Return Path Modem Signal Levels Overview
Return Path Modem
Signal Levels Overview (cont.)

- If you ask a CATV engineer or technician to tell you the TX level of the modem in the customer’s house, what will they tell you?

- Won’t they say that: “Modem TX Level = Return Active Design Input + Modem-to-Active dB Loss”?

- But then, ask them what is that determines the Return Active input level. What will they tell you?

- Usually– they do not know. They were never taught.
For this reason, this simple lesson in CATV return levels is necessary for cable techs & engineers who were never taught the basic rules of return levels.

We know of more than one cable system with return levels completely out of spec because of lack of knowledge concerning the rules governing return levels & consequently incorrect implementation of return plant design.
Return Path Modem
Signal Levels Overview (cont.)

- Return Level Basic Rule:

  Modem TX Level
  =
  dB loss between
  that point & the CMTS
Return Path Modem
Signal Levels Overview (cont.)

- The CMTS requires the modem signal to be at a level of 0 dBmV at its input.
- Thus, the signal level at any point in the return path is equal to the net loss* between that point and the CMTS input (which = dBmV Δ between the two points).

* (The net loss can be determined by injecting a signal from one point in the system to another and subtracting the difference between the two levels.)
The signal level at the return active device input is equal to the loss between that point and the CMTS input (which = the dBmV Δ between the two points).
Return Path Modem
Signal Levels Overview (cont.)

Node Input = CMTS to Node dB Loss

Node Input dB Loss:

- CMTS: +49 dBmV
- 8-Way Splitter: -7 dB of total loss
- Amp 1: +19 dBmV
- Amp 2: +19 dBmV
- Node Input: +5 dBmV
- RX: +19 dBmV
- TX: +19 dBmV

Return RX dBmV:

- +49 dBmV
- +19 dBmV
- 0 dBmV

CMTS dBmV:

- -4 dBmV
- -4 dBmV

MODEM dBmV:

- +19 dBmV

Choice
EL PODER DE HACER MÁS
Return Path Modem
Signal Levels Overview (cont.)

- Amp Input Level = Node Input Level

**Amp Input Level = Node Input Level**

![Diagram](image-url)

- **NODE**: +5 dBmV
  - RX: +19 dBmV
  - TX: -4 dBmV

- **8-Way Splitter**: -4 dBmV
  - +19 dBmV

- **CMTS**: 0 dBmV

- **Return RX**: -4 dBmV
  - +19 dBmV

- **Amp 1**: +19 dBmV
  - MODEM: +49 dBmV

- **Amp 2**: +19 dBmV
  - 7 dB of total loss.
  - Return RX: +49 dBmV

- **MODEM**: +49 dBmV
Return Path Modem
Signal Levels Overview (cont.)

- Modem TX Level = CMTS to Modem Loss

- Modem TX Level = CMTS to Modem Loss

<table>
<thead>
<tr>
<th>Component</th>
<th>Signal Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMTS</td>
<td>-4 dBmV</td>
</tr>
<tr>
<td>8-Way Splitter</td>
<td>+19 dBmV</td>
</tr>
<tr>
<td>Return RX</td>
<td>-4 dBmV</td>
</tr>
<tr>
<td>Amp 1</td>
<td>+19 dBmV</td>
</tr>
<tr>
<td>Amp 2</td>
<td>+19 dBmV</td>
</tr>
<tr>
<td>MODEM</td>
<td>+19 dBmV</td>
</tr>
</tbody>
</table>

7dB of total loss.
How to Achieve Design Return Levels

The active device return input level is specified in the plant design. To ensure modem signals arrive at return active inputs at design specs, and not some other level, you must do 2 things:

1) Make Node to CMTS loss = Return Input level desired
2) Set up the return active RF amplifiers for unity gain.

(See next slide for example illustration of system with 20 dBmV return active design input, configured with 20 dB Node-CMTS loss.)
Return Path Modem
Signal Levels Overview (cont.)

- Example: 20 dBmV Design Return Inputs

NODE 4

RX
TX

8-Way Splitter

-9dB

CMTS

0 dBmV

Return RX

dB loss (dBmV Δ)

Node-CMTS = 20 dB

+20dBmV

12 Amp 1

20 dBmV

20 dBmV

+20dBmV

9 Amp 2

23

+49 dBmV

(6 dB total Drop and splitter Loss)

MODEM

+20dBmV

+20dBmV

20 dB

0 dBmV

Choice
EL PODER DE HACER MÁS
Return Path Modem Signal Levels Overview (cont.)

- Modem TX Level = Modem to CMTS dB Loss (i.e., dBmV Δ)

Losses:
20 + 0 + 29 = 49 dBmV

Modem TX Level = 49 dBmV
Return Path Modem
Signal Levels Overview (cont.)

Return Setup to meet Design Specs
There are several return level design objectives to meet. The following are the most important:

1. Active Device Input Levels
2. Node TX Input Level
3. Hub/HE RX Output Level
4. Modem TX Level
Return Path Modem
Signal Levels Overview (cont.)

