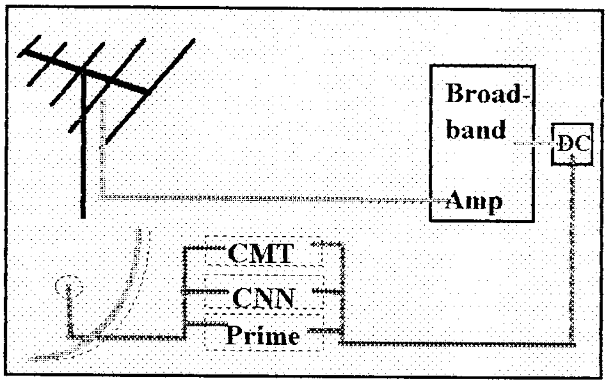
TECH BULLETIN 9405(t)



SATELLITE TO ROOM:

Commercial Satellite Dish Systems / SMATV

System Planning Considerations

-ABOUT TECH BULLETIN-

Tech Bulletin is produced and distributed by technology author and researcher Robert B. Cooper five (5) times per year. **Tech Bulletin** selects a single 'topic' for discussion in each issue to provide readers with a set of reference materials for work in this field.

During 1993, **Tech Bulletin**'s five issues covered: (9301) Co-channel television interference solutions, (9302) VHF fringe area reception and antenna practices, (9303) UHF fringe area reception and antenna practices, (9304) Eliminating man-made noise interference sources from VHF and UHF reception, (9405) Cable TV Basics: Part one of two. Copies are these single issues are available within NZ for $15 each; all five for NZ$60.

In **1994 Tech Bulletin** issues deal with (9401t) Cable TV Basics: Part two, (9402t) MATV/Master Antenna system planning, (9403t) VHF-UHF Receiving Antenna design tricks, (9404t) C and Ku band(s) home satellite installations (9405t) Commercial satellite installations (*this issue*)

Note: 9401t, Cable TV: Part Two, is not presently available. All other issues $15 each or all four remaining for $50. Order directly from:

Robert B. Cooper, PO Box 330, Mangonui, Far North, New Zealand (FAX: 09-406-1083)

THE BASIC PROBLEM:

☐ **Satellite Signals are at microwave frequencies**
- 3.65 to 4.2 Gigahertz (GHz)
- 10.95 to 12.75 Gigahertz

☐ **Satellite signals are transmitted in non-compatible modulation formats**
- Wideband FM (17 to 54 Megahertz in width)
- (Compressed) Digital Video (such as QPSK)

WHEREAS -

☐ **'Standard' TV receivers are designed to respond to:**
- 6 or 7 or 8 Megahertz wide 'channels'
- With Amplitude Modulation (AM) video, and,
- Frequency Modulation (FM) audio

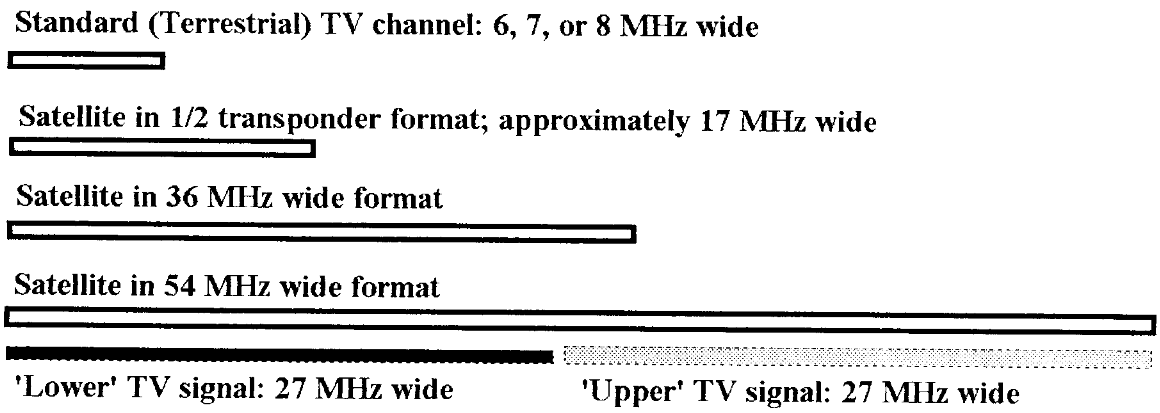
THEREFOR-

☐ **To receive (recover video and audio) from satellite transmission on 'Standard' TV receiver**
- The video and audio modulation from the satellite format must be recovered at 'baseband'
- And, re-introduced through an appropriate 'Standard TV Modulator' to the TV receivers

IT IS NOT ENOUGH TO-

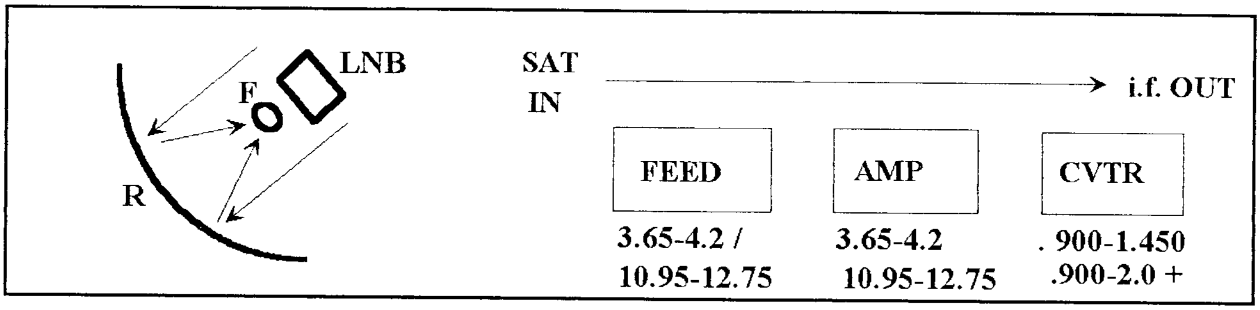
☐ **Simply frequency convert the received satellite signals to terrestrial TV channels**
- A 17 to 54 MHz wide satellite channel will not 'fit' into a 6/7/8 MHz wide terrestrial channel
- A TV receiver designed to 'recover' AM video will not respond (detect) FM video

BANDWIDTH vs. FORMAT



BASICS FIRST-

☐ **A satellite signal is first:**
- Taken off the reflector's surface with a feed antenna
- Amplified at it's incoming frequency (3.65-4.2 GHz; 10.95-12.75 GHz)
- Down converted (frequency translated) to a convenient ('standard') i.f.



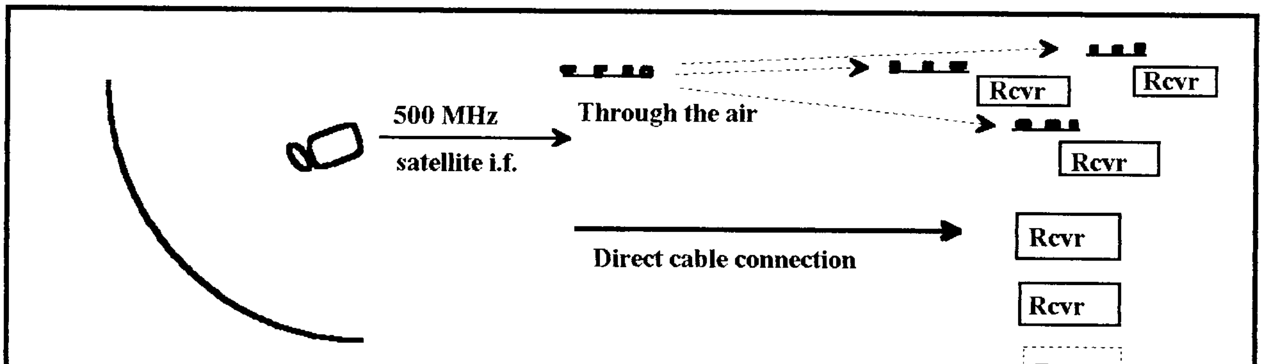
☐ **All satellite signals leave LNB at i.f. (intermediate frequency) as a 'block' of frequencies**
- Bandwidth of 'block' is identical to bandwidth of incoming satellite band
- A 500 MHz (0.5 GHz) wide satellite band requires an i.f. of 500 MHz also

☐ **When satellite(s) utilise a bandwidth greater than 500 MHz, receiver must also be wider**
- Multiple satellites at Ku may use frequency blocks within 10.95-12.75 GHz region
- Receivers must somehow adapt to a spectrum that is wider than 'standard' 500 MHz
  - ✓ Receiver i.f. can be widened to 900-2,100 MHz (total width of 1,200 MHz)
  - ✓ LNB can be 'toggled' by switching voltage/tone to treat each block as a separate function
    - ➢ 10.95-11.45 GHz, 11.45-11.95 GHz, 11.95-12.45 GHz, 12.25-12.75 GHz
    - ➢ 10.95-12.15 GHz, 11.55-12.75 GHz

IN THEORY-

☐ **You may 'distribute' the i.f. 'block' to your actual receivers via coaxial cable, or,**

☐ **You may transmit the 'block' through the air (wireless) to one or more remote receivers**



GETTING i.f. BLOCK TO RECEIVERS

RECEIVERS-

- ☐ **Attempt to standardise i.f. (input) ranges**
  - Any satellite signal appearing within receiver i.f. block can (in theory) be processed
    - √ C or Ku band is not important to receiver demodulator (s)

- ☐ **Output of the LNB (i.f. block) must match the input to the receiver (i.f. block)**
  - 950-1450 MHz LNB output mates to 950-1450 receiver (i.f.) input

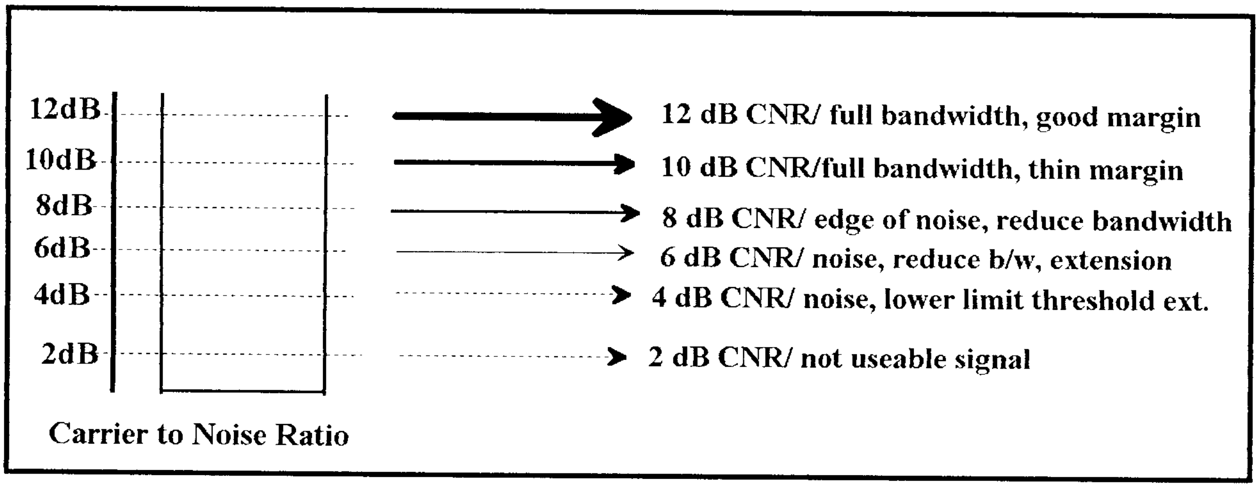
- ☐ **Individual transponder bandwidth (17, 27, 36, 54 MHz) must be compatible with receiver**
  - Receivers have fixed (i.f.) bandwidths
    - √ non-field-adjustable (such as 27 MHz)
  - Receivers have variable (field adjustable / switchable) bandwidths
    - √ continuous (8-32 MHz), or switchable (18, 27 MHz)

- ☐ **A weak (below receiver threshold) receiver may produce more pleasing pictures if:**
  - Bandwidth of receiver is narrowed (below actual satellite signal bandwidth)
  - (if) user is willing to accept reduced bandwidth artifacts (colour ringing, audio buzz)
    - √ Threshold extension systems improve receiver 'threshold' but add artifacts

RULE OF THUMB-

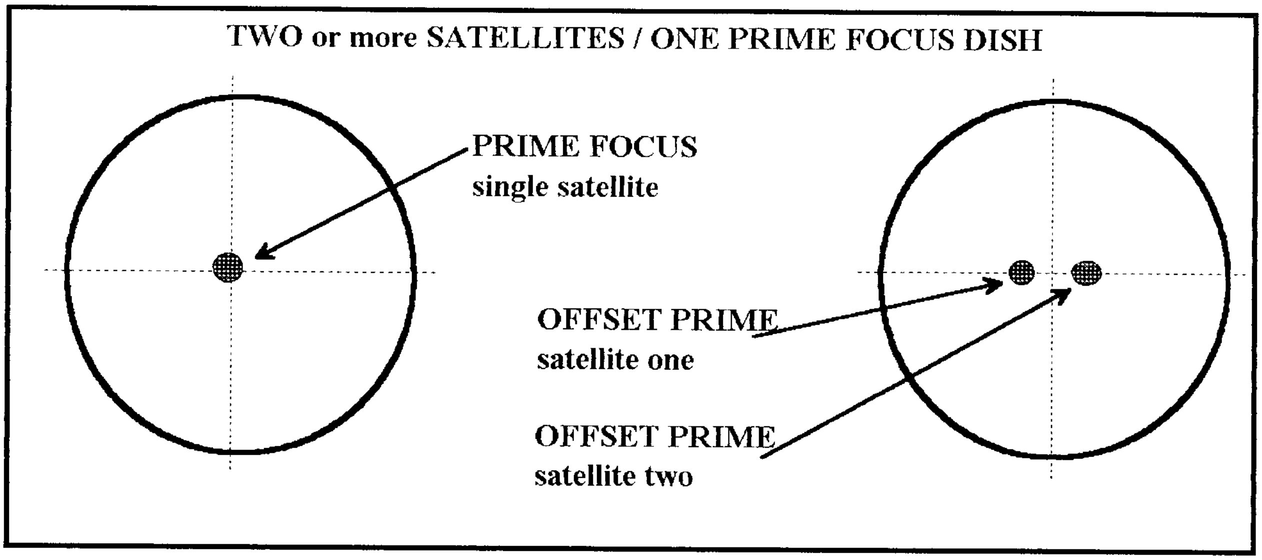
- ☐ A satellite channel that is 'below threshold' (sparklies) when receiver matches transmitted b/w:
  - If 'improved'; by narrowing bandwidth below transmitted bandwidth, or,
  - (if 'improved') by using threshold extension techniques probably needs a bigger antenna

