Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.1 Configuration Guide for Cisco IOS XE Fuji 16.7.x

First Published: 2017-11-20

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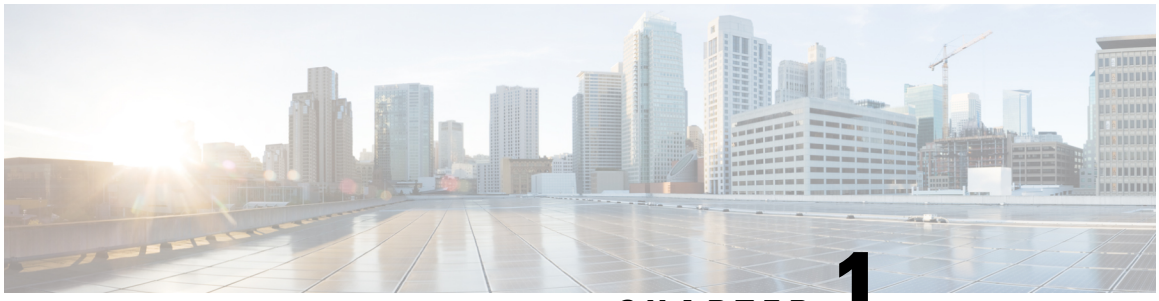

CHAPTER 1

DOCSIS 3.1 OFDM Channel Configuration

This document describes how to configure the OFDM channel on the Cisco cBR Series Converged Broadband Router.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 1
- Information about OFDM Channel Configuration, on page 2
- How to Configure OFDM Channel, on page 3
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Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 1: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about OFDM Channel Configuration

OFDM Channels

DOCSIS 3.1 introduces modes for higher throughput and higher spectral efficiency while still allowing backward compatibility to DOCSIS 3.0. OFDM Channel support includes one OFDM channel per port with channel bandwidth from 24 MHz to 192 MHz wide.

Each OFDM channel supports a control profile, an NCP profile, and up to five data profiles. Profiles support one or more modulations.

Starting from Cisco IOS-XE release 3.18.1SP, you can configure the guard band of an OFDM channel to potentially trade off some performance margin using command **guardband-override**. By default, Cisco cBR-8 router use the default guard band, which is based on the roll off and spacing in OFDM channel profile.

DOCSIS 3.1 OFDM support also allows the user to configure the RF-channels 158 to 162 under the mac-domain as primary channel.

Note OFDM channel can only be used as secondary channel as part of a Wideband group. Primary channel needs to be configured as normal DOCSIS 3.0 primary RF channel.

Channel Profile

A globally configured OFDM channel profile contains channel parameters, and the modulation or modulation profile associated with the control, NCP, and data profiles.

Each OFDM channel must specify an OFDM channel profile in its configuration.

Modulation Profile

A globally configured OFDM modulation profile assigns different modulations to ranges of sub-carriers, or lists of individual sub-carriers.

A modulation profile may be assigned to a control, NCP, or data profile in a channel profile.

OFDM Channel Exclusion Band

Ranges of frequencies can be excluded from all OFDM channels on a port using the **ofdm-freq-excl-band** command.

How to Configure OFDM Channel

Configuring OFDM Modulation Profile

To configure the OFDM modulation profile, follow the steps below:

```
enable
configure terminal
cable downstream ofdm-modulation-profile id
description text
subcarrier-spacing value
width value
start-frequency value
assign {modulation-default mod_prof_id | modulation mod_prof_id {list-subcarriers
 {freq-abs | freq-offset} value | range-subcarriers {freq-abs | freq-offset}
 value width value}}
```

Note Subcarrier spacing must match the subcarrier spacing of each channel profile in which it is configured.

Verifying OFDM Modulation Profile Configuration

To display the OFDM modulation profile details, use the **show cable ofdm-modulation-profiles** command as shown in the example below:

```
Router# show cable ofdm-modulation-profile 10

**** OFDM Modulation Profile Configuration ****

Prof  FFT  Width     Start-freq Modulations
ID    KHz  Hz        Hz
10    50   96000000  627000000  64   default
                                512  freq-abs  709050000 width   12000000
                                2048 freq-abs  629000000 width    6000000

Profile Subcarrier Modulations
  Modulation: Start-freq-abs[start-sc] - End-freq-abs[end-sc] Width-freq[num-sc]
  64  : 572600000[   0] -  626950000[1087]    54400000[1088]
  64  : 627000000[1088] -  628950000[1127]     2000000[  40]
  2048: 629000000[1128] -  634950000[1247]     6000000[ 120]
  64  : 635000000[1248] -  709000000[2728]    74050000[1481]
  512 : 709050000[2729] -  721000000[2968]    12000000[ 240]
  64  : 721050000[2969] -  722950000[3007]     1950000[  39]
  64  : 723000000[3008] -  777350000[4095]    54400000[1088]

**** OFDM Modulation Profile Assigned Channel Profiles ****

Prof  Channel
ID    Profiles
10    30
```

