NSG9000-40G™
DEPI Control

Application Note

Rev C

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Documentation Conventions

This manual uses some special symbols and fonts to call your attention to important information. The following symbols appear throughout this manual:

DANGER: The Danger symbol calls your attention to information that, if ignored, can cause physical harm to you.

CAUTION: The Caution symbol calls your attention to information that, if ignored, can adversely affect the performance of your Harmonic product, or that can make a procedure needlessly difficult.

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NOTE: The Note symbol calls your attention to additional information that you will benefit from heeding. It may be used to call attention to an especially important piece of information you need, or it may provide additional information that applies in only some carefully delineated circumstances.

TIP: The Tip symbol calls your attention to parenthetical information that is not necessary for performing a given procedure, but which, if followed, might make the procedure or its subsequent steps easier, smoother, or more efficient.

In addition to these symbols, this manual uses the following text conventions:

- `Data Entry`: indicates text you enter at the keyboard.
- User Interface: indicates a button to click, a menu item to select, or a key or key sequence to press.
- Screen Output: shows console output or other text that is displayed to you on a computer screen.
- **Bold**: indicates the definition of a new term.
- *Italics*: **used for emphasis, cross-references, and hyperlinked cross-references in online documents.**

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Chapter 1
Overview

1.1 DEPI Control Overview

The ever-increasing demand for high speed data-over-cable service (DOCSIS) is driving more and more cable operators to adopt the modular CMTS (M-CMTS) architecture. Equipment vendors have responded to this need by introducing high-capacity modules such as:

- Cisco's 3G60 line card, which plugs into the uBR10K CMTS platform. Each 3G60 card can drive up to 3Gbps worth of data
- Various dense EQAM (edgeQAM) products, including Harmonic's NSG9000-40G. The NSG9000-40G HectoQAM™ is capable of streaming up to 25 Gbps downstream data, with up to 36 QAM channels per service group

Along with the introduction of these new high-capacity products, cable operators are looking for ways to simplify and stream-line the operation of their rapidly growing M-CMTS deployments. To assist with this effort operators are adopting the DEPI-control protocol, which is specified by the DEPI standard.

This protocol allows the CMTS core (Cisco's uBR10K in this case) to control the EQAM downstream. Using the DEPI control protocol, technicians can easily control and configure much of the EQAM functionality directly from the command console of the CMTS core, without having to directly configure the EQAM. In addition, the DEPI control protocol allows operators to realize N+1 redundancy scheme of their 3G60 line-cards, while ensuring seamless inter-operability with the EQAM.

To support this need, Harmonic has implemented the DEPI-Control capability on its NSG9000-40G. NSG9000-40G also supports DEPI Path Redundancy (DPR). DPR allows the CMTS core to establish backup DEPI sessions on a secondary connection. If the primary connection fails, either because of a line card failure or a network problem, CMTS traffic starts flowing through the secondary connection.

This document provides instructions for setting up and configuring the NSG9000-40G to operate in an M-CMTS environment with DEPI-Control.

1.2 About this Document

This document describes the DEPI control feature in a system with the following:

- CMTS Core - Cisco's uBR
- EQAM - NSG 9000-40G

The uBR is the management client and it controls the EQAM device. All resources managed by the uBR should not be configured by the web GUI of the NSG.

1.3 Related Documentation

- DEPI Control specification by Cable Labs at: http://www.cablelabs.com/specifications/CM-SP-DEPI-I08-100611.pdf
- L2TP RFC 3931 at: http://www.ietf.org/rfc/rfc3931.txt

- Cisco guide for configuring DEPI control at: http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/m-cmts_depi_control_plane.pdf

1.4 System Specifications

- Cisco UBR with 3G60 line card that supports DEPI Control, and IOS version SCF3 or higher.
- NSG-9000-40G with SW version 3.3.x.x and up

Chapter 2
DEPI Control Configuration

2.1 Configuring the NSG

To configure the NSG9000-40G to operate in an M-CMTS environment with DEPI-Control, perform the following in the described order:

- Check network connectivity - see *2.1.2 Network Connectivity* on page 6.
- Configure QAM-RF parameters - see *2.1.3 QAM-RF Configuration* on page 7.
- Enable DEPI control - see *2.1.4 Enabling DEPI Control* on page 9.
- Configure the EQAM via the CMTS Core - see *2.2 Configuring the NSG Via the CMTS Core (uBR)* on page 12.

