citywide cable TV services. Our designs must reflect this niche market or niche design. Some things that are particular to our high-density designs are:

1. We design the existing property. We do not design for future growth. Unless a specific project has design notes indicating future growth, we design the end of the line as if it's really the end of the line. We do not leave excess signal available at the end of line. We meet the distortion requirements at the end of the line, not exceed them.
2. We do not design express, super "D", untapped feeder or other conventional HFC cable TV designs. Our Multi-Family projects rarely are large enough to require these types of architectures to make the "reach" in the RF system part of the project. We do employ dedicated or transportation types of cables to move satellite or microwave signal sources across the property to the headend and we do employ backfeeds (when it makes sense).
3. We are very interested in drop length, drops per location and addresses. When we say the longest drop is 150' feet, we do include the cable inside the unit from point of entry to the set. We also include the vertical routing from floor to floor. The number of drops per locations must clearly line up with the addresses fed from that location. Addresses must be complete, showing all numbers not ranges or groups but individual numbers.
4. We are interested in high quality, cost efficient, design creations. We are not looking for "automated" design. We want the designer's experience and creativity to make the difference. We provide the design rules and the designer provides the innovations that make the difference between automated high production design and well thought out, efficient and practical design.

During the design process, several iterations are usually possible. Different designers, using the same design rules, may produce technically acceptable designs for the same project, using very different approaches. Here are our general guidelines for determining which design is the "best".

> 1) The design must always be in TECHNICAL COMPLIANCE, with some iterations offering less distortion than others do.
>
> 2) When a design is in complete technical compliance, the iteration with the lower BILL OF MATERIALS and LABOR COSTS is the preferred design.

We are not asking for multiple designs for each project. We are asking that every iteration be examined during the design process and the best technical and lowest cost iteration be chosen.

DISTORTION AND REACH

We look at distortion as the overriding element that determines our total geographic RF reach. We have two separate network elements that contribute distortion that will ultimately appear at the customers terminal, first, the headend plus microwave or fiber transport system and secondly, the video or RF distribution system.

VIDEO NETWORK Headend + Microwave or Fiber Distortion Contribution **1**	VIDEO DISTRIBUTION RF System Distortion Contribution **+ 2**	INTERDICTION Device **+ 3**	CUSTOMER TERMINAL Culumative Distortion for entire Network **= 4**

Although both the transport, distribution and interdiction systems make their separate distortion contributions, they are all present at the customer's terminal and determine our overall picture quality.

DESIGN EFFICIENCIES

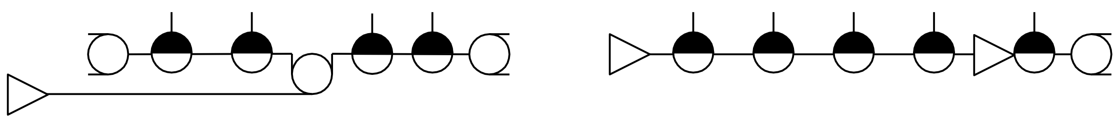
Here are a number of different design approaches that will result in efficient design.

EXPRESS CABLE and BACKFEEDS

We do not use express, untapped feeder, super D, etc. These projects are small multifamily designs and we use DC's to feed tap strings and prefer in-line tapping after the last split. We do use straight transportation cables in cases where the microwave receiver is remote from the headend or the property requires insertion of special video (VCR, CG, and closed circuit). The approach is to use a dedicated .750 coaxial cable to move signal from point A to point B only.

When there is a "future" growth potential, we will identify that to the designer ahead of time and there may be an Express application in that case.

We do use back feeds when we can eliminate an extra amplifier or there is some other solid design efficiency. We are looking for fundamental design specifically tailored to our Multi Family universe, not long haul HFC or other network approach.