- ☐ Signals 'below threshold' and 'electronically altered' to improve apparent quality:
  - Contain undesireable artifacts AFTER processing which magnify in SMATV/CATV system
  - May be subject to undesireable 'weather outages' when rain increases attenuation



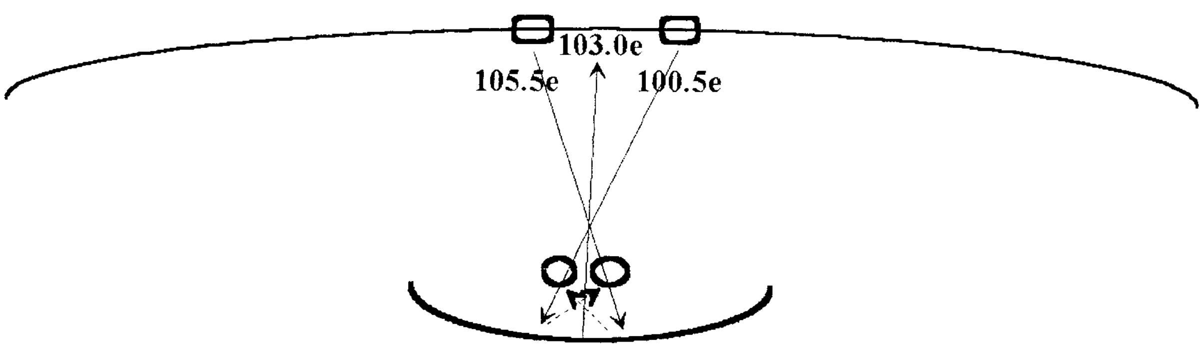
SHARED REFLECTOR / MULTIPLE FEEDS-

☐ **A prime-focus reflector (requiring feed at centre focus 'spot') may:**
- Have it's prime-focus feed moved away from (offset from) centre, at reduced gain
- Have two (or more) feeds positioned (either side of centre) for two closed-spaced satellites



- With 'offset prime' the dish is parked between two satellites; feeds positioned for focus
  - ✓ 'Loss' in gain over single feed at prime focus goes up as feed offset increases
    - ➢ on 4m dish, 4 degrees between satellites typically equals -3dB
    - ➢ by increasing reflector size to compensate (i.e., 3m to 4.5m), one reflector eliminated
- Non-prime-focus reflector designs (i.e., 'banana antenna') reduce offset losses
  - ✓ System planners must weigh costs, space constraints to reach antenna decision

☐ **Candidates for dual-satellite / single reflector include Asiasat 1 (105.5e), AsiaSat 2 (100.5e)**

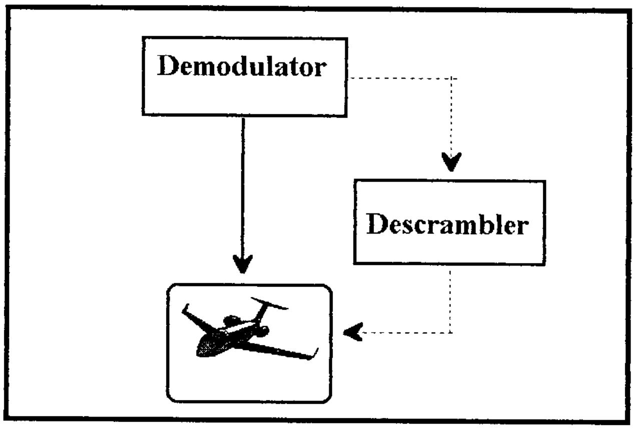


OFFSET Prime Focus for Asiasat 1 and 2 (antenna boresights 103.0e)

PROCESSING SATELLITE SIGNALS-

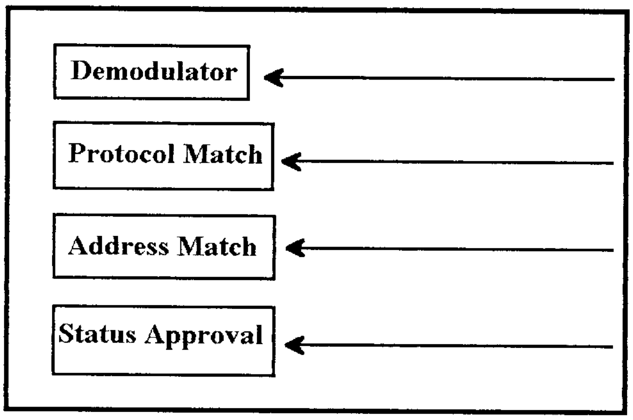
☐ **The satellite receiver demodulator circuit must match modulation format of signal**

- Analogue FM requires FM detector (demodulator)
  - ✓ If transmission is 'in clear' merely tuning receiver produces pictures
  - ✓ If transmission is 'scrambled', descrambler required for 'pictures'
- Digital video requires digital demodulator
  - ✓ Demodulator must match actual modulation format (such as QPSK)
    - ➢ Digital addressing protocol of receiver must match transmitted protocol
      - ○ Receiver's unique digital serial number must be 'addressed' by transmitter



☐ **FM format analogue**

- In-clear pictures go direct to display
- Scrambled (Videocrypt etc.) go to descrambler, then to display
  - ✓ To unscramble pictures requires matching of receiver 'electronic ID' to data stream transmitted by satellite authorisation centre
  - ✓ Each programmer has unique data stream 'code'



☐ **Digital Video Access**

- Is signal in digital format? If yes, go on.
- Is digital video in correct 'format'? If yes...
- Is THIS receiver being addressed? If yes ...
- Is THIS receiver's account current (i.e., paid) at this time? If yes, produce picture.

COMPRESSION-

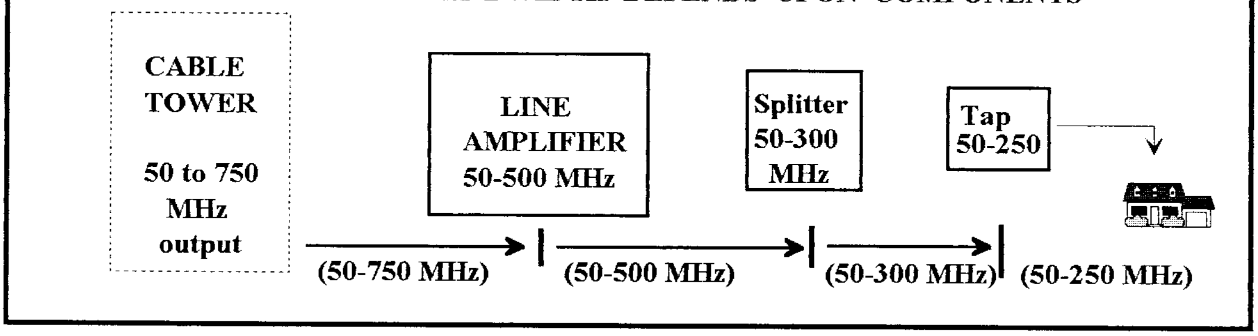
☐ **Digital 'protocol' (format) is a variable at the instruction of the uplinker**

- A single video programme (with audio) can be 'compressed' to occupy as little as 1/12th the 'spectrum space' of an (FM) analogue programme.
  - ✓ Consumer, professional digital receivers are designed for Compressed Digital Video
  - ✓ The amount of compression is set at the uplink
  - ✓ Receivers, on 'instruction' from the uplink, adjust their 'bandwidth' to match

YOUR SMATV/CATV CABLE SYSTEM-

- ☐ **Is a private 'information highway' through which you send signals**
- ☐ **Has an internal 'bandwidth' established by:**
  - ▪ The 'passive' distribution cable
    - ✓ Coaxial cable designed to transport VHF-UHF (television) programming is typically 'useable' from 0 MHz (DC) to at least 750 MHz; often 1,000 MHz (1 GHz)
  - ▪ The passive components design frequency range
    - ✓ Splitters, tap-off (directional coupler) units, connectors
      - ➢ Signal splitters and couplers may be designed for 0-500 mHz or less
  - ▪ The active components design frequency range
    - ✓ All amplifier devices have 'gain-bandpass' specifications
      - ➢ Gains are stated in dB(s)
      - ➢ Bandpass is stated in megahertz (MHz)
  - ▪ The 'Cable System Bandwidth' will be no larger than the most frequency-bandwidth limited device installed in the system between the 'tower/antennas' and the 'subscriber's TV set'

SYSTEM BANDWIDTH DEPENDS UPON COMPONENTS



40 to 1,000 MHz Indoor Amp

54 to 550 MHz Outdoor (line) Amp

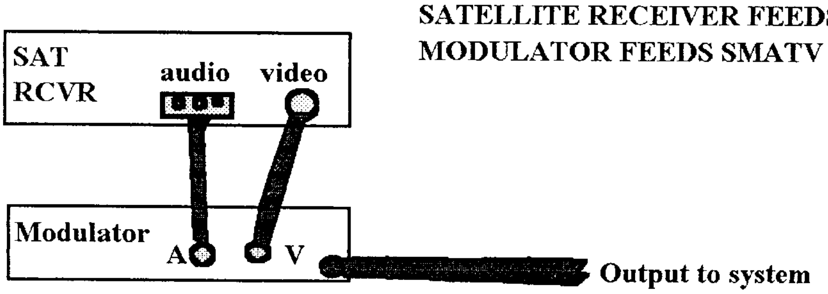
THE HEADEND-

- **The SMATV/CATV Headend is a group of low-power 'transmitters' each on a channel**
  - 'Headend Transmitters' are called modulators
    - √ Modulators have a specified operating format
      - ➢ PAL, NTSC, SECAM
      - ➢ Monaural or stereo audio
    - √ Modulators have a specified maximum output level
      - ➢ +40 to +60 dBmV (+100 to +120 dBuV) is typical
    - √ Modulators allow adjustment of video and aural modulation percentages
      - ➢ Video modulation is peak-sync limited to avoid overdriving circuits
    - √ Modulators are designed for adjacent channel or alternate channel use
      - ➢ Spectral purity (limiting transmission products within the channel) determines whether the unit can be used in an adjacent (consecutive) channel format

TYPICAL SMATV/CATV MODULATOR

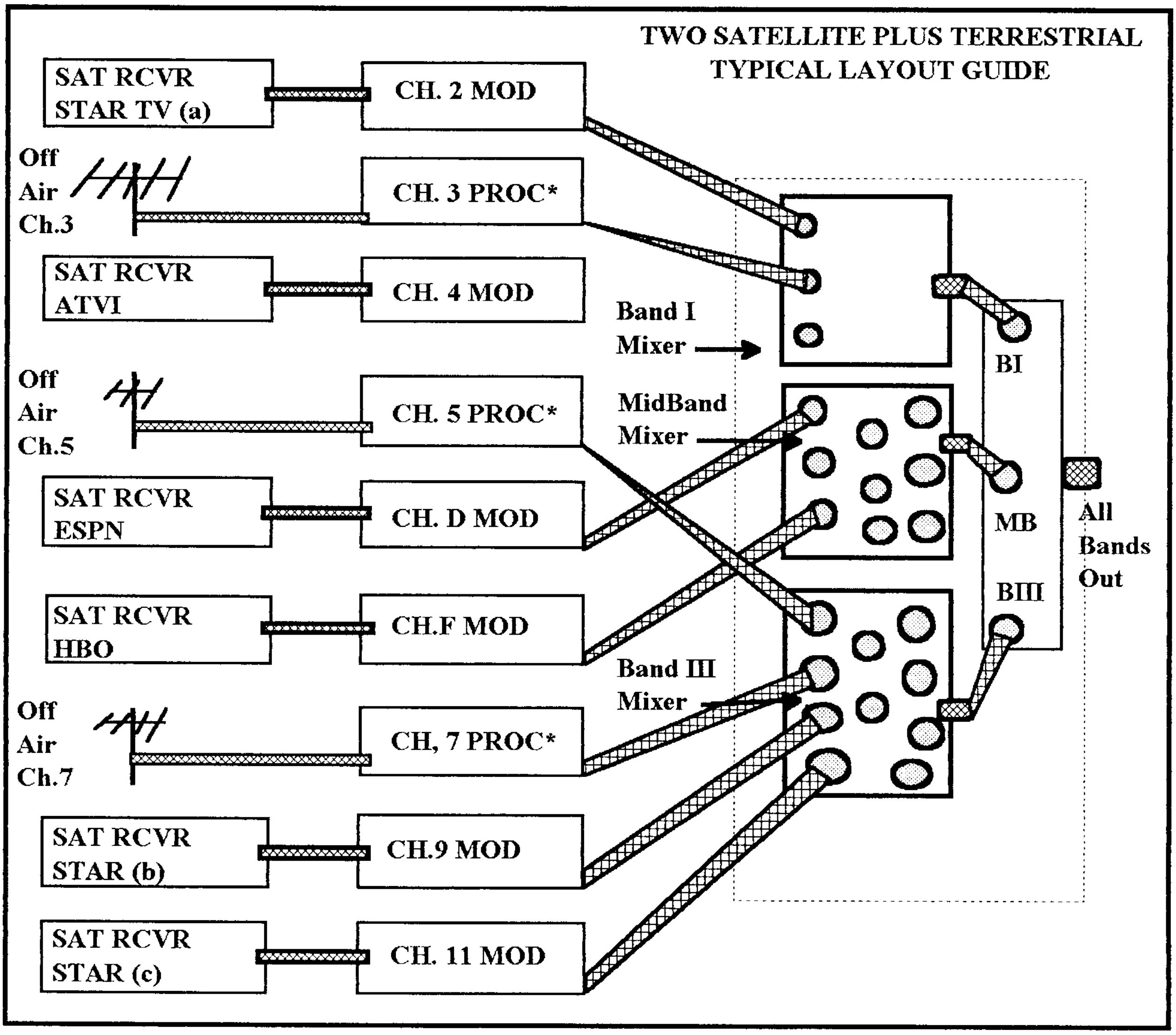
- √ Modulators can be fixed-channel (as supplied by the factory), or 'frequency-agile'
  - ➢ Frequency agile are field-adjustable through channels (such as 50 to 450 MHz)
- √ Modulators are 'fed' baseband video and audio, after the satellite receiver/decoding
  - ➢ Well shielded cables are used to connect baseband signals to modulators