NOTE: To change the configuration of the above parameters, disable DEPI Control as explained in *2.1.5 Disabling DEPI Control* on page 12.

2.1.1 Network Connectivity

Verify network connectivity between the designated uBR GbE port and the NSG GbE port.

If the uBR and the NSG are directly connected, add a routing path as explained below.

NOTE: Typically, in case of direct connection use the 1GbE port.

⇨ To ensure Network Connectivity

1. Connect the NSG GbE port to the uBR GbE port.
2. Verify that both the NSG and the uBR are on the same subnet.
3. Create for the NSG a route through a GbE port to the uBR GbE port:
   a. Open a Web browser.
   b. Enter the IP address of the device.
   c. Enter the user name and password. See NSG9000-40G Software Guide.
   d. Select **Platform** > **General** tab.
   e. In **Back Panel View**, select the required GbE port.
   f. Select **Routing Table**.

   g. Click **Add Route** to add a blank row to the table.

h. Enter the required values as explained below:

- Destination - Enter the IP address of the destination device or network.
- Mask - Specify the subnet mask. The combination of mask and destination IP will determine the exact range of IP destinations that may be accessed through this route.
- Gateway - Enter the IP address of the gateway through which the NSG will attempt to make a connection to a destination. For each GbE port the gateway must be in the same NSG subnet.

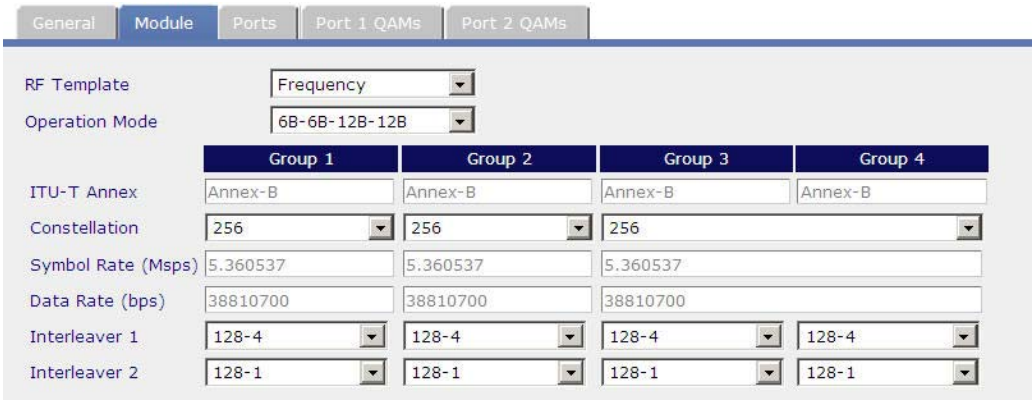
2.1.2 QAM-RF Configuration

To configure QAM-RFs, define the following parameters. You cannot change the configuration of these parameters once DEPI control is activated.

- Operation Mode - configured per QAM-RF module. This configuration defines the required ITU-T Annex, whether Annex A or B. See *2.1.3.1 Configuring Operation Mode* on page 7.
- Number of QAMs per port - see *2.1.3.2 Configuring Number of QAMs per Port* on page 7.
- RF port frequency range - see *2.1.3.3 Configuring RF Port Frequency Range* on page 8.
- TS ID - applies to NSG9000-40G version 3.4 and higher. See *2.1.3.4 Configuring TS ID* on page 9.

2.1.2.1 Configuring Operation Mode

1. Open a Web browser.
2. Enter the IP address of the NSG 9000 device.
3. In the **Back Panel View**, select the required module.
4. Select the **Module** tab.

