Return Path Optimization

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Return Path Familiarization and Node Return Laser Setup

CATV Network Overview

Coaxial Network (RF Distribution)
- Unity Gain
- Reverse Sweep
- Input Levels to Actives

Fiber Network (Laser/Node/Receiver)
- Return Laser Setup
- NPR

Headend Distribution Network
- Optimal Return Receiver Setup
- Input into CMTS port

The X Level

Network Troubleshooting
Typical Two-Way HFC CATV System?

Downstream (Forward)

Upstream (Return)

Stable Network?
• Forward
• Return

Reference Signals?
• Forward
• Return

RF Level Controls?
Does Forward need return?
Does Return need Forward?
With DOCSIS deployed in our Networks, the system looks and functions more like a loop!

Changes in the INPUT to the CMTS cause changes to be made to the output levels of the modems.
Divide and Conquer the Return Path!
RF Network

Forward Path

• Output of Node RX to TV, STB, or Modem

Return Path

• Output of Set Top or Modem to Input of Node

Unity Gain

• Forward Path
• Return Path
Coaxial Cable Attenuation

Total loss from node to subscriber:
63.97 dB @ 750 MHz
38.03 dB @ 30 MHz

Drop loss:
8.48 dB @ 750 MHz
1.77 dB @ 30 MHz
Unity gain in the downstream path exists when the amplifier’s station gain equals the loss of the cable and passives before it.

In this example, the gain of each downstream amplifier is 32 dB. The 750 MHz losses preceding each amplifier should be 32 dB as well.

For example, the 22 dB loss between the first and second amplifier is all due to the cable itself, so the second amplifier has a 0 dB input attenuator. Given the +14 dBmV input and +46 dBmV output, you can see the amplifier’s 32 dB station gain equals the loss of the cable preceding it.

The third amplifier (far right) is fed by a span that has 24 dB of loss in the cable and another 2 dB of passive loss in the directional coupler, for a total loss of 26 dB. In order for the total loss to equal the amplifier’s 32 dB of gain, it is necessary to install a 6 dB input attenuator at the third amplifier.

In the downstream plant, the unity gain reference point is the amplifier output.
Reverse Path Unity Gain

- **Why should the inputs to each active be +20 dBmV or +16 or +18??**
  
  **SYSTEM /DESIGN SPECIFIC**
  
  *Does not matter on Manufacturer’s equipment!*

- Unity gain in the upstream path exists when the amplifier’s station gain equals the loss of the cable and passives upstream from that location.

- In this example, the gain of each reverse amplifier is 19.5 dB. The 30 MHz losses following each amplifier should be approximately 19.5 dB as well.

- **In the upstream plant, the unity gain reference point is the amplifier input.**

- **Set by REVERSE SWEEP!**
Telemetry Injection

- Injections levels may vary due to test point insertion loss differences from various types of equipment.
- The PORT Design level is the important Level to remember!
- The Port Design level determines the Modem TX Level

-20 dB Forward Test Point

-30 dB Forward Test Point
Reverse alignment the wrong way

Terminal transmit levels do not set correctly!
Reverse alignment the right way

Reverse levels should be specified at the amplifier port
CATV Return Distribution Network Design

Modem TX Levels

Values shown are at 30 MHz

Feeder cable: 0.500 PIII, 0.4 dB/100 ft
Drop cable: 6-series, 1.22 dB/100 ft

Amplifier upstream input:

+28 dBmV

- The telemetry amplitude is used to establish the modem transmit level.
- The modem transmit levels should be engineered in the RF design.
- There is no CORRECT answer. IT is SYSTEM SPECIFIC.
- Unity gain must be setup from the last amplifier’s return input to the input of the node port. The same level whatever is chosen or designed into the system!
Reverse Path Conditioning
Design Example Using LEQ-RC’s

Reverse Conditioning Example

Reverse Path Conditioning Example

Number of Tap Ports

Tap Port Power Level (dBmV)

W/o Conditioning  W/ Conditioning

Power Level (dBmV)

W/o Conditioning

W/ Conditioning

Power Level (dBmV)

Tap Port Power Level (dBmV)
Practical effects of reverse conditioning:

Forward levels: 51/41 dBmV

Required reverse Level: 16 dBmV

In blue: previous reverse level required

Reverse ‘window’ narrowed from 13.7 to 4.6 dB
## Reverse Window Tap Specs

<table>
<thead>
<tr>
<th>Tap Loss (± 1 dB)</th>
<th>2-Way</th>
<th>4-Way</th>
<th>8-Way</th>
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<tr>
<td>Frequency</td>
<td>26 dB</td>
<td>29 dB</td>
<td>32 dB</td>
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<tr>
<td>5</td>
<td>22.0</td>
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<td>24.9</td>
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<tr>
<td>870</td>
<td>25.7</td>
<td>28.7</td>
<td>31.2</td>
</tr>
<tr>
<td>1000</td>
<td>26.6</td>
<td>30.2</td>
<td>32.1</td>
</tr>
</tbody>
</table>
Where should my X-Level be?

You should determine your X-Level, not your plant or market health!
Must tighten our TX window!

Running with the proper system designed X-Level requires plant maintenance.

Need good quality noise sources to get good MER!

**MER 2 – 3 dB < CNR**

- +52 dBmV
- +46 dBmV
- +40 dBmV

GREEN

YES!
Reverse Sweep

Must use consistent port design levels for the return path.
- Sets Modem TX Levels
- Establishes the X Level for the network!

Telemetry levels may vary due to insertion losses of test points
- May vary from LE to MB to Node! – PORT LEVEL IS THE KEY!
- Think about the input to the Diplex Filter

Must use a good reference
- How often should a reference be taken?
- Does Temperature effect your reference?

Amplifier Return Pad Selection
- Normally 0 dB pad (Unless) there is a optional plug in splitter or Directional Coupler
- Return port pad should match insertion loss of optional plug in device if prior to diplex filter
Internal Splitters

An Internal Splitter after the Diplex Filter affect the forward and return levels!
Internal Splitter Prior to Diplex Filter

An **Internal Splitter** before the **Diplex** Filter affects only the forward levels! The return levels need to be attenuated the same as the forward!
An **Internal Splitter** before the **Diplex** Filter affects only the forward levels! The return levels need to be attenuated the same as the forward!
SO FAR SO GOOD?

ANY QUESTIONS?
Return Path Optical Transport
Return Path Optical Transport

- Begins at the INPUT to the Node
- Ends at the OUTPUT of the return receiver
- Can have the greatest effect on the SNR (MER) of the return path
- Most misunderstood and incorrectly setup portion of the return path
- Must be OPTIMIZED for the current or future channel load.
- Is not part of the unity gain of the return path
- Must be treated separately and specifically.
- Setup Return Laser/Node Specific
- Requires cooperation between Field and Headend Personnel
3 Steps to Setting up the Return Path Optical Transport

Have Vendor Determine the Return Path Transmitter “Setup Window” for each node or return laser type in your system

- Must use same setup for all common nodes/transmitters

Set the input level to the Return Transmitter

- Set levels using telemetry and recommended attenuation to the transmitter
- Understand NPR

Return Receiver Setup – It is an INTEGRAL part of the link!

- Using the injected telemetry signal ensure the return receiver is “optimized”
Setting the Transmitter “Window”

In general, RF input levels into a return laser determine the CNR of the return path.
- Higher input – better CNR
- Lower input – worse CNR

Too much level and the laser ‘clips’.

Too little level and the noise performance is inadequate

Must find a balance, or, “set the window” the return laser must operate in
- Not only with one carrier but all the energy that is in in the return path.
- The return laser does not see only one or two carriers it ‘sees’ the all of the energy (carriers, noise, ingress, etc.) that is sent to it.
What is NPR?

- NPR = Noise Power Ratio
- NPR is a means of easily characterizing an optical link’s linearity and noise contribution
- NPR and CNR are related, but not the same…but close
- NPR is measured by a test setup as demonstrated below.

\[
NPR = 10 \log \left( \frac{P_s(\text{Hz})}{P_n(\text{Hz})} \right)
\]

\( P_s = \text{Signal Power} \)
\( P_n = \text{Noise Power} \)
DFB NPR Curves

Standard DFB TX
Noise Power Ratio (NPR) Performance

NPR (dB)


Input Power per Hz (dBmV/Hz)

Carrier-to-Noise*

Linear Response

Non-Linear Response (Clipping)

38 dB CNR

Total RF Input Power

Room Temp
- 40 F
+ 140 F
S-A FP and DFB NPR Curves

Standard DFB & FP TX
Noise Power Ratio (NPR) Performance
with 7 dB Optical Link

Input Power per Hz (dBmV/Hz)

NPR (dB)

Room Temp Std DFB
Room Temp Std FP
What’s the Big Deal with NPR?
Your Network

Setup based around manufacturer’s specification when installed
What’s the Big Deal with NPR?