SATELLITE RECEIVER FEEDS MODULATOR / MODULATOR FEEDS SMATV / CATV SYSTEM



MIXING MODULATORS TOGETHER-

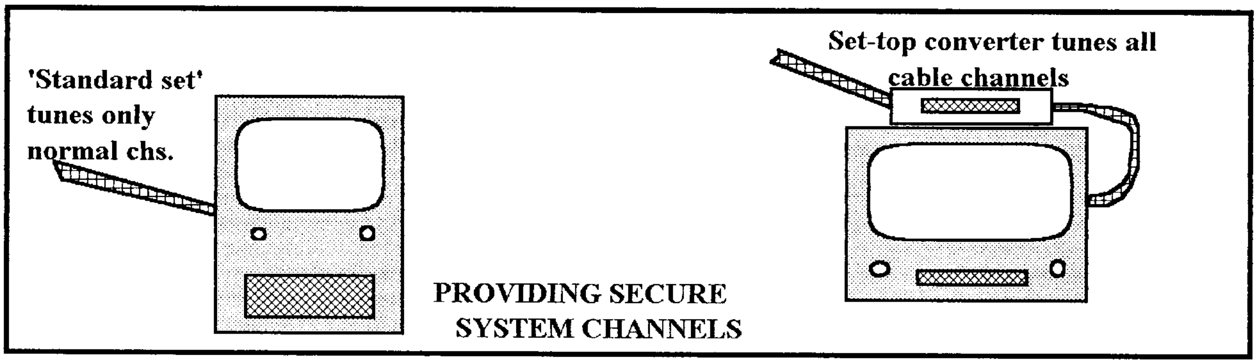
- ☐ Two or more channels fed into the cable require 'mixing' of the signal sources
  - ■ Modulators designed for 'adjacent channel' can be 'combined' with a passive network
    - ✓ Passive networks are either:
      - ➢ A series of tuned input circuits, each to a specified channel, impedance matched to a broadband output network (a self-contained unit called a 'Headend Combiner')
      - ➢ Two or more 'signal splitters', wired up 'backwards' to combine rather than divide signals
        - ○ Use only HYBRID style splitters
      - ➢ Two or more 'Directional Couplers' used 'backwards' so the normal output port becomes the modulator signal source port
    - ✓ All passive combining networks have 'thru loss'
      - ➢ Thru losses may equal as much as 16 dB between modulator output and final (combined) 'trunk-cable' output
        - ○ Modulator output capability should be chosen after calculating 'combiner losses'



WHAT ABOUT SPECIAL-CHARGE CHANNELS?-

☐ **Premium channels (HBO, others wil higher monthly charge) may be made optionally available**

- You may elect to place these programme-channels on a 'secure frequency'
  - ✓ Any TV channel not easily tuned in on standard TV sets can be 'secure', available only to those who pay 'extra' for service
    - ➢ Such channels can also be 'scrambled' for further security
      - ➢ TV channels within 'Mid-Band' (108-174 MHz), 'Super-Band' (230-470 MHz) or 'Hyper-Band' (470-750 MHz) may provide you with security
    - ✓ Channels 'outside' of normal TV set tuning ranges can be system-adapted to secure channels with installation of optional subscriber-set-top converter box



AVOIDING SOME CHANNELS-

☐ **In your area, some cable channels may not be useable**

- Avoid placing satellite services on any channel in-used locally for terrestrial TV
- Avoid any non-standard (mid band, super band, hyper-band) channels used locally for 2-way radio communications
  - ✓ Cable 'ingress' (RF leakage into cable system) can degrade TV service
  - ✓ Cable 'egress' (radiation from cable plant, fittings) can interrupt 2-way services

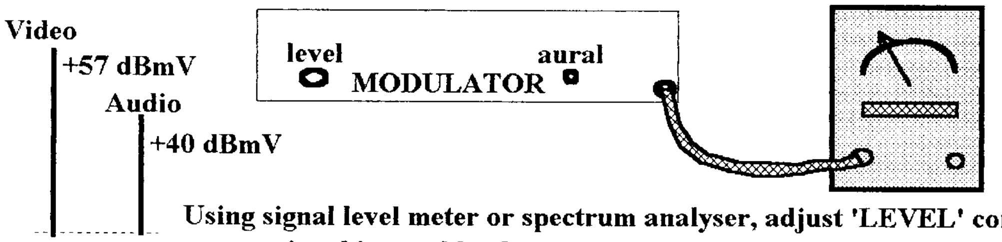
CONSIDERATIONS FOR SECURE CHANNELS-

☐ **Any secure channel using non-standard TV frequencies will require:**

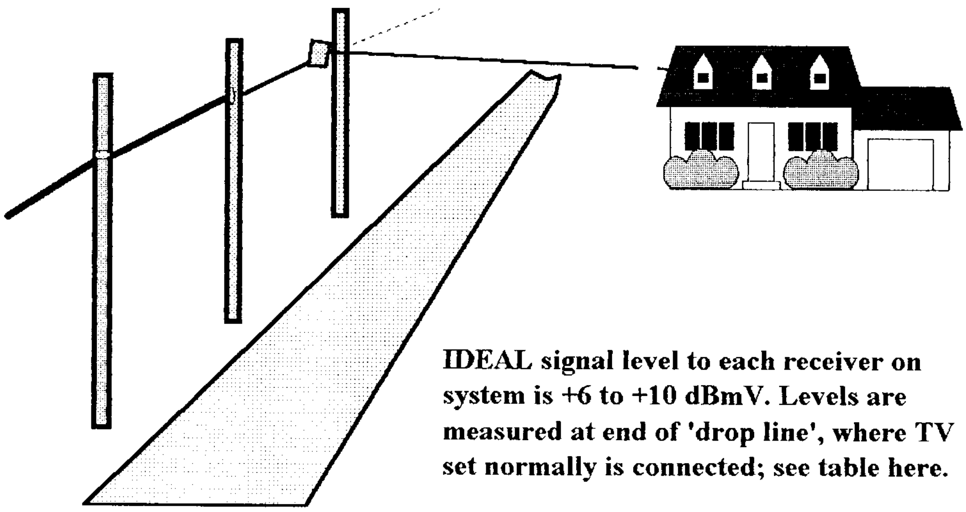
- Set-top converter in each home, each location 'taking' secure channel service
- If channel selection is not adequate security, programming will also need to be 'scrambled'
  - ✓ To descramble at TV set will require set-top descrambler
- Carefully weigh costs of additional (at TV set) equipment against new revenues possible
- Any 'security system' invites 'piracy'
  - ✓ If your set-top unit can be obtained in marketplace, you have no security unless:
    - ➢ Each set-top descrambler is individually addressable with unique electronic address
      - ➢ Your subscriber base justifies investment in complex encoding/addressing system at headend

BASIS FOR CABLE PLANT-

- **Coaxial cable 'plant' (the system) is a private, secure transmission system; people only receive service by being connected directly to system**
  - Coaxial cable has loss
    - √ Loss is measured in dBs or parts of dBs per unit length (100 metres) of cable
      - ➢ Loss increases (becomes larger) when:
        - ○ The frequency of the signal transported goes up (i.e., 55.25 MHz to 175.25 MHz)
        - ○ The diameter (size), or quality, of cable goes down (i.e., RG-11/U to RG-59/U)
        - ○ The physical temperature of the cablke increases (i.e., 20C to 40C)
- **Standards establish the ideal, and minimum service levels to subscribers for quality reception**
  - The ideal 'range' is +6 dBmV (+66 dBuV) to +10 dBmV (+70 dBuV)
  - The 'minimum' level is 0 dBmV (+60 dBuV)
  - Any two adjacent channel carriers should not be more than 2 dB apart in level
    - √ Channel 2 visual carrier: +3.5 dBmV, channel 3 +5.5 dBmV
    - √ Channel 7 visual carrier: +7 dBmV, Channel 8 + 9 dBmV
  - The sound carrier for any channel should be 15 to 17 dB lower in level than the video
    - √ Headend modulators allow separate level-setting of aural carrier
    - √ Headend (off-air signal) Processors allow setting of aural carrier level separate from video
      - ➢ Aural carriers are 'set down' to protect upper adjacent video (picture) from sound



Using signal level meter or spectrum analyser, adjust 'LEVEL' control for proper signal into cable plant; adjust AURAL down 15 to 17 dB from visual



IDEAL signal level to each receiver on system is +6 to +10 dBmV. Levels are measured at end of 'drop line', where TV set normally is connected; see table here.

Chan.	Level
2	3.5
3	4
4	4.5
5	3.5
7	5.5
9	5
11	6

PLANNING THE SMATV/CATV SYSTEM-

☐ **Start with accurate, scaled map of area to be cabled. Mark antenna site / headend on map.**

- Whether a single building (motel, apartment house) or community area:
  - ✓ Draw a preliminary system layout on the map to determine places cable will go
  - ✓ Measure and calculate the longest cable run from your headend to most distant receiver
    - ✓ Calculate, using known loss of cables available to you, dB loss in cable from headend through the cable to most distant TV receiver

Cable Type	54 MHz	90 MHz	174 MHz	230 MHz	550 MHz
RG-59/U	5.64	6.68	9.23	10.9	19.42
RG-6/U	4.43	5.26	7.25	8.57	15.28
.500 aluminium	**1.35**	**1.63**	**2.33**	**2.79**	**5.08**
.750 aluminium	**0.96**	**1.15**	**1.63**	**1.94**	**3.54**

☐ **Losses in table (above) in dB per 100 metres of cable at 20 degrees C for frequency shown**

- A cable plant with 2,000 metres of cable fromthe headend to the furthest TV receiver:
  - ✓ 2,000m is, from table above, equal to 20 x:
    - ➢ 10.9 dB (per 100m) of RG-59/U or 218 dB of cable loss at 230 MHz
    - ➢ 8.57 db (per 100m) of RG-6/U or 171.4 dB of cable loss at 230 MHz
    - ➢ 2.79 dB (per 100m) of .500 (1/2") or 55.8 dB of cable loss at 230 MHz
    - ➢ 1.94 dB (per 100m) of .750 (3/4") of 38.8 dB of cable loss at 230 MHz
- If our goal is to reach the furthest TV set with a level not less than 0 dBmV (+60 dBuV) at the highest frequency channel on the system (same as maximum cable loss):
  - ✓ We require a headend output of:
    - ➢ +218 dBmV if we use RG-59/U cable
    - ➢ +171.4 dBmV if we use RG-6/U cable
    - ➢ +55.8 dBmV if we use .500 (1/2") cable
    - ➢ +38.8 dBmV if we use .750 (3/4") cable
- Maximum achieveable headend output levels are in the region of +60 dBmV (+120 dBuV); therefore to reach the end of a 2,000 metre cable we would require additional gain within the cable plant of:
  - ✓ 218 - 60 = 158 dBg (gain) for RG-59/U cable
  - ✓ 171.4 - 60 = 111.4 dBg for RG-6/U cable
  - ✓ 55.8 - 60 = (+) 4.2 dB with .500 cable
  - ✓ 38.8 - 60 = (+) 21.2 dB with .750 cable
- Additional 'plant gain' comes from line amplifiers and 36 dBg (dB of gain) is a practical maximum when multiple amplifiers must be operated in 'series' on the same line (cascade effect)
  - ✓ For RG-59/U this would require 5 amplifiers of 36 dB gain each
  - ✓ For RG-6/U this would require 3 amplifiers of 36 dB gain each
  - ✓ .500 and .750 require no plant amplifiers

NOT ALL 'CABLE PLANT LOSSES' COME FROM CABLE-

- **Cable plant requires additional passive devices to function, including:**
  - Line splitters (to create two, three, four OUTput legs from one input)
  - 'Directional Couplers', a form of unequal splitter used in certain applications
  - Customer tap-off devices ('directional taps')
  - Connectors, line splices
- **All passive devices have 'thru-loss'; they reduce the signal level going through them**
  - Line splitters:
    - ✓ 2-way splitter: assume 4 dB 'loss' per output leg
    - ✓ 3-way splitter: assume 5.5 dB 'loss' per output leg
    - ✓ 4-way splitter: assume 7 dB 'loss' per output leg
  - Directional Couplers:
    - ✓ Losses vary from minimum of 1.5 dB per leg upwards as a design function
  - Customer tap-off devices ('Directional Taps):
    - ✓ Through losses (between line input, line output) of device varies from 0.1 dB to 4.0 dB
  - Connectors, line splices:
    - ✓ Losses average 0.15 dB per connector or 0.3 dB per line splice
- **Individual item losses of 0.1 or 0.3 dB may seem unimportant, but:**
  - If there are 30 such devices between the headend and the customer, the cumulative total of such 'small losses' could be 3 to 9 dB
  - 'Dynamic Plant Balance' requires careful pre-calculation of every loss factor to facilitate the calculation of where 'plant gain' is required, and how much 'plant gain'