DO THIS **DON'T DO THIS**

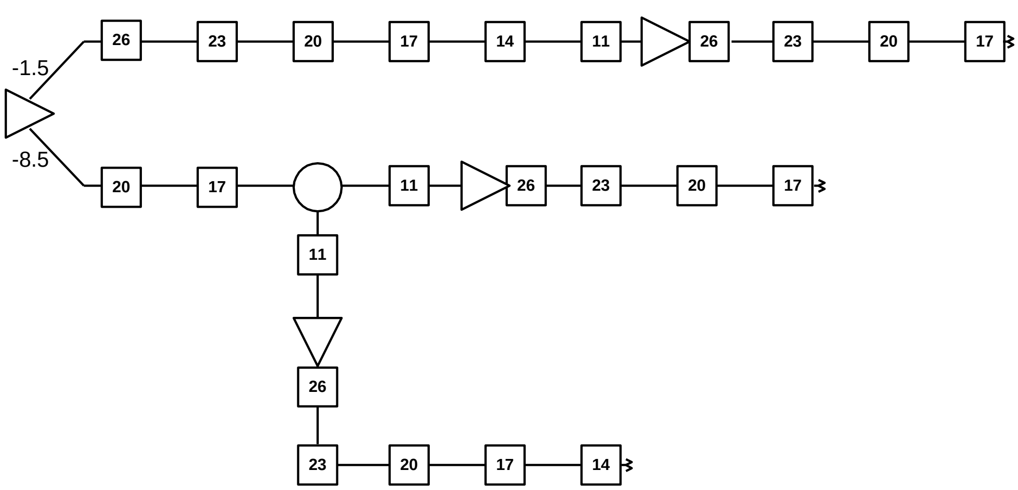
DESIGN BACKWARDS

While this is a commonly understood design standard, more often than not, with computer aided design, designers are designing outbound from the headend as opposed to inbound from the customers tap.

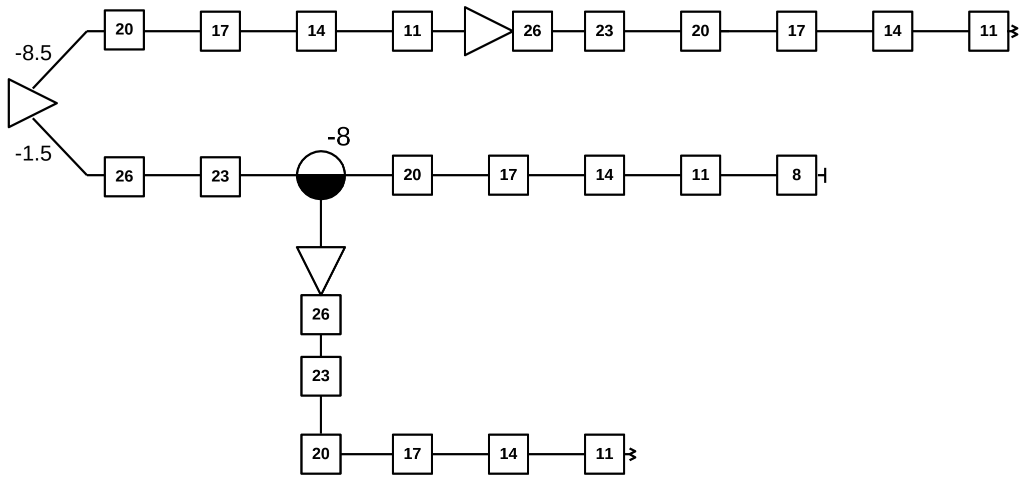
When designing outbound, the value of the last or terminated tap is determined by luck, not planning. In multi-family design, there is no future growth potential at a terminating tap so high value terminating taps equal wasted signal.

Additionally, by designing inbound or backward, there is a greater potential for design efficiency. There is more opportunity for equitable splits and even distribution.

DESIGNED OUTBOUND or FORWARD

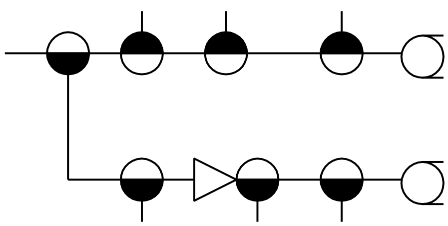


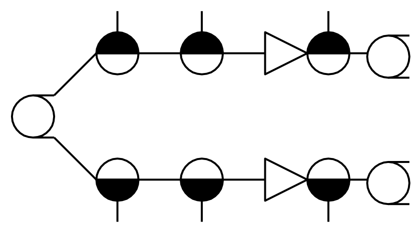
DESIGNED INBOUND or BACKWARD



In this example, the inbound or backward design resulted in one less Line Extender.

SOME COMMON DESIGN PROBLEMS There are some common design problems that seem to never go away. Here are some examples.