To display the associations between OFDM modulation profiles and OFDM channel profiles, use the **show cable ofdm-modulation-profile** command with **channel-profiles** option as shown in the example below:

```
Router# show cable ofdm-modulation-profile channel-profiles

**** OFDM Modulation Profile Assigned Channel Profiles ****

Prof  Channel
ID    Profiles
8     None
9     28
10    30
192   192
```

To display the OFDM modulation profile configurations, use the **show cable ofdm-modulation-profile** command with **configuration** option as shown in the example below:

```
Router# show cable ofdm-modulation-profile configuration

**** OFDM Modulation Profile Configuration ****

Prof  FFT  Width     Start-freq Modulations              Description
ID    KHz  Hz        Hz                                  (Limited to 20)
8     50   192000000 NA         2048 default
                                512  freq-off   48000000
                                     width      24000000
9     50   96000000  627000000  512  default             512-1k-4k
                                1024 freq-abs  635000000
                                     width      74050000
                                4096 freq-abs  629000000
                                     width       6000000
```

```
10    50   96000000  627000000  64   default
                                512  freq-abs  709050000
                                     width      12000000
                                2048 freq-abs  629000000
                                     width       6000000
```

Configuring OFDM Channel Profile

To configure the OFDM channel profile, follow the steps below:

```
enable
configure terminal
cable downstream ofdm-chan-profile id
description text
cyclic-prefix value
guardband-override value
interleaver-depth value
pilot-scaling value
roll-off value
subcarrier-spacing value
profile-ncp modulation-default mod_prof_id
profile-control {modulation-default mod_prof_id | modulation-profile mod_prof_id}
profile-data channel_data_prof_id {modulation-default mod_prof_id |
modulation-profile mod_prof_id}
```

Verifying OFDM Channel Profile Configuration

To display the OFDM channel profile details, use the **show cable ofdm-chan-profiles** command as shown in the example below:

```
Router# show cable ofdm-chan-profile 21
**** OFDM Channel Profile Configuration ****

Prof  Cycl  Roll  Guardband  FFT  Intr   Pilot  Modulation (D-Default, P-Profile)

ID    Prfx  Off   Override   KHz  Depth  Scale  Cntrl   NCP     Data Profiles (count = 0)
                                                             1       2       3       4
      5
21    1024  128   2400000    50   16     48     D:1024  D:16    NA      NA      NA      NA
      NA

**** OFDM Channel Profile Assigned Channels ****

Prof  Admin  Controller:channels
ID
21    Up     6/0/4:158
```

To display the associations between OFDM channel profiles and OFDM channels, use the **show cable ofdm-chan-profiles** command with **channels** option as shown in the example below:

```
Router# show cable ofdm-chan-profile channels

**** OFDM Channel Profile Assigned Channels ****

Prof  Admin  Controller:channels
ID
```

```
20    Up     3/0/1:158             3/0/2:158             3/0/3:158             3/0/5:158

             3/0/6:158             3/0/7:158
30    Up     3/0/4:158
101   Up     3/0/0:158
```

To display the OFDM channel profile configurations, use the **show cable ofdm-chan-profiles** command with **configuration** option as shown in the example below:

```
Router# show cable ofdm-chan-profile configuration

**** OFDM Channel Profile Configuration ****

Prof  Cycl  Roll  Guardband  FFT  Intr   Pilot  Modulation (D-Default, P-Profile)

ID    Prfx  Off   Override   KHz  Depth  Scale  Cntrl   NCP     Data Profiles
             (Limited to 20)
                                                              1       2       3       4
      5
0     1024  128   NA         50   16     48     D:256   D:16    D:1024  NA      NA      NA
      NA
1     1024  128   NA         50   16     48     D:256   D:16    D:2048  D:1024  NA      NA
      NA
2     1024  128   NA         50   16     48     D:256   D:16    D:4096  D:2048  D:1024  NA
      NA
3     1024  128   NA         50   16     48     D:256   D:16    P:0     D:4096  D:2048
D:1024  NA
4     1024  128   NA         50   16     48     D:256   D:16    D:512   P:0     D:4096
D:2048  D:1024
5     1024  128   NA         25   16     48     D:256   D:16    D:1024  NA      NA      NA
      NA
6     1024  128   NA         25   16     48     D:256   D:16    D:2048  D:1024  NA      NA
      NA
7     1024  128   NA         25   16     48     D:256   D:16    D:4096  D:2048  D:1024  NA
      NA
8     1024  128   NA         25   16     48     D:256   D:16    P:1     D:4096  D:2048
D:1024  NA
9     1024  128   NA         25   16     48     D:256   D:16    D:512   P:1     D:4096
D:2048  D:1024
20    1024  128   NA         50   16     48     D:1024  D:16    NA      NA      NA      NA
      NA
21    1024  128   1000000    50   16     48     D:1024  D:16    NA      NA      NA      NA
      NA
```