SUM ALL LOSSES-

- **To calculate losses in a plant, whether in a section (portion of the whole), or longest run:**
  - Layout cable runs on scaled map, building plan
  - Place all splitters, directional couplers, directional taps on the drawing
  - Add the main-line-thru losses for each device
    - ✓ For each entry (input) and exit (output) fitting for any line device, add 0.15 dB loss
  - Resum (again) the losses including cable plus passive devices

dBs versus DOLLARS-

- **Except in very short systems where even using the least expensive cable you can reach the end without additional plant amplifiers:**
  - Calculate the plant at least two ways:
    - ✓ Using 'smaller' cable (with higher loss), AND, plant amplifiers
    - ✓ Using 'larger' cable (with lower loss), AND, eliminating some or all plant amplifiers
      - ➢ The best choice is the system that costs the least to install, requires least maintenance
        - ○ Generally, amplifiers cost more than upgrading to larger cable
        - ○ Amplifiers require powering, through the cable, or mains at each amplifier location
        - ○ Using amplifiers brings in a new considerastion; cascade-ability of amplifiers

METHODS OF REACHING INDIVIDUAL RECEIVERS-

☐ **Headend output levels (typically +40 dBmV; +100 dBuV (+)) are too high for TV sets**

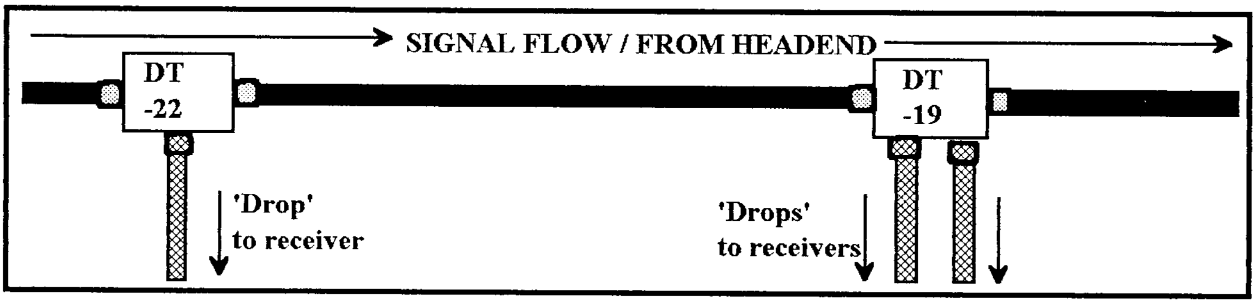
- TV sets have 'ideal input' level ranges; +6 dBmV (+66 dBuV) to +10 dBmV (+70 dBuV)
- Levels that are too low (i.e., below 0 dBmV as a standard) produce 'grainy' (snowy) pictures
- Levels that are too high overdrive receiver AGC functions, saturating the on-screen image

☐ **A proper system has passive devices to connect 'measured signal amount' to each receiver**

- The most successful technique is to employ a 'directional tap' (DT) to 'measure' how much signal (voltage) goes to each receiver location

✓ A directional tap (DT) is a signal coupler. The main line (called trunk or feeder) plugs into the DT, the signal goes through the DT, and exits through the output side.

➢ Within the DT, a capactive network that 'couples' (taps, or extracts) a measured amount of signal out of the thru-line into the 'tap' (receiver) port

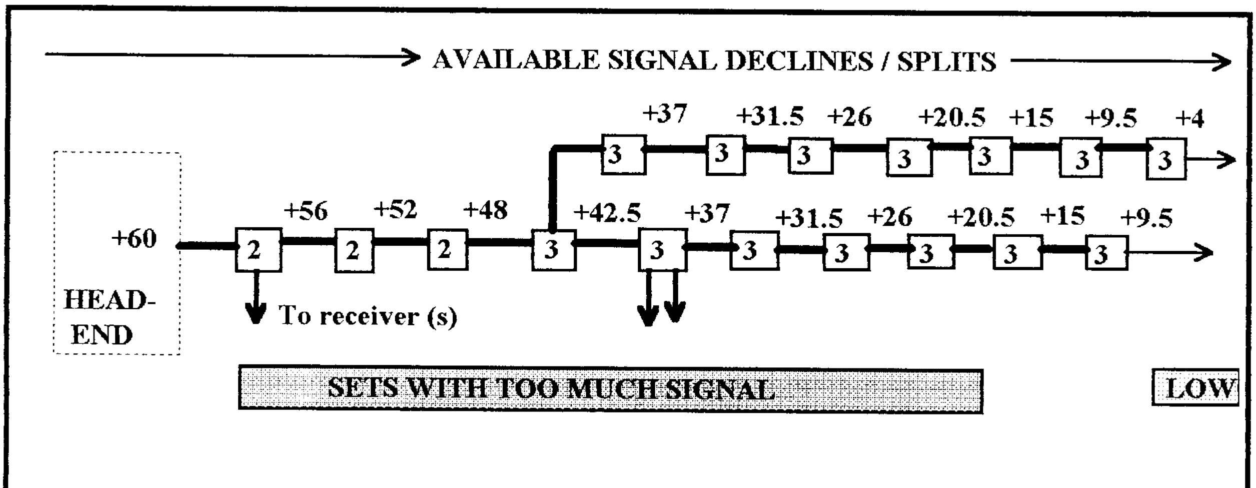


☐ **An alternate way of dividing the signal to receivers is to use signal splitters**

- Commonly available signal splitters divide the available signal by 2 (-4dB per output), by 3 (-5.5dB per output) and 4 (-7dB per output)
- The first TV set(s) following the headend will unfortunately receive far more signal than they need, or can properly use

✓ In a 'divide-down-by-splitting' system, you rapidly run out of signal at the ends as well

➢ Receivers close to the headend receive too much signal, those at end too little



Signal levels (i.e. +37) indicate losses because of splitter losses

ISOLATION BETWEEN RECEIVERS-

- **Individual receivers connected to the system can create interference for other receivers**
  - Receiver local oscillators (LOs) appear at their own antenna input terminals
    - ✓ This LO signal must now be allowed to enter distribution system
      - ➢ LO signals may interfere with reception for other receivers on line
  - LO (and other receiver created signals) are isolated through tap-off devices
    - ✓ Directional taps (DTs) include 'one-way' circuits to cancel signals originating at receivers
    - ✓ Many 'splitters' have no such 'one-way' protection and thus splitter systems are more likely to experience LO interference (one TV set interfering with others)

TYPICAL OUTDOOR (Weatherproof) .500, .750 DIRECTIONAL TAPS

Indoor/Outdoor Splitters

RG-59, RG-6 Indoor/Outdoor Taps

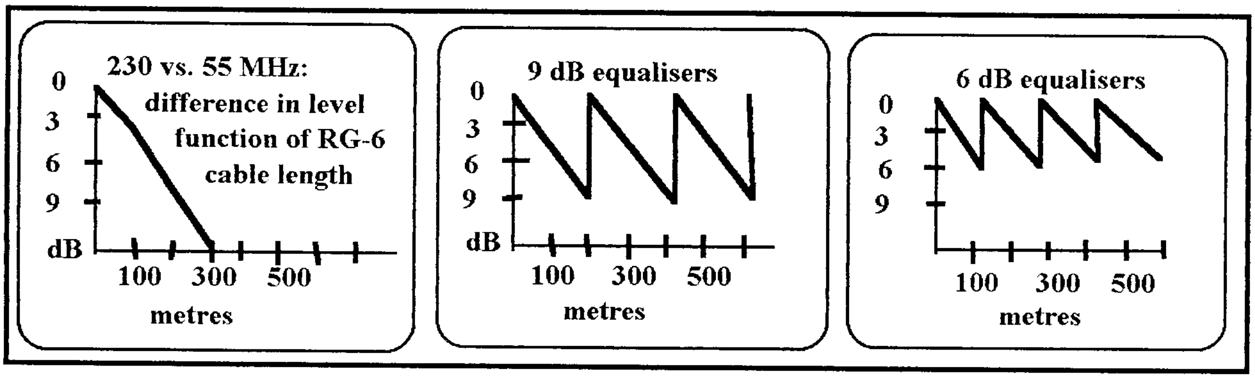
CONNECTION TO RECEIVERS-

- **Every component part of cable system is designed for 75 ohm (unbalanced) impedance**
  - Most modern TV receivers have 75 ohm (coaxial F connector) inputs
  - Those with 300 ohm balanced line inputs must be 'matched' to 75 ohm system impedance
    - ✓ A 'Matching Transformer' is required; 75 ohm 'input', 300 ohm 'output'

Typical 75/300 ohm matching transformer

COMPENSATING FOR UNEVEN CABLE LOSSES-

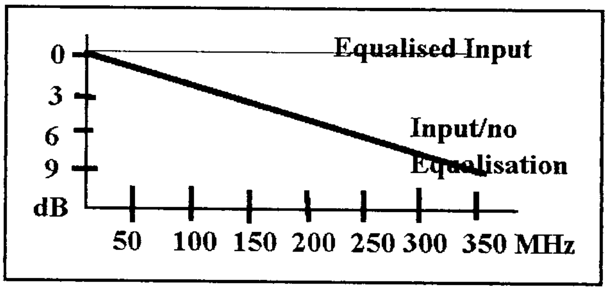
- ☐ **Cable losses vary with the operating frequency**
  - Losses at 230 MHz are 1.94 times greater than at 55 MHz
  - Two modulators, one at 55 MHz and the other at 230 MHz:
    - ✓ after 100 metres of cable, 230 MHz will be only 40.5% as strong as 55 MHz
      - ➢ for RG-6/U cable:
        - ○ after 100 metres, 55 MHz will be 4.14 dB stronger than 230 MHz
        - ○ after 200 metres, 8.28 dB stronger
        - ○ after 300 metres, 12.42 dB stronger
        - ○ after 400 metres, 16.56 dB stronger
        - ○ after 500 metres, 20.7 dB stronger
- ☐ **The DIFFERENCE in losses between the lowest frequency carried (55 MHz) and the highest frequency carried (230 MHz) is termed TILT LOSS**
  - In a system with only headend amplifiers (no cable plant amplifiers), tilt loss must be equalised (corrected) to ensure receivers connected do not experience wide differences in reception quality between low end (55 MHz) and high end (230 MHz) TV channels
  - In a system with plant amplifiers, input levels to plant amplifiers must be FLAT (lowest channel same as highest channel) to ensure proper amplifier operation
- ☐ Tilt can be calculated in advance; a known amount of cable using known lowest and highest frequencies will produce 'X.X' dB of tilt at the end of the cable
  - When the tilt is known (calculated or measured) it can be compensated
    - ✓ Compensation: Turn headend output levels UP on higher channels, down on lower channels
    - ✓ Compensation: Passive 'equaliser' placed within system to re-balance levels
      - ➢ Passive equaliser: frequency selective attenuator, reduces lower frequencies more, higher frequencies less (or not at all)

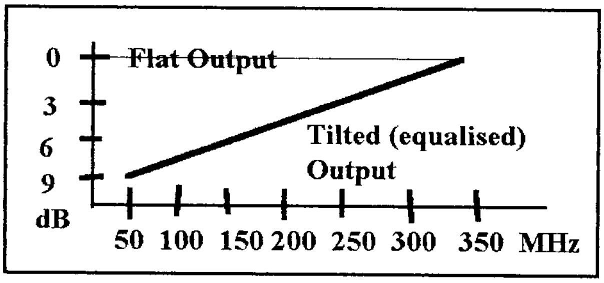


- ☐ **Passive equalisers are placed in cable (trunk) line wherever the balance between low and high frequencies exceeds an acceptable level**
  - Equalisers are frequency-designed (5-600 MHz, 50-300 MHz etc.)
  - Equalisers are 'dB correction' designed (3 dB, 6 dB, 9 dB etc.)
- ☐ **Passive equalisers can also be used for individual receiver 'drops'**
  - Restores 'balance' between low and high frequencies at end of 'drop' (Typical 'F-fitting' grade equaliser: right)

BALANCING AMPLIFIER INPUTS / OUTPUTS-

- ☐ **Rule of thumb: Enter plant line amplifiers 'flat', leave 'tilted'**
  - Amplifiers not only amplify, they also generate undesireable 'trash' products
    - ✓ '2nd Order' (harmonic) products
    - ✓ '3rd Order' (beat) products
  - The quality of an amplifier's output depends upon a rejection of 2nd and 3rd order products
    - ✓ 2nd and 3rd order products create 'beats' or 'interference' for amplified signals
    - ✓ Each successive amplifier increases 2nd and 3rd order products
      - ➢ As more and more amplifiers are used in series (cascade), the greater the products
        - ○ At some point (number amplifiers) the products create significant degradation to pictures and cable system quality becomes unacceptable
  - 2nd/3rd order 'trash' products are minimised when:
    - ✓ Amplifiers are operated 'flat', i.e., equal gain for the full spectrum