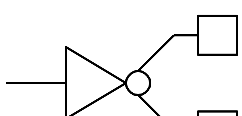


DO THIS **DON'T DO THIS**

SPLIT FEEDING TWO ACTIVES

There will be occasions when this cannot be avoided. However, it will always be challenged and more often than not, reworked.

DO THIS



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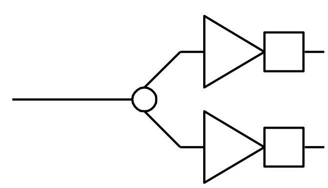
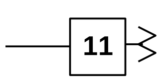


TERMINATING HIGH VALUE TAPS

There will be occasions when this cannot be avoided. But it will always be challenged and more often than not, reworked. Anytime that signal is thrown away, it will be challenged.

DO THIS



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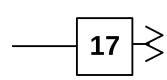
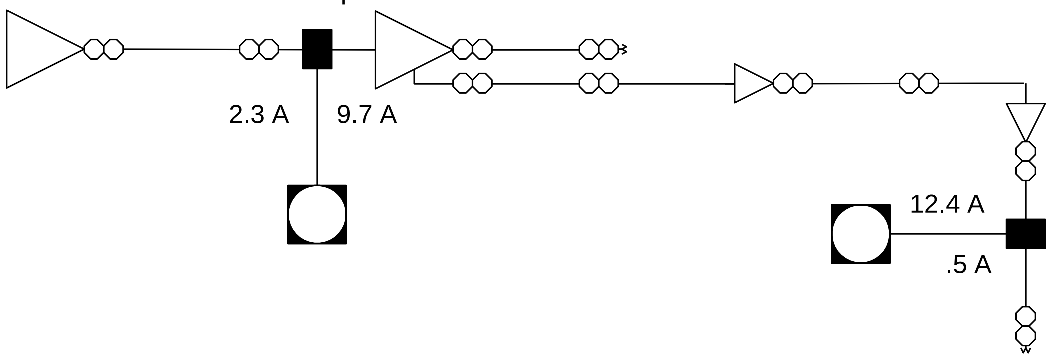


UNJUSTIFIED USE OF HIGH VALUE PADS

Anytime the designer elects to throw away signal there must be a solid justification. In some instances, high pads are the result of an amplifier location that sits on a natural routing intersection or may eliminate the need for a 2nd amplifier. High pad values will always be challenged.

EXCESSIVE PLACEMENT OF DEVICES AT ONE LOCATION
While this common problem appears as a mechanical or construction problem, the designer is the one who must re-design out of this problem, so it's a design problem. Common sense tells you that you can not fit 10 devices into a 3-device pedestal.

UNBALANCED POWER INSERTER
While it is not a perfect world, every effort is to be made to balance the power inserter.
Both are bad choices for the power inserter location.



OpTel BENCHMARKS of EFFICIENT DESIGN

UNITS PER ACTIVE
The more efficient the design, the more units per active device. While there are circumstances where this may not hold true, the units per active is a strong benchmark of design efficiency.

Avg. Property = 270 Units
Avg. # of Actives per Property = 8
270 / 8 = 33.75 units per active
*(Our experience to date shows 5 actives per B/T design (270 units average) or **54 units per active** while SA is at 8 actives per 270 or **34 units per active**.)*

RATIO OF TAP VALUES USED
In the more efficient designs lowest value taps will be used most often.