Configuring OFDM Channel as Primary Channel

To configure an RF-channel in the mac-domain as an OFDM primary channel, use the following commands.

```
enable
configure terminal
interface cable <slot/subslot/port> downstream Integrated-Cable <slot/subslot/port>
rf-channel <ofdm-channel-number: 158-162>
end
```

Verifying OFDM Primary Channel Configuration

To display the OFDM channel configuration details, where the OFDM channel is the primary channel, use the command as shown in the following example:

```
Router#sh run int c3/0/3
Building configuration...

Current configuration : 539 bytes
!
interface Cable3/0/3
 load-interval 30
 downstream Integrated-Cable 3/0/3 rf-channel 0
 downstream Integrated-Cable 3/0/3 rf-channel 158
 upstream 0 Upstream-Cable 3/0/6 us-channel 0
 upstream 1 Upstream-Cable 3/0/6 us-channel 1
 upstream 2 Upstream-Cable 3/0/6 us-channel 2
 upstream 3 Upstream-Cable 3/0/6 us-channel 3
 cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes 80000000
 cable bundle 1
 cable cm-status enable 3 6-11 16-18 20-27
 cable privacy accept-self-signed-certificate
end
```

You can also use the following command to display the OFDM primary channel configuration details as shown in this example.

```
Router#sh cable mac-domain c3/0/3 cgd-associations
CGD Host  Resource  DS Channels            Upstreams    (ALLUS)   Active DS
Ca3/0/3   3/0/3     0                      0-3          Yes        0
                    158                    0-3          Yes        158
```

The **show cable mac-domain Cable <slot>/<subslot>/<port> mdd** command also displays the OFDM primary channel configuration details as shown in the example.

```
...
Downstream Active Channel List
        Channel ID:             159
        Frequency:              836000000Hz
        Primary Capable:        Primary-Capable
        CM-STATUS Event Bitmask:0x36
                                MDD Timeout
                                QAM FEC failure
                                MDD Recovery
                                QAM FEC recovery
        MAP/UCD Transport Indicator:  Can carry MAPs and UCDs
        OFDM PLC Params Bitmask:
               Tukey raised cosine window: 0.625
               Cyclic Prefix: 5.0
               Sub carrier spacing: 50
```

RF channels use a zero-based numbering scheme, whereas the downstream channel IDs are numbered starting from one. Thus RF channel 158 is equivalent to channel ID 159. The Channel ID in this example is 159. The `MAP/UCD Transport Indicator` shows that MAPs and UCDs are sent only on Primary Channels.

Configuring Port/Controller and Channel

To configure the port/controller and channel, follow the steps below:

```
enable
configure terminal
controller integrated-cable slot/subslot/port
```

```
max-ofdm-spectrum value
ofdm-freq-excl-band start-frequency value width value
rf-chan start_id [end_id]
ofdm channel-profile id start-frequency value width value [plc value]
```

Note The range of *start_id* is 158 to 162 in the OFDM channel configuration.

The maximum OFDM spectrum is assigned to OFDM channels, which is used by the the CMTS to calculate default port base power.

Ranges of frequencies can be excluded from all OFDM channels using the **ofdm-freq-excl-band** command.

Verifying Port/Controller and Channel Configuration

To display the RF port details, use the **show controller integrated-cable** command with **rf-port** option as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-port

Admin:  UP  MaxCarrier: 128  BasePower: 33 dBmV  Mode: normal
  Rf Module 0: UP
  Free freq block list has 3 blocks:
    45000000  - 107999999
    624000000 - 644999999
    837000000 - 1217999999
  Rf Port Status: UP
  MaxOfdmSpectrum:  192000000   Equivalent 6MHz channels: 32
  UsedOfdmSpectrum: 192000000   AvailOfdmSpectrum:        0
  DefaultBasePower: 33 dBmV     Equivalent 6MHz channels: 160
  OFDM frequency exclusion bands: None
```

To display the summary information on OFDM channel, use the **show controller integrated-cable** command with **rf-channel** option as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-channel 158

Chan State Admin Mod-Type  Start       Width     PLC        Profile-ID    dcid  power
output
                           Frequency
 158   UP   UP   OFDM      627000000   96000000  663000000       20       159   34
NORMAL
```