- How many channels?
- What Types of Signals?

Why do we change
the number of or
type of signals in
the return path?

- Higher Channel Count yields
  more power into node return path
  transmitters.
- May put transmitters into Clip
  (non-linear condition)

Why do the
number of
channels matter?

- QPSK, 16 QAM, 64 QAM
- Why does my 6.4 MHz wide
carrier look 3 dB lower than my
3.2?
- MER / BER

Why does the
modulation
scheme matter?
Per Carrier Power vs. Composite Power

- Power into Transmitter: 21 dBmV
- Power into Transmitter: 24 dBmV
DFB NPR Curves

- Linear Response
- Non-Linear Response (Clipping)
- Carrier-to-Noise*
- Single Channel
- Two Channels
- 3 dB
- 38 dB CNR

Standard DFB TX
Noise Power Ratio (NPR) Performance

Input Power per Hz (dBmV/Hz)

Input RF Power

Total RF Input Power

3 dB
Per Carrier Power vs. Composite Power

QPSK Carriers

Power into Transmitter: 24 dBmV

21dBmv

QPSK Carriers

Power into Transmitter: 27 dBmV

21dBmv
DFB NPR Curves

![Graph showing DFB NPR Curves with different channels and input powers.]

- **Linear Response**
- **Non-Linear Response (Clipping)**
- **38 dB CNR**

### Key Points:
- **Single Channel**: 3 dB
- **Two Channels**: 6 dB
- **Four Channels**: More than 6 dB

**Legend:***
- Room Temp
- -40 F
- +140 F

- **Carrier-to-Noise**: NPR (Noise Power Ratio)**

**Input Power per Hz (dBmV/Hz)**

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Per Carrier Power vs. Composite Power

As you add more carriers to the return path the composite power to the laser increases.

- By 10 \times \log(\text{number of channels})

To maintain a specific amount of composite power into the transmitter the per-carrier power must be reduced.

- Have we reduced the power of our network signals into our laser?
- How do we do it?

Won’t our modem TX levels change when we lower our input to our laser?

- Depends  
- What about the bandwidth of our carriers?
Per Carrier Power vs. Composite Power

When channel bandwidth is changed, the channel’s power changes.

- The wider the channel the more power it has!
- If a 3.2 MHz-wide signal is changed to 6.4 MHz bandwidth, the channel has 3 dB more power even though the “haystack” appears to be the same height on a spectrum analyzer!

Let’s change our example!

- How will changing the bandwidth of our signals increase power into the return path laser?
Changing Modulation Type – Wider Channel

Note: This example assumes test equipment set to 300 kHz RBW
DFB NPR Curves

Standard DFB TX Noise Power Ratio (NPR) Performance

- Linear Response
- Non-Linear Response (Clipping)
- 38 dB CNR

Carrier-to-Noise*:

- Total RF Input Power
- Two 800 kHz Channels
- Two 3.2 MHz Wide Channels

6 dB

- Room Temp
- -40 F
- +140 F
How do we Fix It?

+40 dBmV to simulate +20 dBmV port design

Node DFB

Return RX

25 dBmV

0 dBmV

25
How do we Fix it?

Carrier-to-Noise*

Standard DFB TX Noise Power Ratio (NPR) Performance

- Linear Response
- Non-Linear Response (Clipping)
- 38 dB CNR

Carrier-to-Noise*
But the Levels Look Different

Modems and EMTAs are constant power devices

Your meter will read digital channels low!
- Apparent amplitude will depend upon the instrument's resolution bandwidth (IF bandwidth).

Must use the Telemetry Signals for the SETUP of a reference of your return path!

This is why we cannot use the eMTA or Modem to establish levels

Telemetry Carrier

3.2 MHz wide Carrier

6.4 MHz wide Carrier

Each carrier has the same amount of energy even though they "look" like they have different levels
Modem Output is Power Limited

Approximate displayed amplitudes on a spectrum analyzer set to 300 kHz RBW
(haystack heights will be 4-5 dB lower if the analyzer's RBW is 100 kHz)
Different Modulation Techniques Require Different SNR (MER)

- Modulation Type Required CNR
  
  Required CNR for various modulation schemes to achieve $1.0 \times 10^{-8}$ (1x10^-8) BER
  
  - BPSK: 12 dB
  - QPSK: 15 dB
  - 16-QAM: 22 dB
  - 64-QAM: 28 dB

- Multiple services on the return path with different types of modulation schemes will require allocation of bandwidth and amplitudes.
  