EFFICIENT

TAP VALUE	23	20	17	14	11
Amount used in design	6	8	14	18	13

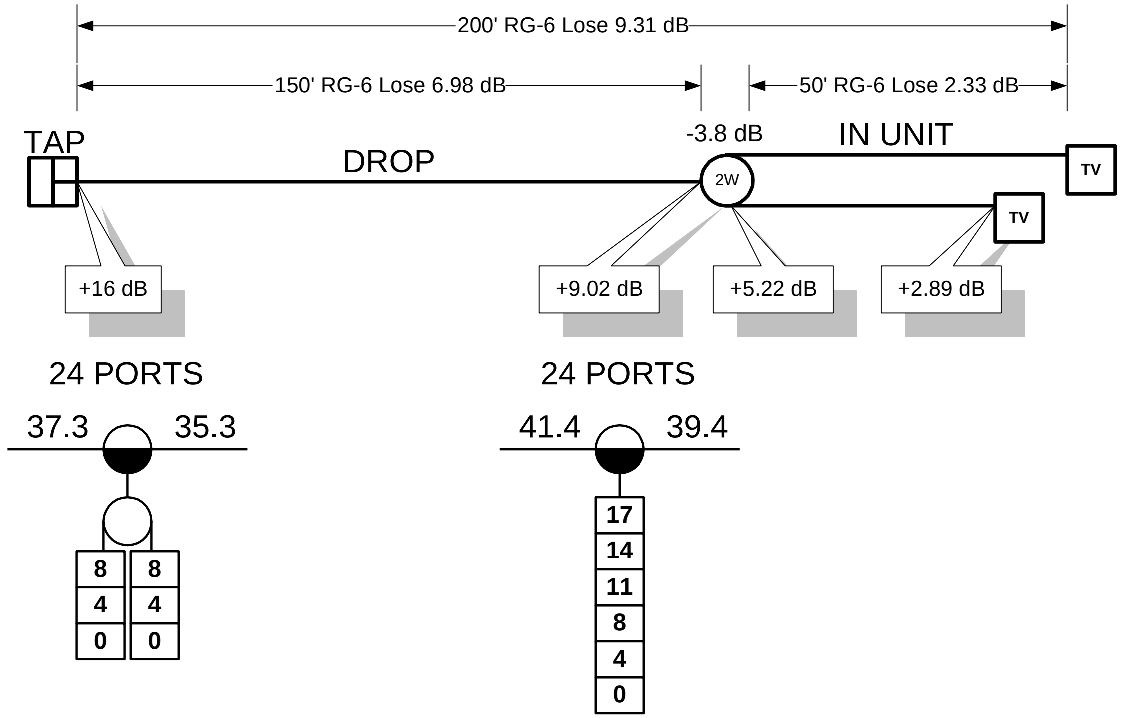
In the less efficient designs higher value taps will be used most often.

IN-EFFICIENT

TAP VALUE	23	20	17	14	11
Amount used in design	13	18	14	8	6

This is a simple benchmark of design efficiency. *(A combination of **units per active** and **tap values used** will be our benchmarks of efficient design.)*
DROP LENGTH RULES
We typically design for 2 outlets per unit. This assumes a maximum of 150' homerun RG-6 to the unit, split in the unit with two 50' RG-6 to the TV. When the drop length or number of outlets exceeds this, here are the design rules:

<u>TYPICAL DROP LOSS CALCULATION</u>



<u>DROP DESIGN RULES</u>

<u>2 OUTLETS PER UNIT</u>

1. 150’ RG-6 and below is OK
2. 150’-200’, 1st Choice: (new or re-build) add second pedestal or lockbox to other side of building to create drops shorter than 150’, 2nd Choice: use RG-11

<u>4 OUTLETS PER UNIT (same for three outlets)</u>

1. 75’ RG-6 and below is OK
2. 75’-150’, 1st Choice: (new or re-build) add second pedestal or lockbox to other side of building to create shorter than 75’, 2nd Choice: use RG-11

<u>MORE THAN 4 OUTLETS requires OpTel Approval</u>

1. Use of apartment type amplifiers at the set.
2. Two drops per unit requiring 2 tap ports per unit

CAD STANDARDS
OpTel prefers CADEX but will accept AutoCAD v.12 or v.13 and LodeData as the design software. OpTel will supply all of the symbology and layering scheme on a floppy.

INTERDICTION TAP GROUPS

<u>DO THIS</u> **<u>DON’T DO THIS</u>**

Two different approaches, two different amounts of signal required to allow each tap group to deliver the correct outputs. By using the 2W split, the second group needs almost 4 dB less than the first group. This holds true for 16 and 20 unit tap locations. It adds up.

DELIVERABLES

SITE SURVEYS The site survey is the most critical step in the entire construction process. Mistakes made during the survey will most often be carried through the design process and not discovered until construction is in progress. The field engineer requires an understanding of design and construction techniques as any errors in survey information that result in additional design or construction rework cost <u>may be charged back to the contractor.</u> Examples may include overlooked routes that would improve the design efficiency, failure to identify or incorrectly identify street crossings, bores or even hand trench, construction restrictions verbalized by the property manager or engineer during the survey, longest drop length is grossly understated, etc.