To display detailed information on OFDM channel, use the **show controller integrated-cable** command with **rf-channel** and **verbose** options as shown in the example below:

```
Router# show controller integrated-cable 3/0/0 rf-channel 158 verbose

Chan State Admin Mod-Type  Start       Width     PLC        Profile-ID    dcid  power
output
                           Frequency
 158   UP   UP   OFDM      627000000   96000000  663000000       30       159   32
NORMAL
 Resource status:   OK
 License: granted <17:02:35 EDT May 18 2016>
 OFDM channel license spectrum width: 92200000
 OFDM modulation license (spectrum width): 2K (6000000)
 OFDM config state: Configured
```

```
 OFDM channel details: [3/0/4:158]
-----------------------------------------
 OFDM channel frequency/subcarrier range     : 627000000[1088] - 722999999[3007]
 OFDM spectrum frequency/subcarrier range    : 572600000[   0] - 777399999[4095]
 Active spectrum frequency/subcarrier range  : 628900000[1126] - 721049999[2969]
 OFDM channel center frequency/subcarrier    : 675000000[2048]
 PLC spectrum start frequency/subcarrier     : 663000000[1808]
 PLC frequency/subcarrier                    : 665800000[1864]
 Channel width                               : 96000000
 Active Channel width                        : 92200000
 OFDM Spectrum width                         : 204800000
 Chan prof id                                : 30
 Cyclic Prefix                               : 1024
 Roll off                                    : 128
 Interleave depth                            : 16
 Spacing                                     : 50KHZ
 Pilot Scaling                               : 48
 Control modulation profile                  : 10
 NCP modulation default                      : 16
 Data modulation default                     : None
 Data modulation profile                     : None
 Lower guardband width in freq/subcarriers   : 1900000[38]
 Upper guardband width in freq/subcarriers   : 1900000[38]
 Licensed 4K modulation spectrum width       : 0
 Licensed 2K modulation spectrum width       : 6000000

 PLC spectrum frequencies [subcarriers]             :
  663000000[1808] - 668999999[1927]

 PLC channel frequencies [subcarriers]               :
  665800000[1864] - 666199999[1871]   Size: 8 subcarriers

 Excluded frequencies [subcarriers]                :
  572600000[   0] - 628899999[1125]     721100000[2970] - 777399999[4095]
  Count: 2252

 Pilot frequencies [subcarriers]                   :
  *:PLC pilots
  630700000[1162]   634300000[1234]   637900000[1306]   641500000[1378]
  645100000[1450]   648700000[1522]   652300000[1594]   655900000[1666]
  659500000[1738]   663450000[1817]*  664050000[1829]*  664600000[1840]*
  665050000[1849]*  666900000[1886]*  667350000[1895]*  667900000[1906]*
  668500000[1918]*  669100000[1930]   672700000[2002]   676300000[2074]
  679900000[2146]   683500000[2218]   687100000[2290]   690700000[2362]
  694300000[2434]   697900000[2506]   701500000[2578]   705100000[2650]
  708700000[2722]   712300000[2794]   715900000[2866]   719500000[2938]
  Count: 32

 Active frequencies [subcarriers]                  :
  628900000[1126] - 721099999[2969]
  Count: 1844

 Data frequencies [subcarriers]                   :
  628900000[1126] - 630699999[1161]     630750000[1163] - 634299999[1233]
  634350000[1235] - 637899999[1305]     637950000[1307] - 641499999[1377]
  641550000[1379] - 645099999[1449]     645150000[1451] - 648699999[1521]
  648750000[1523] - 652299999[1593]     652350000[1595] - 655899999[1665]
  655950000[1667] - 659499999[1737]     659550000[1739] - 663449999[1816]
  663500000[1818] - 664049999[1828]     664100000[1830] - 664599999[1839]
  664650000[1841] - 665049999[1848]     665100000[1850] - 665799999[1863]
  666200000[1872] - 666899999[1885]     666950000[1887] - 667349999[1894]
  667400000[1896] - 667899999[1905]     667950000[1907] - 668499999[1917]
  668550000[1919] - 669099999[1929]     669150000[1931] - 672699999[2001]
```

```
 672750000[2003] - 676299999[2073]     676350000[2075] - 679899999[2145]
 679950000[2147] - 683499999[2217]     683550000[2219] - 687099999[2289]
 687150000[2291] - 690699999[2361]     690750000[2363] - 694299999[2433]
 694350000[2435] - 697899999[2505]     697950000[2507] - 701499999[2577]
 701550000[2579] - 705099999[2649]     705150000[2651] - 708699999[2721]
 708750000[2723] - 712299999[2793]     712350000[2795] - 715899999[2865]
 715950000[2867] - 719499999[2937]     719550000[2939] - 721099999[2969]
 Count: 1804

Profiles:
 Number of profiles: 2
 CTRL profile (Profile A): rate: 461916 kbps, usable rate: 368000 kbps
 Active frequencies [subcarriers]:
 Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
 ------------------------------------------------------------------
 64   :628900000[1126] - 628950000[1127]     2048 :629000000[1128] - 630650000[1161]
 2048 :630750000[1163] - 634250000[1233]     2048 :634350000[1235] - 634950000[1247]