  Can be engineered.

  Requires differential padding in Headend
BER vs NPR

DFB Tx - 16QAM & 64QAM BER (Pre-FEC)
Full Load = (1) 3.2 MHz 16QAM, (3) 6.4 MHz 64QAM, (1) 6 MHz 64QAM Annex C)
DFB Tx (1310nm 2 dBm), 17 km glass, 7 dB total link loss, thru PII HDRxR
2-26-08

DFB Transmitter Composite Input Level - (dBmV)

NPR (dB)

1.0E-08 1.0E-07 1.0E-06 1.0E-05 1.0E-04 1.0E-03 1.0E-02 1.0E-01

NPR, 5-40 MHz

64QAM, Full Load

16QAM, Full Load
QPSK vs 16 QAM vs 64 QAM vs 256 QAM Constellations
QAM MER / BER

- Data Received Correctly
- Decision Boundary
- Error

MER: 23.6 dB

Estimated BER:
- Pre: 5.6E-5
- Post: 1.4E-7
Why do we have to reset our Return Transmitter Input Levels?

- The laser performance is determined by the composite energy of all the carriers, AND CRAP in the return path.

- What is return path CRAP?

- Can it make a difference in return path performance?

- How does it effect system performance?

- How can you increase your Carrier-to-Crap Ratio (CTC)?
Energy in the Return Path

- What does your return path look like?
- The return laser ‘sees’ all the energy in the return path.

The energy is the sum of all the RF power of the carriers, noise, ingress, etc., in the spectrum from about 1 MHz to 42 MHz.

The more RF power that is put into the laser the closer you are to clipping the laser.

A clean return path gives allows you to operate your system more effectively.

The type of return laser you use has an associated window of operation.
Ingress Changes over Time

Node x Instant
Looks Pretty Good

Node x Overnight
Oh, no!
One Bad TV takes out a Node
AT&T in the Return Path!
Return Laser Performance Summary

What Affects Return Path Laser Performance?
- Number of Carriers
- Carrier Amplitude
- Symbol Rate (Bandwidth)
- Ingress

Will Laser Performance Change over Temperature?

At what temperature should you setup your optical return path transport?

Always follow your manufacture’s setup procedure for the return laser input level!
Setting Return Levels in a Non Segmented Node

Install 0 dB pads at all port return input locations.

Ensure correct PDM is installed for node configuration (4x4).

Ensure that the return TX is plugged into slot 1 in the GS7000 lid.

Measure Optical Output using optical power meter or multi-meter, 1310 or CWDM: +2 Vdc or +3 dBm
Analog ITU: +5 Vdc or +7 dBm.

Install a +20 dB pad on the OIB output to the return transmitter. Refer to above chart for proper input pad.

According to local practice, inject telemetry into forward test point. (Design Input Level +20 for test point insertion loss). Allow Headend personnel to setup input levels to CMTS.

Confirm good optical level and all Headend personnel to setup the return receiver for new laser. DO NOT CHANGE THE TX PAD IN THE OIB FOR THE TX SETUP! The headend must pad the output of the return RX for the new setup.

<table>
<thead>
<tr>
<th>Design Return Input Level</th>
<th>Forward Test Point Insertion Loss</th>
<th>Telemetry Level</th>
<th>Return Transmitter Input pad</th>
<th>Laser Test Point Level (for LED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+16 dBmW</td>
<td>-20 dB</td>
<td>+36 dB mV</td>
<td>8</td>
<td>+7 dB mV</td>
</tr>
<tr>
<td>+17 dBmW</td>
<td>-20 dB</td>
<td>+37 dB mV</td>
<td>9</td>
<td>+7 dB mV</td>
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<td>+19 dBmW</td>
<td>-20 dB</td>
<td>+39 dB mV</td>
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<td>+40 dB mV</td>
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<td>+7 dB mV</td>
</tr>
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<td>-20 dB</td>
<td>+41 dB mV</td>
<td>13</td>
<td>+7 dB mV</td>
</tr>
</tbody>
</table>
Setting Return Levels in a Half Segmented Node