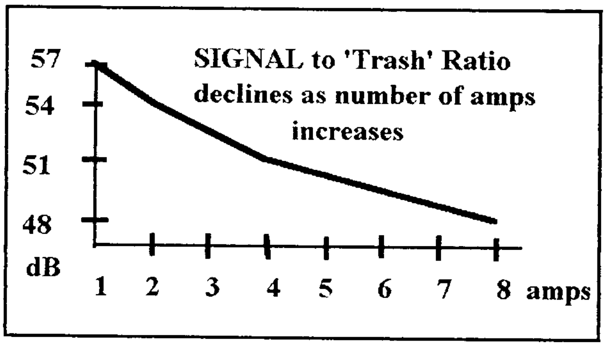




- ✓ Active amplifier stages operate 'flat', i.e., equal gain all frequencies
- ✓ Passive equalisation 'tilts' output AFTER amplifier output before signal re-enters cable

CASCADING AMPLIFIERS-

- ☐ **Two or more amplifiers connected 'in series' are operating 'in cascade'**
  - Amplifiers are rated by their 'Cascade-Ability'; how many amplifiers of the same type can operate 'in series' without objectionable degradation?
  - Each individual amplifier adds distortion, beat-products, 'trash' to the amplified signals
  - Typically, each time the number of amplifiers 'in series' (cascade) doubles, the objectional 'trash' doubles in strength
  - With each 'doubling' of 'trash' the margin (signal to trash ratio) reduces



SELECT AMPLIFIERS BASED UPON
- Composite Triple beat (more better)
- 2nd Order Distortion (more better)
- Noise figure (less better)
- Minimum Input level (less better)
- Maximum output level (more better)
- Channel Capacity (More better)
- Bandwidth (Buy what you need)

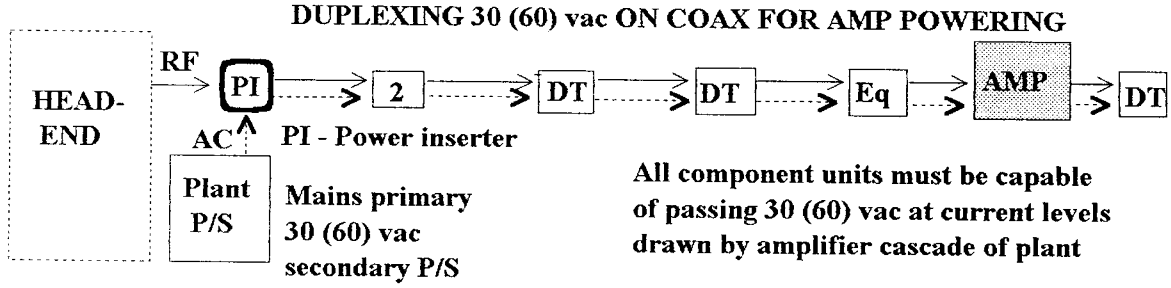
POWERING IN-PLANT AMPLIFIERS

☐ **In-plant amplifiers must be powered to operate**

- Power can come from mains (connect 230vac amplifier p/s to mains at each amp location)
- Power can be fed to amplifier through coaxial cable 'trunk'
  - √ Plant amplifiers designed to be cable-powered:
    - ➢ Typically operate from 30 to 60 VAC sources
      - ○ Actual amplifier operating voltage typically 18-21 vac
    - ➢ DC voltage is NOT used because of electrolysis (corrosive build up) at high current points (the lead-acid auto battery 'effect')
    - ➢ Typical plant amplifiers require 250 to 500 mA of 30 to 60 vac current
- When AC power is duplexed onto the coaxial cable for plant-amplifiers:
  - √ All in-line components (splitters, directional taps, equalisers etc.) must have an AC power passing capability
    - ➢ The current that will pass through any in-line device must not exceed the current passing capability of the component unit

- 30 - 60 VAC voltage fed through coaxial cable originates in mains primary/30 (60) vac transformer power supply
- Within each amplifier, the 30 (60) vac is converted to DC for amplifier operation

DUPLEXING 30 (60) vac ON COAX FOR AMP POWERING



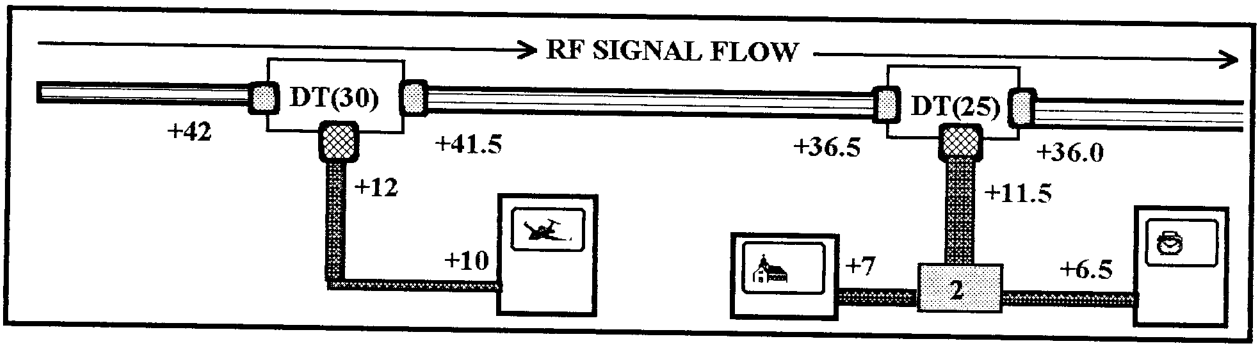
PROTECTING AGAINST CABLE / SYSTEM DAMAGE-

☐ **Neither VHF 'RF' nor 30 (60) vac like intrusion of 'foreign elements'**

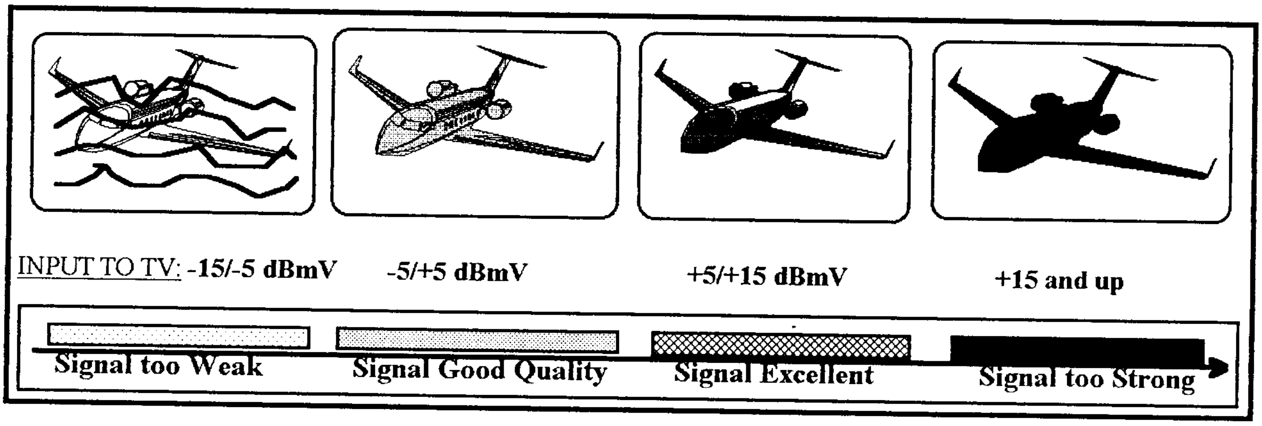
- Cables must NOT be bent (curved) or crimped such that their outer shield is 'creased'
  - √ A 'creased' cable can:
    - ➢ Allow ingress of outside radio spectrum signals
    - ➢ Allow egress of cable plant signals to outside world ('radiation')
    - ➢ Allow moisture to penetrate cable causing signal degradation, AC powering 'shorts'
    - ➢ Set up 'standing waves' that 'trap-out' (selectively attenuate) certain frequencies
- Do not use nails (bent over) or hammer-driven staples to attach cables to support members
  - √ 'Crimping' coaxial cable is a bad mistake
  - √ Multiple, randomly spaced, crimps cause 'suck-outs' of unpredictable frequency groups
- Seal ALL connections with an approved Silicone seal to prevent moisture seepage

CALCULATING TAP VALUES-

- ☐ **Goal of each 'DT' (directional tap, signal tap-off device) is to supply proper amount of signal to each receiver in system**
- ☐ **Because you know (from measurements) the signal level leaving the headend;**
  - Because you can calculate the signal losses from the headend to each 'DT'; location:
    - √ Subtract cable losses to that point (so many dB per 100 metres or fraction of 100m)
    - √ Subtract losses in passive devices (splitters, other DTs, connectors, etc.) between headend and the DT point
      - ➢ You can calculate the actual 'line level' for each DT location in advance, on paper
- ☐ **DTs are available in various 'isolation values'**
  - Isolation value (a dB number) describes "How many dB BELOW the line level the signal will be out of the DT receiver port"
    - √ EXAMPLE: a 20 dB 'Tap' (DT) will produce a signal to the receiver that is 20 dB less-than (i.e., -20 dB) the thru-line signal to the DT
      - ➢ If the calculated line level is +42 dBmV (+102 dBuV) at a point, and you install a 30 dB value DT, the actual signal level leaving the DT receiver port will be 42 - 30 or (+)12 dBmV / +72 dBuV



- ☐ **The actual signal level to the receiver is:**
  - Line level at DT location
  - Minus 'isolation value' of DT
  - Minus any additional cable losses to receiver
  - Minus any losses from in-house splitters
    - √ DT 'value' is adjusted for any outlet requring splitters, or requiring long (signal lossy) runs



MATCH, MIS-MATCH and FITTINGS-

☐ **Cable system reception quality depends upon:**

- The signal to noise ratio of each channel as measured at the headend
- The signal (voltage) level as delivered to each receiver, on each channel
- The signal to 'trash' ratio between desired signals and non-desired system generated 'trash' as measured at each receiver (drop) location
- The intergity of the system operating impedance (75 ohms, unbalanced) starting at the headend and ending at the receiver input

✓ Operating impedance integrity is called 'match'

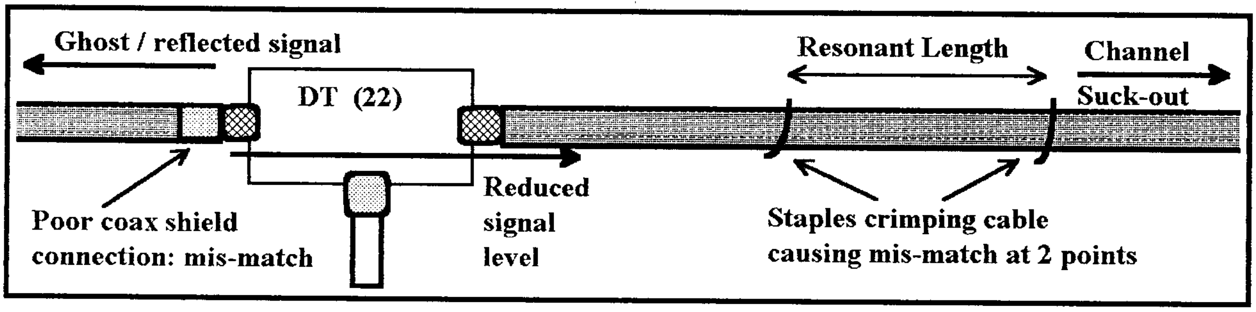
➢ Within the system, the operating impedance is established by the cable selected

○ All non-cable parts must 'match' (have the same impedance as) the cable

➢ Variations in 'match' are quantified by measurement of 'mis-match'

○ Any mis-matched component creates system loss at the point of mis-match

○ Mis-match points in the system cause visible degradation known as 'ghosts'



☐ **When shield-side of coax is not properly connected to DT a significant mis-match occurs**

- Mis-match causes some signal energy to be lost at the connector
- Mis-match leaves the lost energy with no place to go except 'backwards' towards the source

✓ This reverse-flow causes 'ghosts' on the receivers in the affected area since they now receive two signals for each channel; the forward direction strong signal, the reverse direction, weaker, reflected signal

➢ Ghost images typically follow (on the right hand side of) the primary signal

➢ The major effect of ghosts is a blurring of images, the loss of 'sharp, distinct edges' on video images (edges soften, blend into the next object to right on screen)

○ Significant mis-match causes double (ghost) images on screen

☐ **Crimping of cable causes a change in the cable's impedance at the point of 'crimp'**

- Two or more (multiple) crimps caused by multiple staples that have been poorly installed

✓ The electrical distance between staples ('crimps') establishes a 'resonant line section'

➢ At some TV channel wavelength within the cable spectrum, the resonant line will become a 'signal trap'

➢ At this frequency, on this channel, one (or two) channels will attenuate (reduce in level)

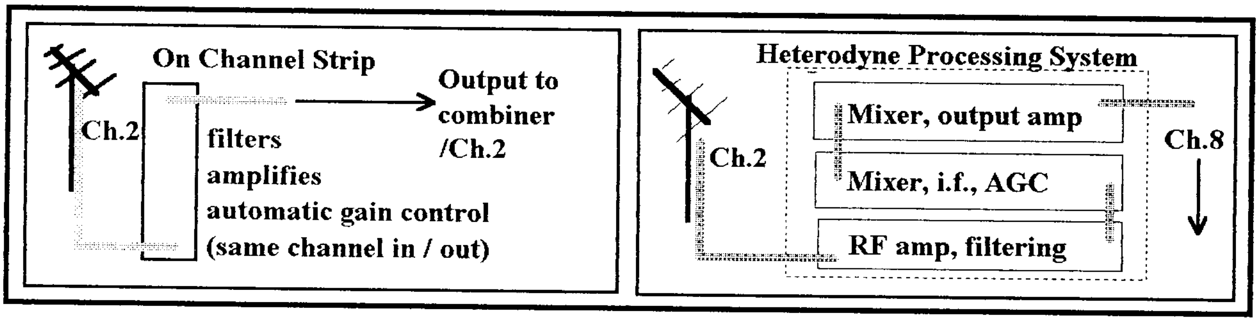
○ At all points AFTER this resonant length, this channel(s) will unexplainably be weaker than the others on the system