 64   :635000000[1248] - 637850000[1305]     64   :637950000[1307] - 641450000[1377]
 64   :641550000[1379] - 645050000[1449]     64   :645150000[1451] - 648650000[1521]
 64   :648750000[1523] - 652250000[1593]     64   :652350000[1595] - 655850000[1665]
 64   :655950000[1667] - 659450000[1737]     64   :659550000[1739] - 663400000[1816]
 64   :663500000[1818] - 664000000[1828]     64   :664100000[1830] - 664550000[1839]
 64   :664650000[1841] - 665000000[1848]     64   :665100000[1850] - 665750000[1863]
 64   :666200000[1872] - 666850000[1885]     64   :666950000[1887] - 667300000[1894]
 64   :667400000[1896] - 667850000[1905]     64   :667950000[1907] - 668450000[1917]
 64   :668550000[1919] - 669050000[1929]     64   :669150000[1931] - 672650000[2001]
 64   :672750000[2003] - 676250000[2073]     64   :676350000[2075] - 679850000[2145]
 64   :679950000[2147] - 683450000[2217]     64   :683550000[2219] - 687050000[2289]
 64   :687150000[2291] - 690650000[2361]     64   :690750000[2363] - 694250000[2433]
 64   :694350000[2435] - 697850000[2505]     64   :697950000[2507] - 701450000[2577]
 64   :701550000[2579] - 705050000[2649]     64   :705150000[2651] - 708650000[2721]
 64   :708750000[2723] - 709000000[2728]     512  :709050000[2729] - 712250000[2793]
 512  :712350000[2795] - 715850000[2865]     512  :715950000[2867] - 719450000[2937]
 512  :719550000[2939] - 721000000[2968]     64   :721050000[2969] - 721050000[2969]
 Active subcarrier count: 1804, ZBL count: 0
 Discontinuity time [days:hours:mins:secs]: 00:00:54:32 [16:15:02 EDT May 18 2016]

 NCP profile:
 Active frequencies [subcarriers]:
 Modulation:Start-freq[start-subcarrier] - End-freq[end-subcarrier]
 ------------------------------------------------------------------
 16   :628900000[1126] - 630650000[1161]     16   :630750000[1163] - 634250000[1233]
 16   :634350000[1235] - 637850000[1305]     16   :637950000[1307] - 641450000[1377]
 16   :641550000[1379] - 645050000[1449]     16   :645150000[1451] - 648650000[1521]
 16   :648750000[1523] - 652250000[1593]     16   :652350000[1595] - 655850000[1665]
 16   :655950000[1667] - 659450000[1737]     16   :659550000[1739] - 663400000[1816]
 16   :663500000[1818] - 664000000[1828]     16   :664100000[1830] - 664550000[1839]
 16   :664650000[1841] - 665000000[1848]     16   :665100000[1850] - 665750000[1863]
 16   :666200000[1872] - 666850000[1885]     16   :666950000[1887] - 667300000[1894]
 16   :667400000[1896] - 667850000[1905]     16   :667950000[1907] - 668450000[1917]
 16   :668550000[1919] - 669050000[1929]     16   :669150000[1931] - 672650000[2001]
 16   :672750000[2003] - 676250000[2073]     16   :676350000[2075] - 679850000[2145]
 16   :679950000[2147] - 683450000[2217]     16   :683550000[2219] - 687050000[2289]
 16   :687150000[2291] - 690650000[2361]     16   :690750000[2363] - 694250000[2433]
 16   :694350000[2435] - 697850000[2505]     16   :697950000[2507] - 701450000[2577]
 16   :701550000[2579] - 705050000[2649]     16   :705150000[2651] - 708650000[2721]
 16   :708750000[2723] - 712250000[2793]     16   :712350000[2795] - 715850000[2865]
 16   :715950000[2867] - 719450000[2937]     16   :719550000[2939] - 721050000[2969]
 Active subcarrier count: 1804, ZBL count: 0

CCCs:
  OCD CCC: 2
  DPD CCCs:
    Control profile  (Profile A) CCC: 2
```

```
        NCP profile  CCC: 2
 Resource config time taken: 2286 msecs


JIB channel number: 776
Chan Pr EnqQ  Pipe  RAF   SyncTmr DqQ ChEn   RAF Pipe Phy0 Phy1 Tun# SessId 0[TkbRt MaxP]
    1[TkbRt MaxP]
 776  0   384     1   725       0 384 0100 13032    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  1   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  2   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  3   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  4   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  5   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  6   384     1  4786       0 384 0100  2190    1    0    1    2      0 479610000 4485120
 383688000 4485120
 776  7   384     1     0       0 384 0100     0    1    0    1    2      0 479610000 4485120
 383688000 4485120

Chan   Qos-Hi   Qos-Lo    Med-Hi   Med-Lo    Low-Hi   Low-Lo
 776   368640   245760    368640   245760    614400   368640
Chan  Med Low TB-neg Qos_Exc  Med_Xof  Low_Xof  Qdrops(H-M-L)  Pos    Qlen(Hi-Med-lo) Fl
Tgl_cnt Rdy_sts
  776   0   0      0       0        0        0    0    0    0  Y      0      0      0  0
      0 ff
Chan       Rate   Neg   Pos    LastTS  CurrCr  Pos  [PLC Rate Neg Pos]
 776   10485750 65535 65535 116199669 268431360   Y [MM 86 128 1114][EM 87 128 6204][TR 2
9 3102]
DSPHY Info:
 Local rf port 0 , rf chan 158 pic loss 123
 non short CWs: = 235681130, shorts = 0, stuff bytes = 235639172 bch 235681130
 NCP msgs: = 453809753, PLC encodings = 16902476
 flow0 rcv 70203 flow1 rcv 3 flow0 drops 0 flow1 drops 0
```