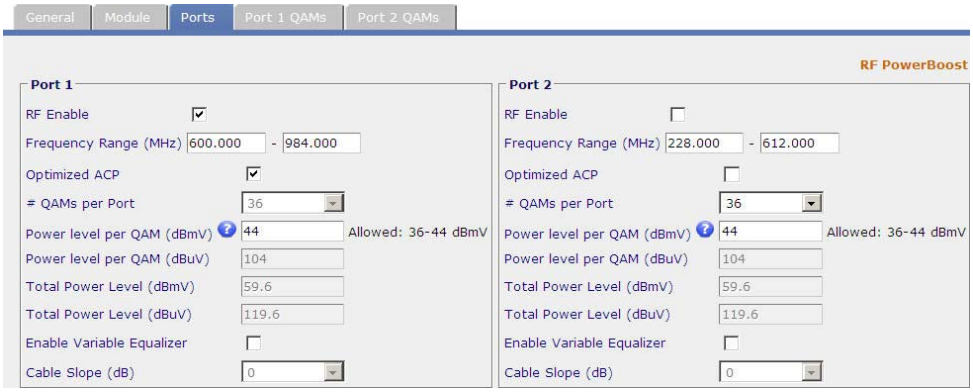


5. Open the **Operation Mode** list and select one of the following:
   - 6B-6B-12B-12B - for Annex B
   - 4A-4A-9A-9A - for Annex A

2.1.2.2 Configuring Number of QAMs per Port

1. Open a Web browser.
2. Enter the IP address of the NSG 9000 device.
3. In the **Back Panel View**, select the required module.

4. Select the **Port** tab.



5. Open the **# QAMs per Port** list and select the required number of QAMs:
   - For Annex A - a number between 1 to 26
   - For Annex B - a number between 1 to 36

2.1.2.3 Configuring RF Port Frequency Range

Each RF Port spans across 384MHz transmission frequency of the 1GHz spectrum (to be accurate 50MHZ-1GHz).

You can locate along the spectrum, for each RF port, its Span window = 384MHz divided into steps of 6MHz for Annex B, or 8MHz for Annex A. You can set the Span window with accuracy of up to 1Khz along the 1GHz spectrum. For example 228.001 - 612.001.

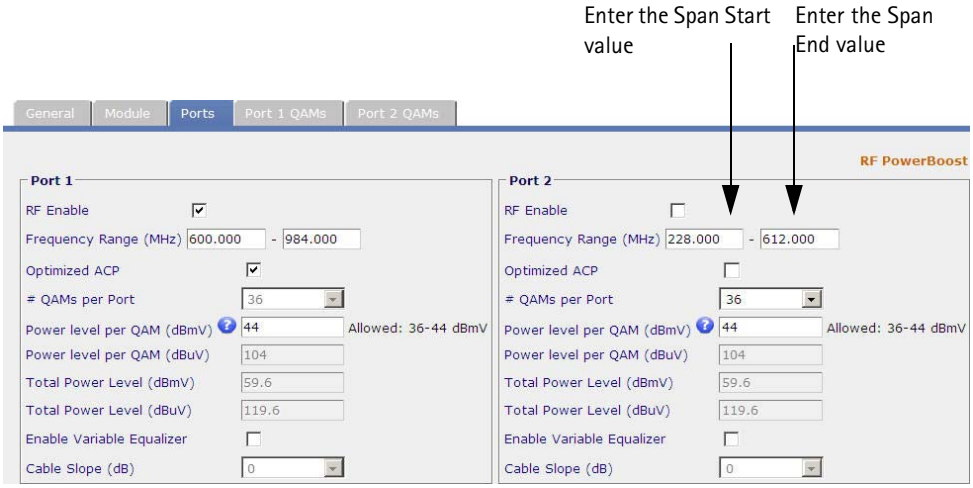
When Span window moves, all the allocated QAMs move accordingly. So if e.g. the window moves by +1Mhz, all allocated QAMs shift by +1Mhz.