YOUR CHANNEL INVENTORY-

- **Your cable spectrum (such as 50-450 MHz) is your 'inventory'**
- **Within the inventory are at least two 'classes' of product:**
  - Local (terrestrial) signals, received direct or via satellite 'relay'
    - ✓ The 'value' of this inventory will differ from your non-local signals
  - Satellite delivered programming channels
    - ✓ Within the 'satellite class' of channels may be two or more additional 'sub-classes'
      - ➢ Advertising supported 'free to air' programme channels
      - ➢ Premium channels (which may or maynot include advertising; ESPN, for example)
- **Traditionally, 'local channels' capture upwards 60% of viewer's attention (viewing time)**
- **Satellite-only channels, however, offer programming options not otherwise available and account for 90% of the interest in being a part of a SMATV/CATV system**

Creating Channel Schemes-

- **Local channels may be best retained on their as-received channel**
  - If the cable system is within the very strong signal area of a local channel, the channel may be moved to a new dial position to avoid direct-pick-up ghosting
    - ✓ Local channels are placed on the cable after 'processing'
      - ➢ 'Processing' involves filtering (to eliminate interference), amplification, AGC
        - ○ During processing, the signal level of the aural carried is adjusted (downward) to allow operation in an 'adjacent-channel' (stacked channel) format
  - Processing can be done 'on channel' with 'strip amplifiers' (single channel amplifiers)
  - Processing on channel, or, by moving a channel as received off-air to a new channel, is done with 'heterodyne signal processors'
    - ✓ Heterodyne channel processors receive any VHF / UHF channel, reduce it to an i.f. range, reconvert from i.f. back to a (system chosen) output channel



- **Channel grouping by interest areas is often employed**
  - If your local channels can be grouped (using heterodyne processors to new channels):
    - ✓ If the local networks are widely known by their channel or service numbers, try to make their dial position correspond to their on-air identification numbers
    - ✓ If this results in 'empty dial positions' between channels, do not group the more popular satellite channels together; spread them out on the dial
      - ➢ This forces more frequent 'Channel Surfing', which adds to the perceived value of the cable service (viewers are forced to confront and evaluate different channel offerings each time they change channels)

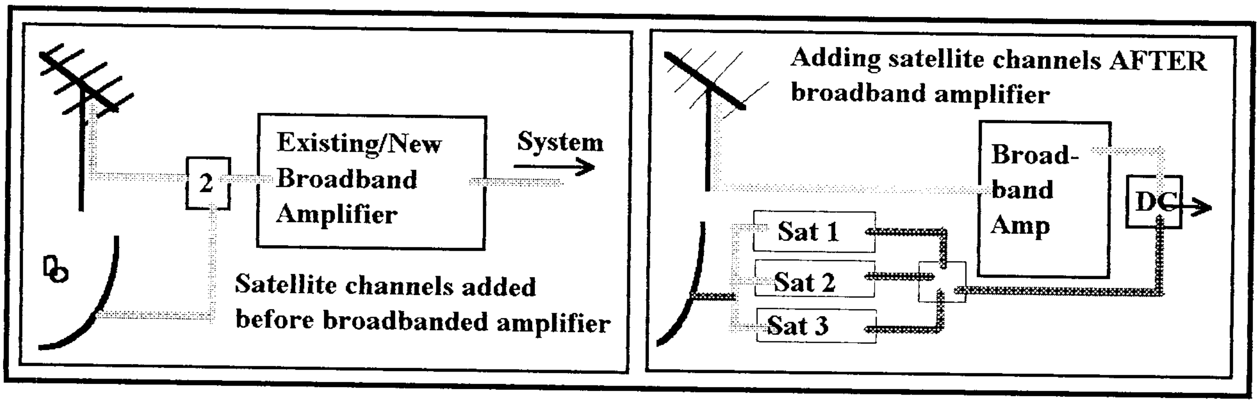
ADDING (new) SATELLITE CHANNELS TO EXISTING SYSTEMS-

☐ **Satellite channels may be added to existing MATV systems; with caution -**

- If MATV systems place local, terrestrial signals onto cable withOUT using strip or heterodyne processing, do not use 'adjacent channels' for satellite programming
  - ✓ Lacking processing, the local signals will interfere with new adjacent channel satellite signals
  - ➢ Local channel sound carriers, as a minimum step, must be 'turned down'
- If MATV system uses broadbanded amplifier for gain:
  - ✓ Will the existing amplifier carry additional satellite channels without overloading?
- If MATV system uses in-plant (line) amplifiers, will they accept additional carriers without overload, degradation?
- What is quality of reception at various existing outlets? Does system need repair?

☐ **Adding channels from satellite must be done such that when entering the system these new channels will 'match' the signal voltage level of existing terrestrial channels**

- If the MATV system has only a single (headend) broadbanded amplifier, and this amplifier cannot accept the new satellite channels:
  - ✓ Satellite channels from their respective modulators can be combined as a sub-group
  - ✓ The satellite sub-group is added to system through (DC) directional coupler AFTER the existing broadbanded amplifier



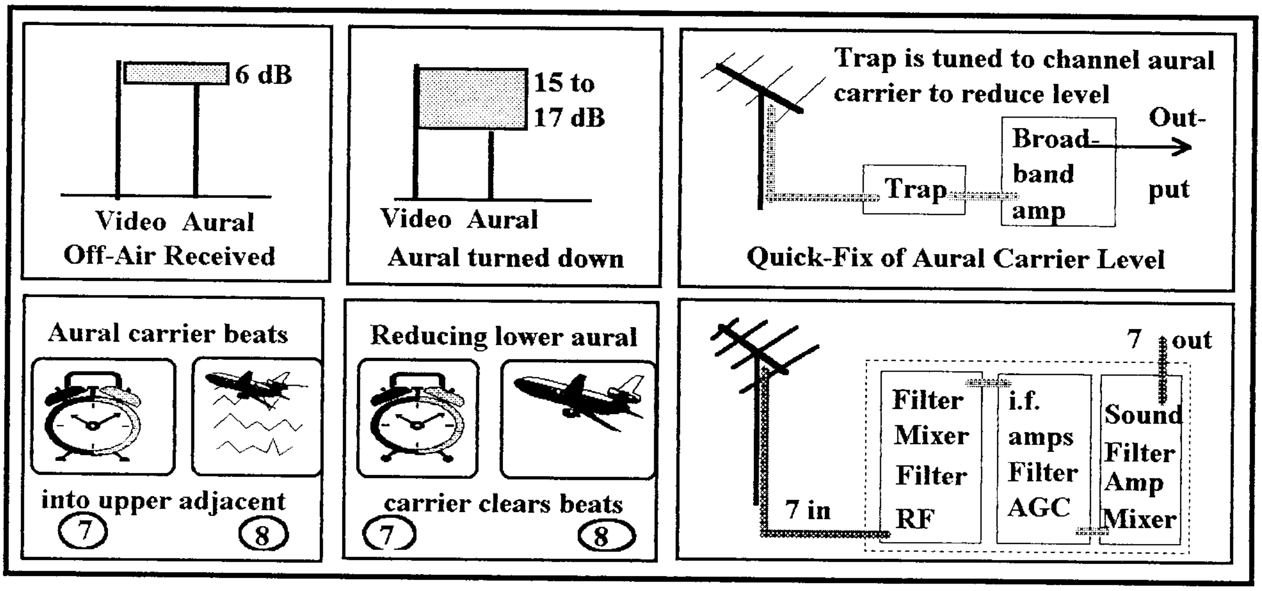
☐ To ensure the blend of terrestrial and satellite mixes well together:

- Select frequency assignments for satellite that avoid conflicts with terrestrial channels
  - ✓ Avoid channels in use in your **region**, not just your immediate area
  - ✓ Avoid channels which may have conflicts from 2-way and FM broadcast radio
  - ✓ Avoid channels one-up from terrestrial signals unless you will process the local channel by turning 'down' its aural carrier level
- Add the satellite channel to the system without overdriving MATV system amplifiers
  - ✓ Where required, replace existing limited-capacity amplifiers with new high capacity units
  - ✓ In systems with in-plant line amplifiers, verify their ability to handle additional channels
- Before adding new channels, check present reception at all cable-leg ends to verify existing system performance
  - ✓ Adding new channels won't affect system taps (passives) but may present opportunity to have existing problems repaired

STEPS TO SET-UP NEW CHANNELS-

☐ **Select appropriate frequency for new channel**
- Choice of:
  - ✓ Factory-assigned, as-built modulator frequency (i.e., pre-channelised)
  - ✓ Frequency-agile modulators (i.e., any channel from 50 to 450/550 MHz; field set up)

☐ **Determine how new channel(s) will fit into total channel plan**
- Possible upgrade of existing channels in system at same time
  - ✓ Replace existing all-channel broadbanded amplifier(s) with individual channel processing at headend
  - ✓ At very least, install tuneable sound carrier trap on terrestrial channels to set audio down 15 to 17 dB reference visual carrier
    - ➢ By controlling a channel's sound carrier, you open up use of the next upper (adjacent) channel for use by a satellite service
      - ○ Without sound carrier control, upper adjacent channel cannot be used for satellite



☐ **Carefully select combining hardware to add new service(s) to existing system**
- (Hybrid) splitters are a poor second choice for combining channels; directional couplers offer better isolation between sources, better operation

☐ **After combining satellite modulators to existing system:**
- Adjust video modulation following instructions for no more than 87.5% modulation peaks
  - ✓ Carefully monitor during regular programming for minimum of 15 minutes to ensure modulation does not exceed set-level on 'peaks'
- Adjust aural modulation following instructions and monitor for at least 15 minutes
  - ✓ If aural modulation sounds 'confined', re-check impedance matching between satellite receiver and modulator input
- Verify the quality of the new channel by inspecting the reception on a number of receivers, preferably varying brands and models

☐ **NEVER select 'double sideband' modulators for satellite channels**

SKY EXTENSION TO SHADOWED AREAS

MINISTRY OF COMMERCE APPROVES REFLECTORS / On-Channel Boosters

Rules of the game changed?

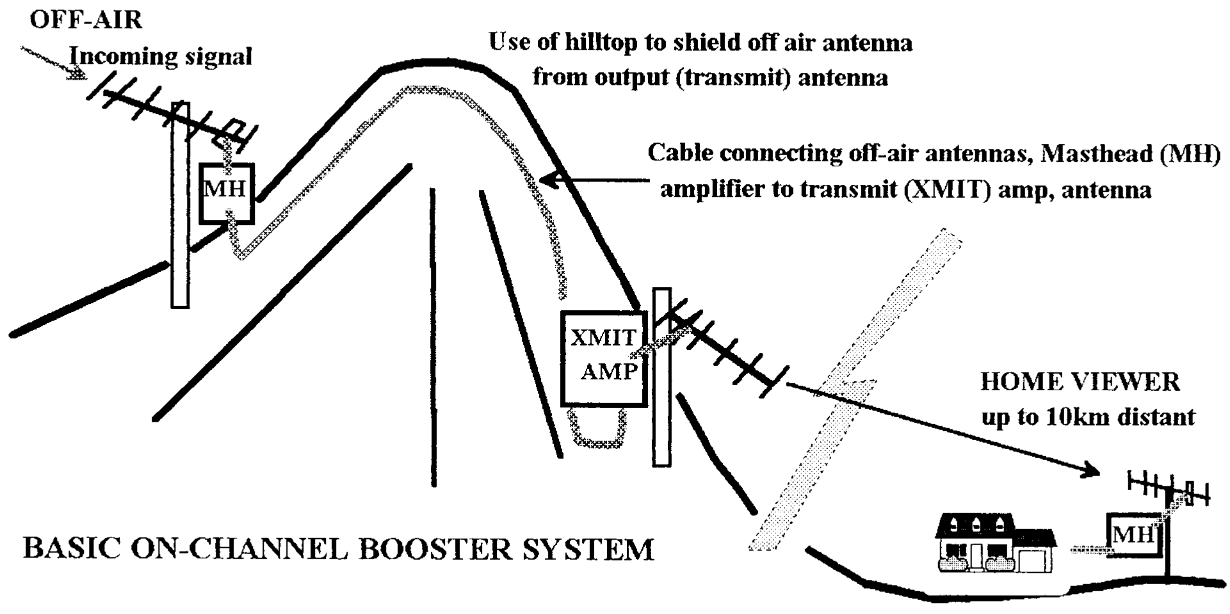
DO IT YOURSELF

The Ministry of Commerce has approved a scheme to licence a device that can extend UHF television signals into relatively small 'pocket areas' which are shadowed by terrain from direct reception. The new licences are relatively inexpensive to procure, the paperwork is minimal, and the equipment required to extend UHF signals could cost as little as $700 at aerialist-installer wholesale pricing. And breaking with tradition, licences may be held by private individuals, or business entities. Previously all UHF telecasting licences were granted only to holders of Management Rights. The new 'on-channel booster' stations will operate outside of the Management Rights scheme, and will be 'secondary users' of the spectrum. There are restrictions and caveats:

1) Booster stations must not cause interference to any other class of service (such as cellular telephone).

2) Booster stations are responsible to not cause any interference to people who have direct reception of the same (or other) UHF stations which the booster station is repeating. Demonstrating that no such interference will occur is a part of the application procedure.

3) Booster station operators are obliged to notify the transmission originator (such as SKY, or TAB, et al) of their station's operation. However, the rules do not require the booster station operator to secure the permission of the originator to operate nor to be licensed.