Configuration Examples

This section provides examples for configuring the OFDM channel.

Example1: Configuring OFDM Channel

Note The OFDM modulation profile must be configured before the OFDM channel profile which references it.

The following example shows how to configure the OFDM channel:

```
enable
configure terminal
cable downstream ofdm-modulation-profile 9
description 512-1k-4k
subcarrier-spacing 50KHz
width 96000000
```

```
start-frequency 627000000
assign modulation-default 512-QAM
assign modulation 1024-QAM range-subcarriers freq-abs 635000000 width 74050000
assign modulation 4096-QAM range-subcarriers freq-abs 629000000 width 6000000
exit
configure terminal
cable downstream ofdm-chan-profile 20
description Data profiles: 2 single mod, 1 mixed mod
cyclic-prefix 192
interleaver-depth 16
pilot-scaling 48
roll-off 128
subcarrier-spacing 50KHz
profile-ncp modulation-default 16-QAM
profile-control modulation-default 256-QAM
profile-data 1 modulation-default 1024-QAM
profile-data 2 modulation-default 2048-QAM
profile-data 3 modulation-profile 9
exit
configure terminal
controller integrated-cable 3/0/0
max-ofdm-spectrum 96000000
ofdm-freq-excl-band start-frequency 683000000 width 10000000
rf-chan 158
power-adjust 0
docsis-channel-id 159
ofdm channel-profile 20 start-frequency 627000000 width 96000000 plc 663000000
```

Example 2: Configuring OFDM Primary Channel in the MAC Domain

```
enable
configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
interface cable 3/0/0
downstream Integrated-Cable 3/0/3 rf-channel 158
end
```

Additional References

Related Document

Document Title	Link
Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.0 Configuration Guide	http://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_cbr_layer2_docsis30.html

MIBs

MIBs	MIBs Link
DOCS-IF31-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

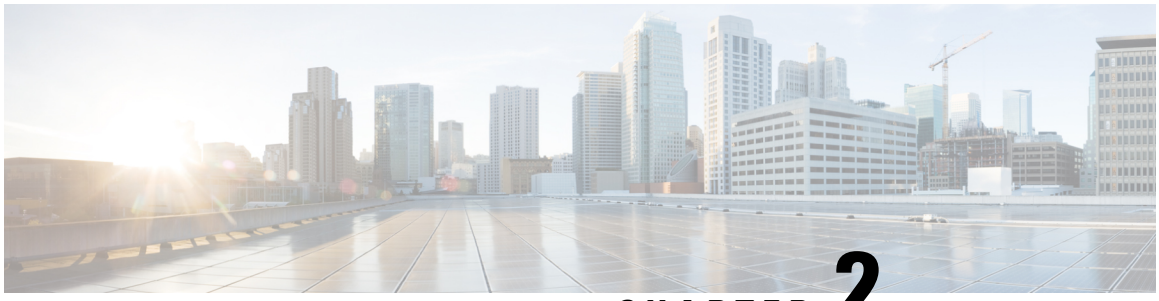
Feature Information for DOCSIS 3.1 OFDM Channel Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 2: Feature Information for DOCSIS 3.1 OFDM Channel Configuration