NOTE: In case any of the QAMs is in DEPI control, you cannot change the span window.

⇨ To configure the RF frequency span

1. Open a Web browser.
2. Enter the IP address of the NSG 9000 device.
3. In the **Back Panel View**, select the required module.

4. Select the Port tab.

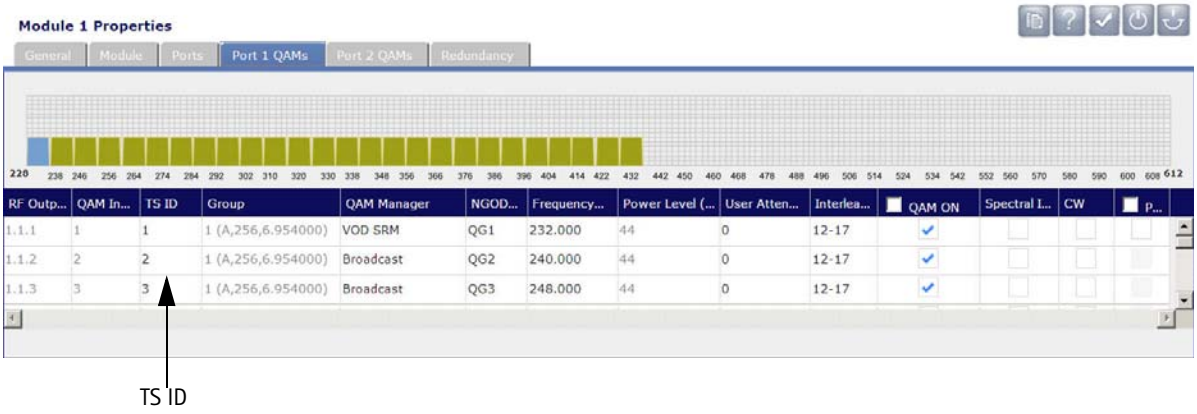


5. In Frequency Range (MHz), enter the required value to start and end the range. You can enter either start or end value and the corresponding value is automatically computed by the device.
6. Click Apply.

2.1.2.4 Configuring TS ID

NOTE: Applies to NSG9000-40G version 3.4 and higher.

1. Open a Web browser.
2. Enter the IP address of the NSG9000 device.
3. In the Back Panel View, select the required slot/module.
4. Select the Port # QAMs tab.



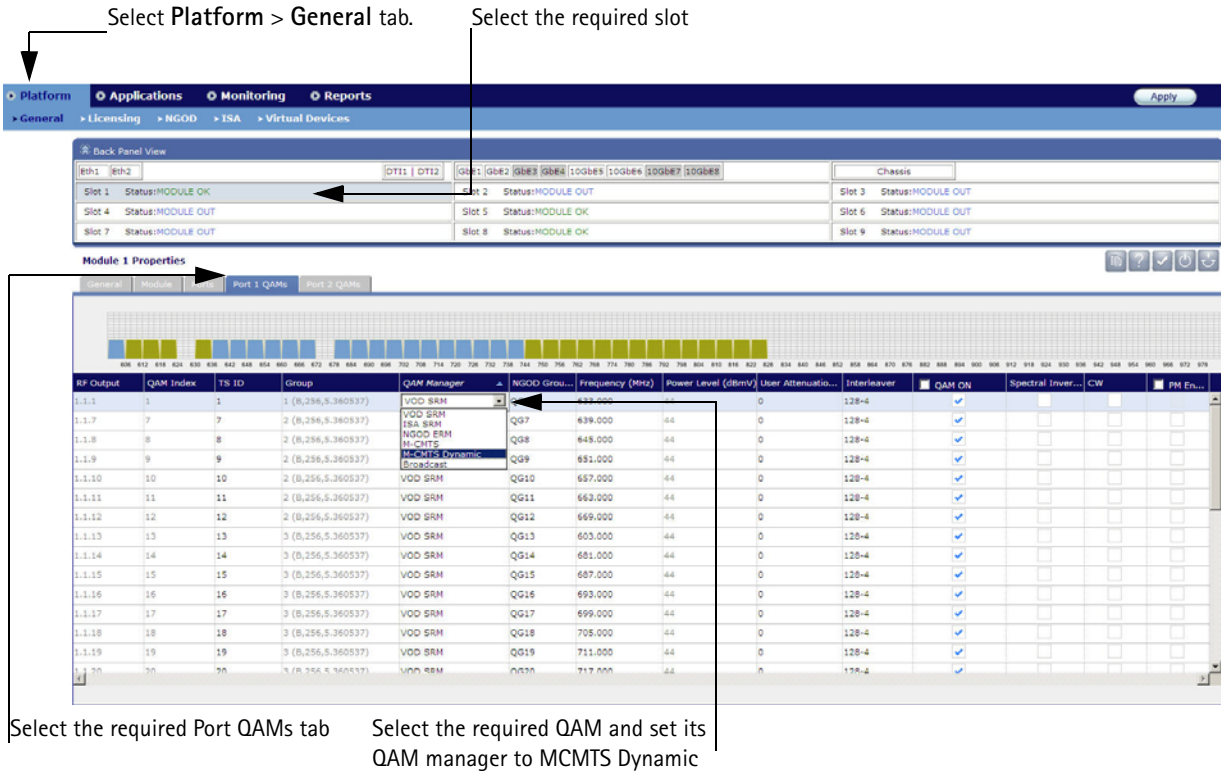
5. Under TS ID, enter the required TS ID for the QAM.