1. Install 0 dB pads at all port return input locations.
2. Ensure correct RCM is installed for node configuration (4x2).
3. Ensure that a return TX is plugged into slots 1 and 3 in the G32000 IDC.
4. Measure Optical Output using optical power meter or multi meter. 
   - 1510 or CWDM +2 Vdc or +3 dBm
   - Analog ITU: +6 Vdc or +7 dBm
5. Install at x dB pad on the OIB input to the return transmitters. Refer to above chart for proper input pad.
6. According to local practice, inject telemetry into forward test point (Design input level +20 for test point insertion loss). Allow Headend personnel to setup input levels to CMTS.
7. Confirm good optical level and all headend personnel to setup the return receiver for new/later.
   DO NOT CHANGE THE TX PAD IN THE OIB FOR THE TX SETUP! The headend must pad the output of the return RX for the new setup.

Input Pad Selection Chart – All Analog Return Transmitters

<table>
<thead>
<tr>
<th>Design Return Input Level (dBm)</th>
<th>Forward Test Point Insertion (dB)</th>
<th>Telmetry Level</th>
<th>Return Transmitter Input Pad</th>
<th>Laser Test Point (dBm)</th>
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<td>13</td>
<td>+7 dBm</td>
</tr>
</tbody>
</table>
Setting Return Levels in a Fully Segmented Node

- Install 0 dB pads at all port return input locations.
- Ensure correct RCM is installed for node configuration (4x4).
- Ensure that a return TX is plugged into slots 1-4 in the G.7000 lid.
- Measure Optical Output using optical power meter or multi-meter, 1310 or CWDM: +2 Vpc or +3 dBm, Analog ITU: +5 Vpc or +7 dBm.
- Install 5x4 dB pad on the OB input to the return transmitters. Refer to above chart for proper input pad.
- According to local practice, inject telemetry into forward test point. (Design Input level +20 for test point insertion loss). Allow Headend personnel to setup input levels to CMTS.
- Confirm good optical level and all headend personnel to setup the return receiver for new laser. DO NOT CHANGE THE TX PAD IN THE OIB FOR THE TX SETUP! The headend must pad the output of the return RX for the new setup!
**Headend Distribution Network**

 Begins at the OUTPUT of the optical return path receiver(s)

 Ends at the Application Devices
   
   CMTS, DNCS, DAC, etc.
Return Path Headend RF Combining

RF Levels Set for Input to CMTS in the RF combining network AFTER the return receiver

Optimize for Performance not Levels
PII HD Dual Return RX

Reverse Data and Video Receivers

[Diagram of optical attenuators, RF amplifiers, test points, and outputs]

Optical Input 1
Variable Attenuator
Optical Input 2
Variable Attenuator
RF Output 1
RF Output 2
Microprocessor
Temperature Sensor
Rx 1 Front Panel Test Point -20 dB
Rx 2 Front Panel Test Point -20 dB
75 Ohm
75 Ohm
Output RF vs Input Light

Typical RF Output vs. Optical Input

Optical Input (dBm) vs. RF Output (dBmV)
Optimal Input Optical Level
Headend Optical Return RX Setup

OPTICAL INPUT POWER
- To much optical power can cause overlaoding (clipping) in the receiver
  - Typical maximum input -3 dBm, minimum input typical -17 dBm
  - Use optical attenuators on extremely short paths or where too much optical power exists into a receiver
- To little optical power can cause CNR problems with that return path, even if the node’s transmitter is optimized.
  - For **BEST RECEIVER PERFORMANCE, DO NOT** optically attenuate optical receivers to the lowest level in the headend (farthest node).
- Find the level with which you get the best noise performance out of the receiver.
  - From experimentation most receiver are at their “sweet spot” from -12 dBm inputs to -6 dBm optical inputs.