Feature Name	Releases	Feature Information
DOCSIS 3.1 OFDM Channel Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Full Spectrum 108-1218 MHz Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 OFDM Primary Channel Support	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
Enhanced support for subcarrier spacing, exclusion band, and LCPR	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 2

OFDM Channel Power Profile

The OFDM Channel Power Profile feature helps in adjusting the power-level of 6 MHz bands in a DOCSIS 3.1 downstream OFDM channel.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 15
- Information About OFDM Channel Power Profile, on page 16
- How to Configure the OFDM Channel Power Profile, on page 17
- Configuration Example for OFDM Power Profile, on page 19
- Feature Information for OFDM Channel Power Profile, on page 19

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 3: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information About OFDM Channel Power Profile

The OFDM power profile provides a better, consistent power-level output at the cable modem, compensating the power levels at a finer granularity. It reduces the differing amounts of cable-loss over the bandwidth of OFDM channel.

This feature enables the Cisco cBR Series Converged Broadband Router to correct the transmission loss due to the cable in the plant.

The OFDM power profile (ofdm-power-profile) adjusts the transmission power level of each 6 MHz in an OFDM channel. The OFDM channel width can range from 24 MHz to 192 MHz, resulting in band-counts between 4 and 32 for the profile.

Each 6 MHz band is referenced by a band index (band-index) that is zero-based, with a maximum band range of 192 MHz OFDM channel being 0 to 31. Each band within the OFDM channel can have a unique power level setting. The OFDM power profile allows a total band adjustment range of 8 dB. Under some specific conditions, if the OFDM channel's downstream controller's base channel power is set to exceed the maximum DRFI specification power level, the OFDM power profile adjustment range can become as high as 9 dB.

In a power profile, you can set the power level (power-adjust-default) to a default value. This default value is applied to any band that is not configured through any other means.

You can configure band power levels in two methods: through the power tilt config (power-tilt-linear) or by configuring the power level for a band or range of bands (band-index). You can use both methods for configuring the band power levels simultaneously within an OFDM power profile.

The power tilt configuration applies a linear power-adjust value between the `power-adjust-default` value applied to the band index 0, and the power-tilt-linear adjust value applied to the highest band index of the profile. For example, an OFDM Power Profile of 96 MHz, with a power-tilt-linear of 4 dB, and power-adjust-default of 0 dB, has16 bands numbered 0 to 15, band index 0 is +0 dB, band index 15 is +4 dB, and bands 1 to 14 contain the linear power level setting based on the slope of the line between the band 0 and band 15 to the nearest 1/10th dB.

The band-index configuration applies a specified value to the indicated bands. The band-index configuration can specify a single band or a range of bands. A power-adjust configuration is used to specify the power level for the bands to the nearest 1/10th dB.

You can simultaneously use both power tilt and band index, where band-index is applied last. When you use both, the power-tilt-linear values can be overridden using the band-index power-adjust values.

A maximum of 64 OFDM power profiles can be configured on the Cisco cBR routers, numbered from 1 to 64. You can apply a single OFDM power profile to multiple controller OFDM channels, across line cards, as long as all validity checks pass during configuration. The router console displays an error message explaining any configuration errors or warnings.

Restrictions for Configuring OFDM Power Profile

The following restrictions are applicable for configuring an OFDM power profile:

- OFDM power profile can be configured only on DOCSIS 3.1 system
- The power profile can be applied only to downstream controller OFDM channels (RF-channels 158 to 162)

How to Configure the OFDM Channel Power Profile

Configuring OFDM Power Profile Using Band-index

Use the following commands along with the band-index configuration to configure OFDM Power Profile, where the band-index values act as an override.

```
enable
configure terminal
cable downstream ofdm-power-profile <profile_id>
  power-adjust-default -2.1
  band-index 0 7
    power-adjust -1.0
  band-index 8 15
    power-adjust -0.5
  band-index 16 23
    power-adjust 0.5
  band-index 24 31
    power-adjust 1.5

controller Integrated-Cable {slot}/{subslot}/{port}
```

```
rf-channel {158 - 162 }
power-profile {ofdm-power-profile-id}
```