BASIC ON-CHANNEL BOOSTER SYSTEM

4) Booster station operators are restricted to 0.5 watt radiated output power (eirp) per channel; a point we shall return to shortly.

5) The new licences are called 'Multi-Frequency Licences' (MFL) and are being granted under provisions of S.48 of the Radiocommunications Act.

If a single booster station (i.e., system) will boost (on channel) programme channels from more than a single holder of Management Rights (such as SKY and TAB), two separate licences will be granted. This does double the cost of annual licensing (typically $45 per frequency per year).

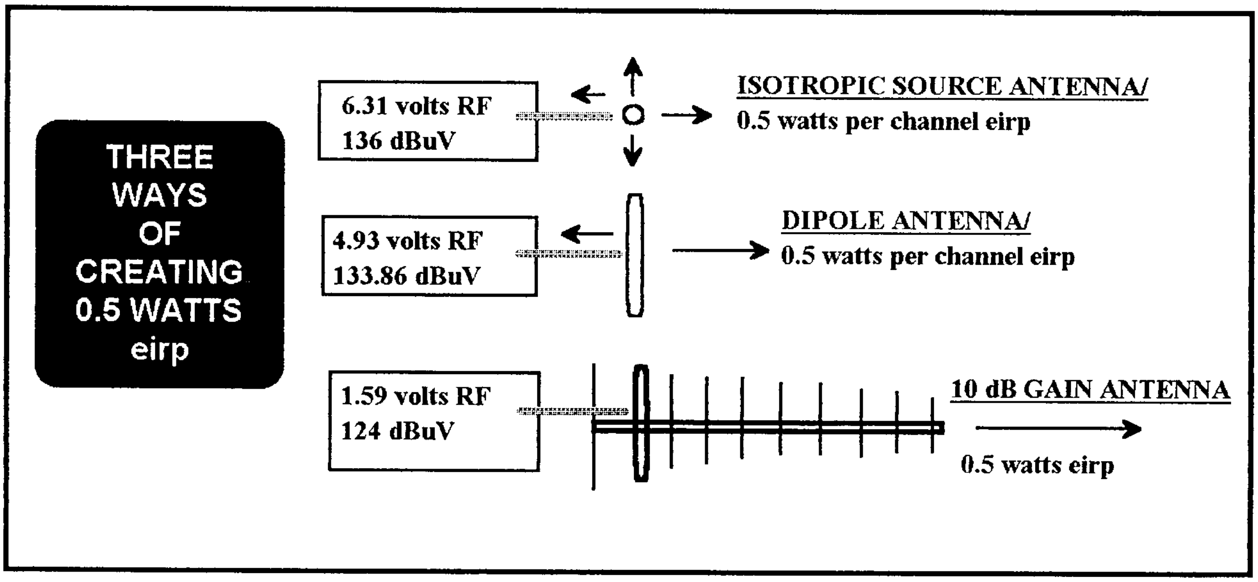
If a booster station seeks to boost (on channel) both UHF and VHF channels into a pocket area, unfortunately the new Multi-Frequency Licence scheme does not allow for joint licensing of the VHF channels. The Ministry notes that when the VHF Management Rights programme is implemented, they will revisit this question. In the interim, they suggest VHF boosted channels should be licensed under the existing Radio Apparatus Licence system. As a practical matter, virtually no would be installer of a VHF booster will be able or willing to proceed to licensing under the Radio Apparatus Licence programme; *the system is simply not user friendly.* So for the moment, on-channel boosting using licensed, legal stations will be limited to UHF band IV and V channels.

6) Term of licence is five years.

Practical Designs

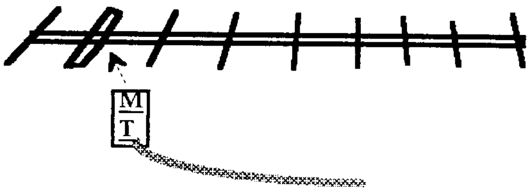
Most installers will be concerned they are getting maximum coverage bang for their buck. The Ministry, and the radio inspection chaps, will be concerned your achieve your coverage by not exceeding their maximum radiated power criteria nor causing any interference. As a practical matter, given the type of off-the-shelf equipment likely to be employed in booster installations, about the best you are likely to do is just nudge the radiated power limitations anyhow.

The power allowed is 0.5 watts eirp; eirp is shorthand for effective isotropic radiated power. This is the sum of your booster-amplifier (i.e., transmitter) output power level added to the forward direction gain of your transmitting antenna. The important point to keep in mind is that your 'eirp' is the sum of two gain numbers; if you increase the gain of the antenna (by selecting a higher gain transmit antenna), you can reduce the actual power level of the amplifier and still achieve the same 'eirp'.



The installer is dependent upon two as-supplied specifications from the equipment supplier(s):
1) The forward direction gain (in dB over an isotropic source; dBi) of the antenna
2) The output power level (in dBmV or dBuV) for the booster amplifier.

Antenna gains supplied on data sheets are generally over-stated; that's an unfortunate part of the hype in the antenna selling business. Gains may be stated as so many decibels above a dipole reference antenna (dBd), or reference an isotropic source antenna (dBi). Antenna gain reference a dipole is 2.14 dB less than gain reference an isotropic source and it is important you know which reference is being used for your own system calculations. Another concern is the reference impedance of the antenna. If the antenna is nominally a 300 ohm design, but will be used in a 75 ohm (coaxial cable) configuration, you are allowed to subtract 2.0 dB of antenna gain to represent the power loss you will experience through a standard 300 to 75 ohm matching transformer.

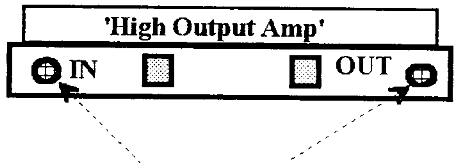


MANUFACTURER CLAIMS:

15 dB gain reference isotropic
You subtract 2.14 dB for dipole reference
No loss in MT (matching transformer)
You subtract 2.0 dB for real losses

Bottom line: An antenna *claiming* 15 dBi of forward gain with a 300 ohm feed impedance will, in your system, have 13 dB of gain reference a dipole and 11 dB of gain after the losses in a matching transformer. 11 dB, then, becomes your system computation number for the antenna portion.

The amplifier you select for on-channel boosting must be capable of supplying the required output power level for each of the UHF channels which you will be 'boosting'. If you are boosting only SKY channels, the power level to be measured is for each of the three (or four) channels; add TAB, and it is for five channels. Only a handful of generally available amplifiers claim the output ability to do this job; the installer is warned that advertising claims are not the same as actual performance and as a part of your own system installation you will have ample opportunity to verify the accuracy of the amplifier manufacturer's claims.



TIP: Belling Lee (PAL type) plugs are NOT designed for RF signal voltages over +120 dBuV and amplifiers using these plugs over this level should be avoided!

MANUFACTURER CLAIMS:

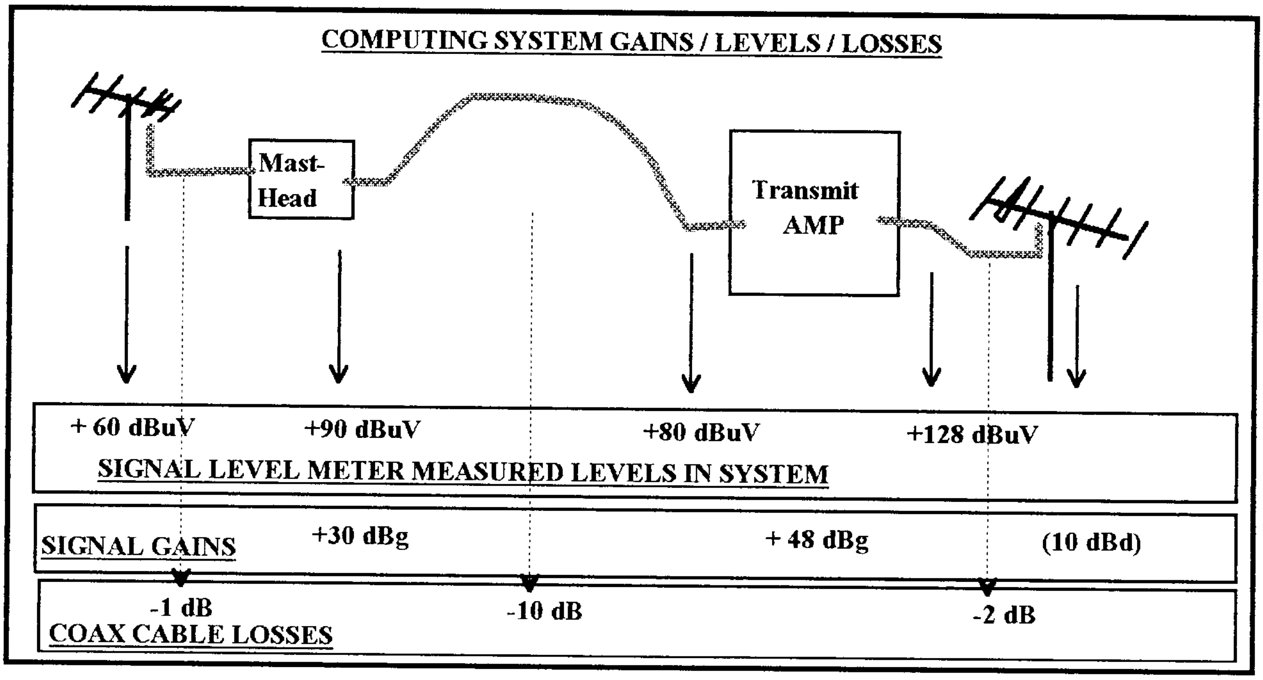
126 dBuV output
You ask "How Many Channels?"

Generally speaking, you want to source an output amplifier which is capable of delivering as many as six independent channels at an output in the 1.5 to 2.0 volts per channel range. That's the same as +64 dBmV / +124 dBuV to +66 dBmV / +126 dBuV. Be especially wary of amplifiers which claim a maximum output capability in this region, but then in the fine print suggest you actually operate the amplifier at 3 dB lower levels to avoid sync compression. Or, amplifiers that rate their outputs in this range and then in the fine print tell you this is for single channel operation only.

System Gain

So far we have discussed only the output side of the booster station. In most booster installations, there will be a pair of amplifier units; one located at the input (off air) antenna side, the other located at the output (transmit antenna) side. In calculating your own system, you must start with the off-air signal level (as measured with your input antenna connected to a signal level meter). To that you add the (signal voltage) gain of your input (masthead) amplifier and the (signal) voltage gain of your output (transmit) amplifier. We diagram such a computation here.

In the complete system gain computation, you also have some losses to subtract. The cable that interconnects the input antenna amplifier to the output (transmit) amplifier will often be 30 to 100 metres in length in a typical installation. The loss in this cable, at the highest frequency channel to be boosted in your system, is subtracted out of the overall circuit gain to arrive at the final computation of output radiated power.



System Stability

An on-channel booster functions by taking a relatively weak signal (as received from the off-air antenna), amplifying it (with a masthead amplifier), and then connecting this pre-amplified signal(s) through a length of cable to a new power amplifier. After the 'transmit amplifier', the signal is connected to a second set of antennas which radiate (transmit) the boosted (amplified) signals off through the air to distant receivers. All of this happens on the same channel or channels.

In electronic terms, there is ample opportunity here for the system to 'oscillate' or 'go into feedback mode'. This is not good; in fact, if this happens your system is shut down.

Feedback mode occurs when the radiated signal from the transmit antenna finds its way back to the original receive antenna. This creates a 'loop' which is self-perpetuating; the same signal goes around and around and in the process this blocks any new signal from getting into the input antenna side. Think of it as freeze (still) frame on a VCR gone beserk.

To insure there is no feedback loop, some precautions must be taken.

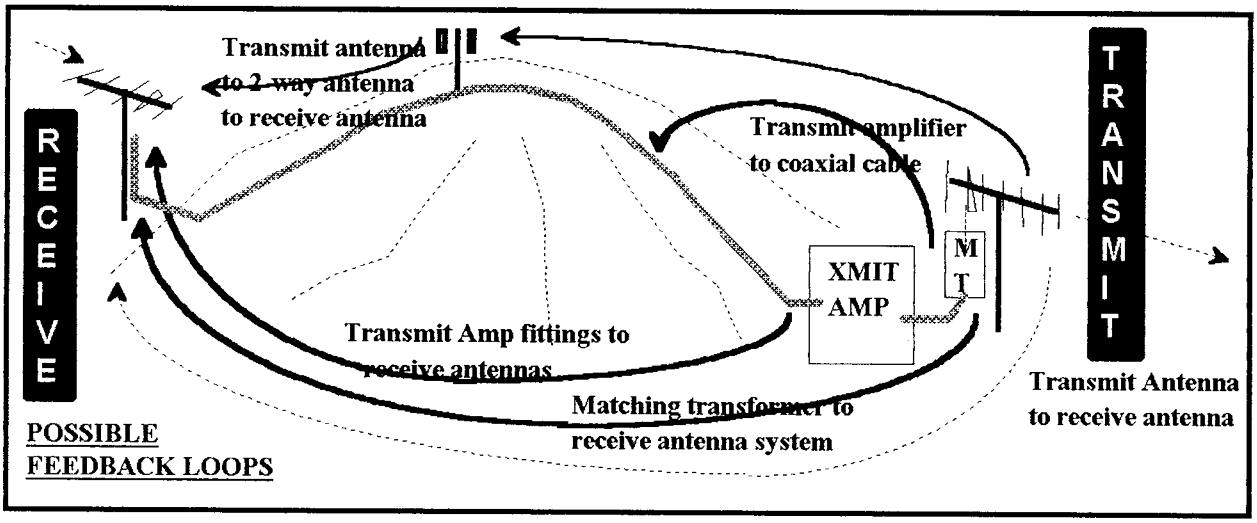
1) Flip polarities. If the original incoming signals are polarised vertical, the new boosted transmit signals should be horizontally polarised. This provides a measure (in technical jargon, around 30 dB) of 'isolation' between the input and output signals.