RF OUTPUT LEVEL
- RF Level should **NOT** be attenuated using the internal attenuator on analog return receivers
- Attenuates the RF input the output gain blocks of the receiver
- Lowers the CNR
- Levels should be attenuated on the output of the receiver in the RF management
  - In line pads
  - Plug in pads on splitters/combiners
- If combined with other return receiver outputs can create noise issues on more paths
PII HD Dual Return RX

Reverse Data and Video Receivers

Optical Input 1

Variable Attenuator

RF Amp

Rx 1 Front Panel Test Point -20 dB

RF Output 1

Optical Input 2

Variable Attenuator

RF Amp

Rx 2 Front Panel Test Point -20 dB

Temperature Sensor

Microprocessor

75 Ohm

N O

N C

T8048
Cisco HDRx Receiver Pad Use

HDRx RF Output vs. Optical Receive Level

HDRx Output Level (dBmV)

Optical Receive Level (dBm)

Pad Level

HDRx

HDRx High Gain
Return Path Headend RF Combining

The RF pad at the node TX sets the PERFORMANCE!

The RF pads at the HE or Hub set the LEVEL!
Intermediate Hub Setup

- Must optimize each section separately
- Must continue to use telemetry!
THE X LEVEL!
Setting up the Return Path

- Determine your system “X” Level
- Determine the Return Transmitter “Window”
- Padding the Transmitter
- Optimize Return Receiver Setup
- Distribution out of the Return Receiver
- Padding the inputs to the Headend Equipment
Changes to the Return Network

- ANY CHANGES TO THE RETURN PATH FROM THE SUBSCRIBER TO THE HEADEND CAN EFFECT ITS PERFORMANCE

- Planned
  
  Segmentation of Return
  
  Changes in Headend or Node

- Un-Planned
  
  Bad tap
  
  Optoelectronics Failure
  
  Ingress
  
  Technician – Laser RF input level changes in the field
ANY CHANGES TO THE RETURN PATH FROM THE SUBSCRIBER TO THE HEADEND CAN AFFECT ITS PERFORMANCE
ANY CHANGES TO THE RETURN PATH FROM THE SUBSCRIBER TO THE HEADEND CAN AFFECT ITS PERFORMANCE
Return Path
Maintenance and Troubleshooting
Group Delay

- Group delay is defined in units of time, typically nanoseconds (ns).
- In a system, network or component with no group delay, all frequencies are transmitted through the system, network or component with equal time delay.
- Frequency response problems in a CATV network will cause group delay problems.
- If a cable network’s group delay exceeds a certain amount, data transmission and bit error rate may be affected.
- As long as group delay remains below a defined threshold—DOCSIS specifies 200 nanoseconds/MHz in the upstream—group delay-related BER shouldn’t be a problem.
Group Delay

Group Delay:
What we don’t see on our sweep gear

Frequency Response:
What we see on our sweep gear
Group Delay

- Specialized test equipment can be used to characterize upstream in-channel performance.
- In this example, in-channel group delay ripple is about 60 ns.

Courtesy of Sunrise Telecom
Conclusions

- Return system is a loop
- Changes anywhere in the loop can effect the performance of the network
- Once the return laser is setup DON’T TOUCH IT
  - Changing the drive levels can affect the window of operation of the laser
- Work as a team to diagnose system problems
  - LMC
    - Market Health, Scout, Score Card
- Avoid performing node setups during extremes in outdoor temperatures
Questions
Backup Slides
Determining Power Levels

- **Power per Hz:**
  
  \[
  \text{Power per Hz} = \text{total power} - 10 \log(\text{total bandwidth in Hz})
  \]

- **Channel power from power per Hz**
  
  \[
  \text{Channel power} = \text{power per Hz} + 10 \log(\text{channel bandwidth in Hz})
  \]
Power Levels

Example: Calculate the power per Hz for a manufacturer’s +45 dBmV maximum laser input power specification in the 5-40 MHz reverse spectrum (35 MHz bandwidth)

\[
\text{Power per Hz} = \text{Total power} - 10\log(\text{total bandwidth in Hz})
\]

\[
\text{Power per Hz} = +45 \text{ dBmV} - 10\log(35,000,000)
\]

\[
\text{Power per Hz} = -30.44 \text{ dBmV per Hz}
\]

-30.44 dBmV per hertz represents the maximum power into the laser allocated over 35 MHz

Now let’s calculate what a 2 MHz wide QPSK carrier would need to be to equate to that level.
Determining Digital Power Levels

Example: Calculate allocated channel power for a 2 MHz wide QPSK digitally modulated signal carried in the reverse path of the previous example.

\[
\text{Channel power} = \text{power per Hz} + 10\log(\text{channel bandwidth in Hz})
\]

\[
\text{Channel power} = -30.44 + 10\log(2,000,000)
\]

\[
\text{Channel power} = +32.57 \text{ dBmV}
\]