2.1.3 Enabling DEPI Control

- Select and configure QAMs for DEPI control
- Enable the RF port

2.1.3.1 Select QAMs for DEPI Control

1. Open a Web browser.
2. Enter the IP address of the device.
3. Enter the user name and password. See *NSG9000-40G Software Guide*.
4. Select **Platform** > **General** tab.



5. In **Back Panel View**, select the slot.
6. Select the required **Port 1/2 QAMs** tab.
7. Select the required QAM to be managed by the uBR.
8. Under QAM Manager, open the list and select M-CMTS Dynamic. QAM manager of all QAMs in the group in both RF ports, changes to M-CMTS Dynamic. If the QAM belongs to group 3 or 4, the QAM manager of both groups on both RF ports changes to M-CMTS Dynamic.
9. Click **Apply**.
   The following takes place:

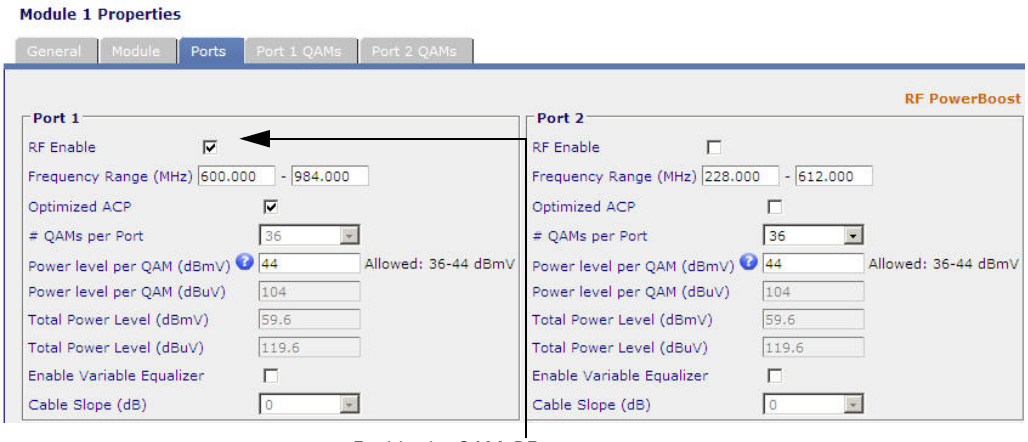
- All QAMs with QAM manager *M-CMTS Dynamic* are muted until the uBR enables them.
- Applies to NSG9000-40G version 3.3.x.x and lower. TS ID is set the QAM index.
- Interleaver 2 assumes the value of interleaver 1
- Constellation, the type of RF modulation, is set to 256, unless it is set to 64. In case it is set to 64, do not change it.
- Symbol rate:
  - Annex A is set to 6.9520
  - Annex B:

If constellation is set to 256, symbol rate should be 5.360537
If constellation is set to 64, symbol rate should be 5.056941

- RF Port Optimized ACP is disabled, and is read only.
- The following listed parameters are blocked when working in DEPI Control mode:
  - QAM parameters: Frequency, QAM mute, TSID, CW - set to Off.
  - Port: RF Power, Number of QAMs, RF range, ACP enable - set to disable.
  - QAM Group: Group Mode, Constellation, Symbol rate, Interleaver
  - Global RF scheme

2.1.3.2 Enabling RF Port(s)

1. In the web client of the NSG device, select the **Ports** tab. To access the **Ports** tab, follow steps 1 to 5 in *2.1.4.1 Select QAMs for DEPI Control* on page 10.



Enable the QAM-RF port

2. Select **RF Enable** to enable the RF port.

NOTE: If the RF port is disabled, or if the QAM-RF is missing and the uBR initiates DEPI control sessions for the disabled RF port or the missing QAM-RF module, the NSG rejects the sessions.

3. Click **Apply**.

2.1.4 Disabling DEPI Control

When you disable DEPI control for QAMs, the QAMs are controlled by the web client of the NSG 9000-40G device.

NOTE: Disabling DEPI control is service affecting for the QAMs that are removed from DEPI control.

1. Via the uBR, close all DEPI sessions.
2. Access the NSG 9000 Web client.
3. In the NSG 9000 Web client, in **Back Panel View**, select the required module.
4. Select the required **Port # QAMs** tab.
5. Select a QAM in the required QAM Group, and set its QAM manager to the desired value, such as VOD or ISA.
   The change applies to all QAMs in the QAM Group in both RF ports. For groups 3 or 4, the QAMs of both groups in both ports are changed to the new QAM manager.

6. Click **Apply**.
   NSG rejects uBR requests to setup DEPI sessions on these QAMs.

2.2 Configuring the NSG Via the CMTS Core (uBR)

2.2.1 General Guidelines

- When creating the configuration data of the EQAM on the uBR, the configuration data should comply to the EQAM capabilities and configuration logic.
  For example: If you configure the RF power level of QAM 1 to 51dBmV and you set the power level of QAM 2 to 52dBmV, the EQAM sets the power level of the port according to the last entered value.
- If the uBR requests to configure a parameter with an incorrect value, or to configure a value which conflicts with other sessions, the DEPI session is rejected.
- Troubleshooting - If DEPI sessions were not set up, you can view DEPI debug messages in a syslog server. Configure the syslog server IP address by selecting **Chassis** > **SNMP & Syslog** tab. In **Syslog Server IP Address**, enter the required IP address.

2.2.2 TS ID

Applies to NSG9000-40G version 3.3.x.x and lower.

The TS ID you configure on the CMTS core, is identical to the QAM index on the EQAM. For example, TS ID 109 is actually QAM index 109 on the EQAM.

2.2.3 RF Frequency Guidelines

Define the frequency range of the RF port via the EQAM Web client prior to creating the DEPI sessions. See *2.1.3.3 Configuring RF Port Frequency Range* on page 8.

To configure the QAM-RF frequency, refer to the following guidelines:

Once you defined the Span window, locate the available QAM channels along this span window while each QAM channel utilizes six MHz in Annex B. For example, if the Span Window = 384 MHz and Span Start = 228 MHz, you can configure QAM channels with any frequency between 228Mhz - 612 MHz. However, the frequency of the QAM channels is defined according to the center frequency. In this case, the first QAM channel valid frequency is 231MHz in steps of 6MHz. For example:
231, 237, 243…
You can locate the QAMs any where along the Span window. For example, QAM #4 can be located at 255MHz.
For Annex B, QAM frequency is calculated according to the following formula:

$f_{QAM} = SpanStart + 3MHz + n*6MHz < SpanEnd$
$n=\{0.....63\}$

For Annex A, QAM frequency is calculated according to the following formula:

$f_{QAM} = SpanStart + 4MHz + n*8MHz < SpanEnd$
$n=\{0.....47\}$

2.2.4 RF Power Guidelines

RF power level is the same for all sessions in a port. If you change the power level of the RF port via the uBR, it affects all the QAMs of the RF port including QAMs with QAM manager other than M-CMTS.