GENERAL REQUIREMENTS for ALL Surveys

1. Property Name, address, Mgr. Name, Mgr. phone
2. Property Type (Garden, high rise, mobile home)
3. Security
4. Mgr. Comments (do not route through garages, etc.)
5. # of Units
6. # of drops to unit, # of outlets per unit, split in unit or at tap, (show on map details if varies)
7. Additional outlets not in residential units (office, clubhouse, etc.)
8. Closed Circuit Camera or other video requirements/locations (give ALL details on map)

A Base map should be as accurate as possible including a scale reference. Existing facility maps, Developer blue lines, power trench maps, Platt maps, etc. are the first choice. If the map is a “Management Office” type of map, the correct scale must be added. To add the correct scale, note a measured footage on the longest straight line in the property (street that runs along the side or through the property. Give overall (not patios, alcoves) building outside dimensions (for example: 165’ X 75’), if building sizes repeat, measure only one, if different, give measurements for each size and note distance between buildings. Give at least three random footages (per property) between buildings for reference.

BASE INFORMATION REQUIRED
1. all structures
2. all roads
3. Retaining walls
4. adjacent parking areas
5. Pertinent lakes, creeks, etc.
6. Pertinent greenbelt, parkways, etc.

As Built Survey: Is defined as an on-site inspection and inventory of all existing facilities. This includes all existing routing and footage’s required completing any type of design without a return trip to the site. In addition to the general requirements for all surveys, the new site survey requires:

EXISTING FACILITIES
1. Routing w/footage (estimated, wheeled, fished)
2. Buried cable, direct bury
3. Conduits, size and type, sweep, plugs
4. Grounds, size and location, ground wire size, ground source
5. Vaults, location and size, condition,
    a) cables, how many, type and condition
    b) devices, type, values and condition
    c) drops, type, tags, condition, how many and longest (use symbol)
1. Pedestals, location and size, locked, condition
    a) cables, how many, type and condition
    b) devices, type, values and condition
    c) drops, type, tags, condition, how many and longest (use symbol)
1. Dog houses/utility closets, location and size, locked, condition
    a) cables, how many, type and condition
    b) devices, type, values and condition
    c) drops, type, tags, condition, how many and longest (use symbol)

1. Lockboxes, condition, locked, location, height and size, A/C in box
    a) cables, how many, type and condition, exposed or in conduit, molding
    b) devices, type, values and condition
    c) drops, type, tags, condition, how many and longest (use symbol)

(CONDITION will be considered "GOOD" unless noted otherwise. Use of OpTel provided symbology required))

New Site Survey: Is defined as a on-site inspection to identify all potential routes, facilities placement locations and construction details required to complete any type of design without a return trip. In addition to the general requirements for all surveys, the new site survey requires:

1. Identify all available street crossings (note bore or cut, footage and any special requirements)
2. Identify all sidewalk and parking areas cuts and bores
3. Recommended routes and alternative routes available identify all construction methods for all recommended routes
4. Available and restricted locations for placement pedestals, lockboxes, etc. (note all pertinent details i.e. landscaping, restoration issues, sprinklers, etc.)
5. On site restrictions to work crews.
6. Potential microwave receive sites / locations (OpTel)

(A short dashed line is assumed to indicate hand trench. Use of OpTel provided symbology required))

Final As-Built Changes: After construction and activation is completed, any and all changes to the original design are noted on the design and returned for final drafting.

1. Tap values, pads, EQ's, inputs, outputs and end of lines
2. Route changes
3. Footage changes
4. Pedestal moved, lockbox moved, etc.
5. Added / removed units
6. Address changes from original design
7. Interdiction device ID is assigned to the address it serves.

RF DESIGN The design is considered completed when OpTel has received the following. Invoice payment will be approved after the package has passed the Quality Assurance Review. Packages missing any elements shown below will not be approved for payment.
1) Paper Design Map (2 ea. "D" size, plus 2 ea. "B" size, bond paper)
2) ACAD 12 DWG (on 3 1/2 floppy or Colorado QIC 80 or other digital media as agreed upon)
3) BOM (ASCII on 3 ½ floppy and paper)
4) All original site survey materials
5) Design Profile with each project
    a) Project Name
    b) Address
    c) Number of Actives
    d) Number of Units
    e) Units per Active
    f) Route footage
    g) Cable footage
    h) Number of power supplies and load %

(Initial design shipment is to include all of the digital media above and is to be shipped as an Email attachment via America On Line, no substitutions i.e. BBS, etc. the approved design package, everything above, is to be shipped US Mail unless otherwise agreed upon by both the contractor and OpTel)