2) Put space between the input and output side antennas. How much space? Generally 30 metres is a minimum but this also depends upon the 'shielding' that you can achieve between the two sets of antennas. If you can place the off-air receive antenna (plus its masthead) on one side of a hill, and the transmit antenna (plus its transmit amplifier) on the opposite side of a hill, the natural 'shielding effect' of the hill will be far more important than the actual distance between the two. Under no circumstances should the transmit antenna system be 'line of sight' to the receive antenna system.

3) Carefully route the connecting cable. The line interconnecting the receive antenna portion to the transmit portion should be a high quality coaxial cable with 90% shielding as a minimum. The cable represents an opportunity for the 'feedback loop' to occur and ideally it will be buried a few cm below ground level to add the shielding effects of the earth to the cable's own shield.

4) Matching transformers, especially at the transmit antenna side, should be very carefully selected. The best option is to not use an antenna that requires a balun / matching transformer; select a transmit antenna that directly accepts 75 ohm cable. A matching transformer housed in a plastic container is very ill advised as the shielding of the plastic to radio frequency signals is zero. The transformer represents a high current point in the system, and most matching transformers are so poorly designed to begin with that you will have impedance mismatch (VSWR) within the unit. This leads to signals that radiate, with a polarity of their own, and that can mean you radiate output signals from the matching transformer back through the air to the original off-air (input) antennas.

5) Other antennas at the site. If the booster site has other antennas for other radio services in place, they can (and often will) pick up the transmit side signal and reradiate it back into the input side antenna. If you have followed all of the rules, and still have 'feedback', try moving the transmit side antenna up and down, left and right a metre at a time. This will help you find a 'null' which minimises the feedback loop.



Range

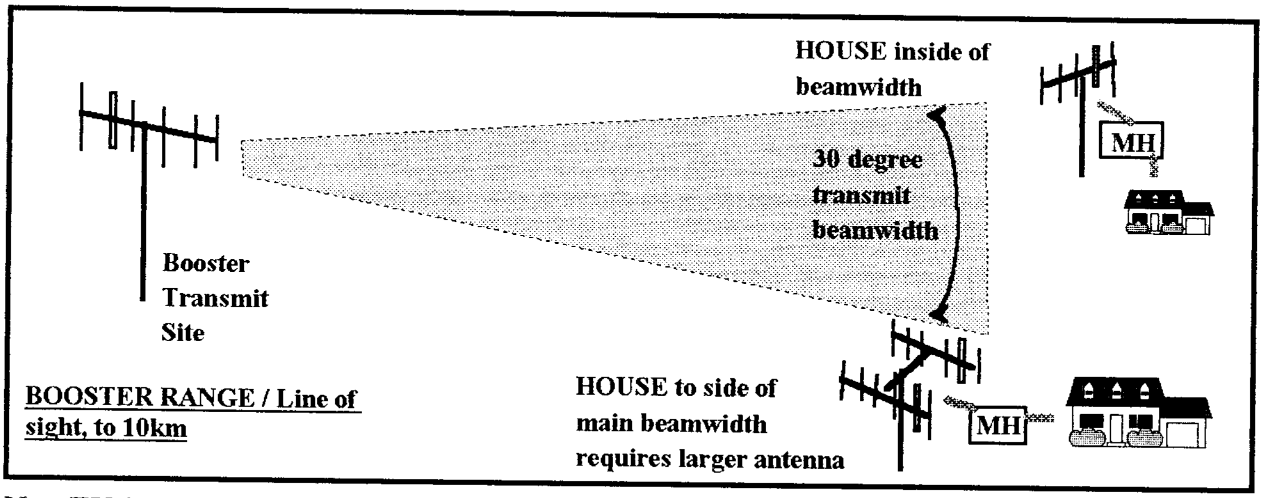
The distance covered by an on-channel booster will depend upon:

1) Line of sight (any viewer receiving site that can 'see' the transmit antenna site should work)

2) Your transmit antenna pattern (an antenna that compresses the forward direction signal to a 30 degree wide swath will have noticeably reduced coverage 50 degrees off to the side)

3) The gain of the viewer location receiving antenna system (a 10 dBg home antenna coupled to a 20 dB gain masthead would be a common installation). Once you have relaunched the signal through the booster, normal fringe area receiving antenna design practices apply (Tech Bulletin 9303).

Having said all of this, ranges to several kilometres, up to 10 if everything is dead on, are practical.



Non TV System Interference

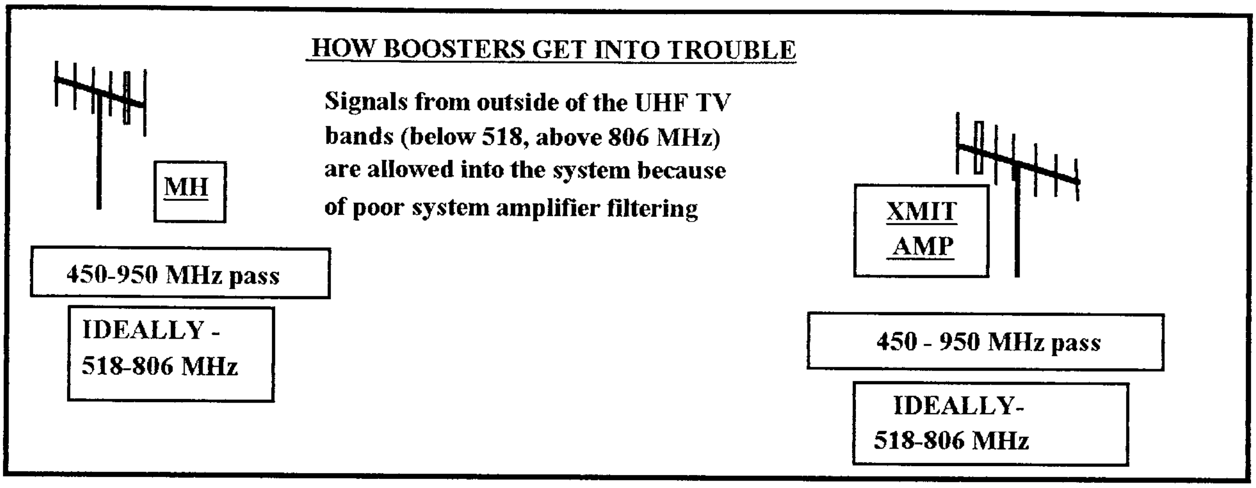
The gain-bandpass of an on-channel booster is determined by the amplifier characteristics of the system. A receive-side masthead amplifier that offers 'broadband gain' over a frequency range of 500 to 900 MHz will treat all signals within that range as if they were a desired TV signal. Even above 900 MHz and below 500, you will still have (some) gain from the masthead amp.

The transmit-side amplifier will have similar characteristics. The sum of the 'out of band gain' (at say 470 MHz or 940 MHz) between the two amplifiers can be quite high; enough so that two-way radio systems or cellular telephone signals picked up at the input side will also be amplified and redirected at the output side.

In the original installation for Te Kuiti (See CTD 9409; p.8) the broad band frequency response nature of the installation caused significant trouble for a local cellular telephone site. The answer is to 'narrow band' the broadband system; to reject signals that come into the system from frequencies outside of the required TV channel ranges. Under the Ministry Rules, it is the responsibility of the system installer to take steps to cure such cases of repeated-interference. In fact, if such interference occurs, the licencee is obliged to turn off the system until the problem is corrected.

Rejecting undesired signal sources involves either trapping out the unwanted signals at the input (usually directly after the off-air masthead amplifier), or, channelising the transmit side of the system. In both cases, whether trapping or channelising, the devices you install must be designed to work in a 75 ohm coaxial cable system. Traps, for example, designed to work in a 50 ohm coaxial cable network will not function properly if 'stuck in the 75 ohm coax line'.

1) Traps. This is the least expensive 'fix' but properly tuning up or even checking out such a system will require access to a spectrum analyser. A signal level meter is not a substitute here since



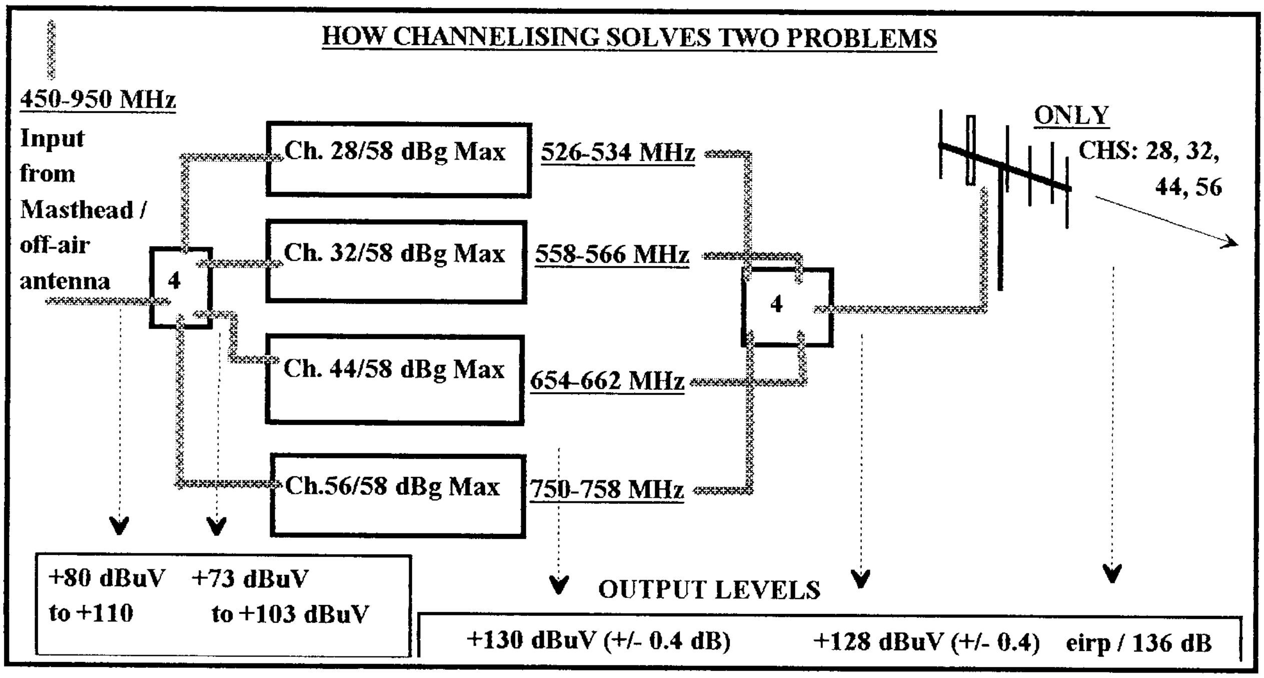
you need to see a visual display of all of the signals passing through the system to be certain the trap(s) you are installing are operating after installation on the correct frequency, and, there are not other undesired frequencies getting through the system as well.

2) Channelised outputs. This costs more money, but has additional benefits. First, channelised (single channel) output amplifiers can be installed and set up with nothing more complex than a signal level meter. Second, a reasonable quality channelised UHF single channel (strip) amplifier also provides AGC; automatic gain control. Why is that good?

Most booster stations will operate with a relatively steady (non-fading) input signal. Unfortunately, there will be times when because of atmospheric conditions the signal level becomes far stronger than 'usual', or conversely, far weaker than usual. Of the two:

1) A weaker signal may reduce the quality of the retransmitted signals to the point where snow (noise) enters the retransmitted signal. In this case, every home receiver viewing the service experiences the same snowy conditions.

2) A stronger signal is more dangerous. If you system is set up to function with a 'normal' input signal level, an increase in the signal level will raise signal voltages through the entire system. If



your transmit output amplifier is operating at close to its maximum output ratings (such as 126 dBuV output for a 128 dBuV maximum output rated unit), the increase in input signal level will be reflected with a corresponding increase in output signal level as well. That sounds all right until you realise that as the input signal continues to become stronger, the output rating of the transmit amplified is exceeded. Now the pictures overload the output amplifier, causing the video sync tips (signal peaks) to be 'clipped' (distorted) in the amplifier. At this point all of the channels on the system begin to 'roll' vertically, the blacks become saturated, and the sound (audio) begins to buzz. Not a happy situation.

The solution to this is to use an output amplifier that employs AGC; automatic gain control. Now as the input signal from the off-air antenna and masthead amplifier becomes stronger, the AGC system in the channelised output amplifier steadies the signal to its original maximum-adjusted output level. And where without AGC the input signal level might move upward only 2 or 3 dB before you begin to experience the ill effects of overloading, with AGC the signal can move upward as much as 30 dB without reaching the overload point.

All of this is in addition to having a channelised output that also rejects signals that come through the input antennas off-frequency; i.e., cellular telephone and two-way radio. Of course what started out as a simple, relatively inexpensive system has now become slightly more complicated and in the process it has also become more expensive. But, it has also eliminated any opportunity for off-frequency channel interference and eliminated the ill effects of changing input signal levels at the same time.

Dealing With Ministry Field Offices

Radio Frequency Service offices now have in their files a document entitled "Licensing of 'On-Channel Boosters' For Television," dated 01 July 1994. Applicants should query their regional RFS office for assistance in framing applications for this service. Logically, initial applications will be a learning curve for both RFS personnel and yourself.

We are interested in feedback of your results as you work through this process. Address communications to: Robert B. Cooper, P.O. Box 330, Mangonui, Far North (FAX: 09-406-1083).