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Table 2-1: Power Level Per QAM Ranges

Number of QAMs per Port	Min. Power Level per QAM	Max. Power Level per QAM
1	44	52
2	44	52
3	44	52
4	44	52
5	44	52
6	44	52
7	44	52
8	44	52
9	43	51
10	43	51
11	42	50
12	42	50
13	41	49
14	41	49
15	40	48
16	40	48
17	40	48
18	39	47
19	39	47
20	39	47
21	39	47
22	38	46
23	38	46
24	38	46
25	38	46
26	38	46
27	37	45
28	37	45
29	37	45

Table 2-1: Power Level Per QAM Ranges

Number of QAMs per Port	Min. Power Level per QAM	Max. Power Level per QAM
30	37	45
31	37	45
32	37	45
33	36	44
34	36	44
35	36	44
36	36	44

2.2.5 RF modulation and Symbol Rate Guidelines

- RF modulation is the same for all sessions in an RF group.
- In Annex B, groups 3 and 4 share the same modulation.

2.2.6 Interleaver Depth Guidelines

Interleaver Depth is the same for all sessions in an RF group.

2.2.7 ITU-T Annex Guidelines

You can configure the ITU-T Annex only via the EQAM Web client. The configuration is per RF module. See *2.1.3.1 Configuring Operation Mode* on page 7.

2.3 Viewing DEPI Control Sessions

Once DEPI control is enabled, you can setup on the CMTS core DEPI sessions. You can view a list of the configured DEPI sessions via either of the following:

- CMTS core by using Cisco CLI
- NSG web client - select **Application** > **M-CMTS** > **Session** tab. In the Session tab, the Type column the following may appear:
  - Static - a static M-CMTS session.
  - Dynamic - DEPI control M-CMTS session with no DPR support.
  - Dynamic (P) - DEPI control M-CMTS session. This session is the Primary DPR session.
  - Dynamic (S) - DEPI control M-CMTS session. This session is a Secondary DPR session.

2.4 Configuring Cisco's uBR

NOTE: The following section provides an example of how to configure Cisco's uBR while working with Harmonic's EQAM. For authorized and comprehensive instructions, refer to the uBR documentation provided by Cisco.

2.4.1 Example of a DEPI Tunnel

The following example shows global configuration which applies to several DEPI sessions:

```
l2tp-class LC1
 retransmit retries 5
 retransmit timeout max 2
!
depi-class DC1
 mode mpt
!
depi-tunnel nsg1
 dest-ip 10.30.4.103
 l2tp-class LC1
 depi-class DC1
!
```

2.4.2 Example of a DEPI Session

The following example shows configuration for a single DEPI session. If some parameters are incorrect, or conflict with other sessions, the session is rejected.

```
controller Modular-Cable 6/0/0
 rf-channel 0 cable downstream channel-id 1
 rf-channel 0 frequency 447000000 annex A modulation 64qam
 rf-channel 0 depi-tunnel nsg1 tsid 17
 rf-channel 0 rf-power 52.0
 no rf-channel 0 rf-shutdown
!
```

2.4.3 Useful UBR Commands

The following commands monitor the DEPI Control support:

uBR commands, such as:

`"show depi sessions"` - especially "show depi session NNN verbose"

`"show depi sessions configured"`

`"show cable modem"`

uBR debug messages, such as:

`"debug depi"` - events and errors

`"debug l2tp"` - especially "debug l2tp packets brief"

`"show logging"`

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