Return Path Levels

Example

- To give an example, assume the design values are the following:
  1. Active Device Input Levels = 19 dBmV
  2. Node TX Input Level = +5 dBmV
  3. Hub/HE RX Output Level = +19 dBmV
  4. Modem TX Level = Maximum = 49 dBmV
With 19 dBmV injected at the Node return input (39 dBmV through a -20 dB TP), the RX in the Hub is adjusted to 19 dBmV (which is the design level for the Hub RX output).

With 19 dB of loss between the output of the Hub 8-way splitter and the CMTS input pad -8dB, the loss between the node input and the CMTS is 19 dB. Therefore, return active input levels will be the 19 dBmV amount that is specified in the design.
The Node TX design input is +5 dBmV in this example.

With a 3 dB node return input pad installed and internal loss of 11 dB there is a net loss of 14 dB between the node input and the input to the node TX.

Thus, the return level at the node TX input = +5 dBmV, the design specification.
The Hub RX output is, by design, =19 dBmV (at the 8-way splitter port) in this example.

This level has already been set-up (when optical link was set-up.)
Return Path Modem Signal Levels Overview (cont.)

Modem TX Level

Losses

$$19 + 0 + 30 = 49$$

CMTS “asks for” 0 dBmV at its input

CMTS

NODE

RX TX

-19

0

23

-30

(23 dB tap +7 dB splitter & Drop Loss)

MODEM

Modem Tx Level = 49 dBmV
Return Path Modem
Signal Levels Overview (cont.)

Remember, the rule for the TX level of the modem in the home (or anywhere in the feeder plant) is:

$$\text{Modem TX Lvl} = \text{Modem to Amp Loss} + \text{Node to CMTS Loss}$$
What did you say the formula for modem TX level is? The loss between the modem and the CMTS? Yes, but--

This loss is made up of two parts,
1. The loss between the modem and the amplifier input
2. The loss between the node and the CMTS.

Remember this because some cable people are very good about recognizing the modem to amplifier loss when they think about Modem TX levels, but sometimes forgetful on the Node-to-Hub part of it.
If you are not clear about the node-to-Hub loss part of it, you can easily end up with the wrong modem return levels. The story is told of cable systems that went for years with incorrect return levels, because they were clear about the modem to amp part of the formula, but not the node to Hub part.
Questions????
Return Path Modem
Signal Levels Overview (cont.)

TX Levels & Noise Attenuation

Between the Modem and the Return Active Input
On the downstream:

dB loss between the amplifier output and the tap port of any tap along the line = Amplifier Design Output – Signal Level at Tap Port, approximately.

In other words on the downstream the dB loss between the amplifier and any tap port are approximately the same. Thus, the downstream signal level at the tap port of every tap along the line is approximately the same.
Without some method of “equalization” of losses along the tap line both TX level and Drop Noise attenuation will be maximum at the highest tap value (23 tap in this design). Sample return path modem levels on a tap line where return equalization is not used are shown on the following slides.
## Return Path Modem
### Signal Levels Overview (cont.)

#### Falling TX Levels Along Tap Line

<table>
<thead>
<tr>
<th>Tap TX Level</th>
<th>Home TX Lvl</th>
<th>Cable Modem</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>49</td>
<td>Cable Modem</td>
</tr>
<tr>
<td>41</td>
<td>48</td>
<td>Cable Modem</td>
</tr>
<tr>
<td>39</td>
<td>46</td>
<td>Cable Modem</td>
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<td>35</td>
<td>42</td>
<td>Cable Modem</td>
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<tr>
<td>34</td>
<td>41</td>
<td>Cable Modem</td>
</tr>
<tr>
<td>31</td>
<td>39</td>
<td>Cable Modem</td>
</tr>
</tbody>
</table>

RDI = 19dB
Question: What Happens to Levels When You Change a Return Pad Value?

When you change a return pad value:

Do modem signal levels on the return go up?
Do modem signal levels on the return go down?
Do modem signal levels on the return stay the same?
Return Path Modem Signal Levels Overview (cont.)

Answers:

- Return modem levels in the direction toward the node stay the same.

- Return modem levels in the direction away from the node change, in the following manner:
  1. Increased attenuation results in increased return path modem signal levels.
  2. Decreased attenuation results in decreased return path modem signal levels.
Return Path Modem
Signal Levels Overview (cont.)

What Happens to Noise When You Change a Return Pad Value?

Answer:

An increase in padding on the return reduces the noise going back to the CMTS from that point. A decrease in padding on the return increases the noise going back to the CMTS from that point.
Return Path Modem
Signal Levels Overview (cont.)

- When you change a pad-- or any attenuation-- on the return path, modem levels change in one direction and stay the same in the other. There are 3 rules to remember:

1. Return modem levels in the direction away from the node change.
2. Return modem levels in the direction toward the node stay the same.
3. Increased attenuation results in increased return modem levels & reduced attenuation results in decreased return modem levels.
Return Path Modem
Signal Levels Overview (cont.)

Final Questions?