Verifying the Power Profile Configuration

To display the power profile configuration details, use the **show cable ofdm-power-profile** command as given in the following example. This command also displays the actual power-band power levels as set by the profile.

```
Router> show cable ofdm-power-profile 3
OFDM Power Profile 3

Power-Adjust-Default(*): -2.1

Power-Band:
[00-07]   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0   -1.0
[08-15]   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5   -0.5
[16-23]    0.5    0.5    0.5    0.5    0.5    0.5    0.5    0.5
[24-31]    1.5    1.5    1.5    1.5    1.5    1.5    1.5    1.5

  +4 .0 |
        |
  +3 .0 |
        |
  +2 .0 |                                                       * * * * * * * *
        |
  +1 .0 |                                     * * * * * * * *
        |
  +0 .0 | ------------------------------------------------------------------------
        |                    * * * * * * * *
  -1 .0 | * * * * * * * * *
        |
  -2 .0 |
        |
  -3 .0 |
        |
  (dB)    0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 3 3
          0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
                                band-index
```

Configuring OFDM Power Profile with Linear Power-tilt

Use the following commands to configure the OFDM power profile with a linear power-tilt and the band-index override.

```
enable
configure terminal
cable downstream ofdm-power-profile <profile_id>
  power-adjust-default 0.0
  power-tilt-linear 3.5
  band-index 0
  power-adjust 4.0
```

Verifying the Power Profile Using show controller Command

Use the **show controller** command to display the absolute power-band levels as set by the power profile. When the power-profile is applied to the controller, the power level displayed is the actual transmit power level in dBmV.

```
Router>show controller Integrated-Cable 3/0/0 rf-channel 158 verbose
Chan State Admin Mod-Type  Start  Width     PLC        Profile-ID    dcid  power  output
                           Frequency
 158   UP   UP   OFDM      849000000   96000000  856000000       20       159   33.0
NORMAL
 Resource status:   OK
 License: granted <09:23:14 EDT Aug 1 2016>
 OFDM channel license spectrum width: 92200000
 OFDM config state: Configured

 OFDM Power Profile: 3
Power-Band:
[00-07]   32.0   32.0   32.0   32.0   32.0   32.0   32.0   32.0
[08-15]   32.5   32.5   32.5   32.5   32.5   32.5   32.5   32.5
[16-23]   33.5   33.5   33.5   33.5   33.5   33.5   33.5   33.5
[24-31]   34.5   34.5   34.5   34.5   34.5   34.5   34.5   34.5

OFDM channel details: [3/0/0:158]
-----------------------------------------
```

Configuration Example for OFDM Power Profile

This section provides example for the OFDM Power Profile configuration.

Example: OFDM Power Profile with Linear Power-tilt Configuration

```
enable
configure terminal
cable downstream ofdm-power-profile 3
  power-adjust-default 0.0
  power-tilt-linear 3.5
  band-index 0
  power-adjust 4.0
```

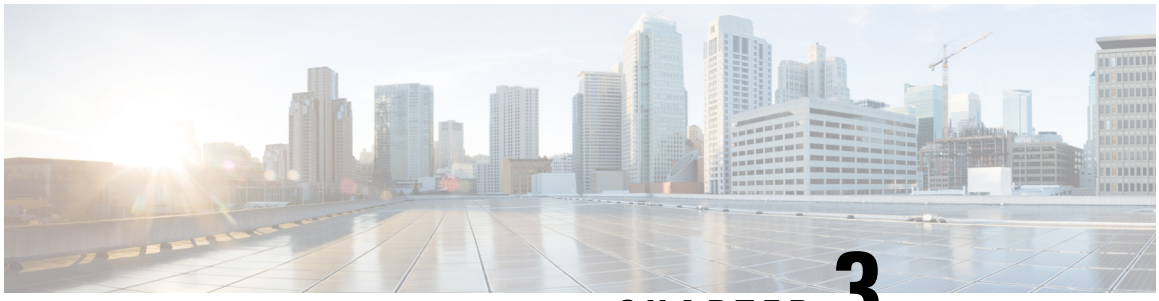
Feature Information for OFDM Channel Power Profile

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 4: Feature Information for OFDM Channel Power Profile

Feature Name	Releases	Feature Information
OFDM Channel Power Profile	Cisco IOS XE Fuji 16.7.1	This feature was integrated into the Cisco cBR Series Converged Broadband Routers.



CHAPTER 3

DOCSIS 3.1 Path Selection

This document describes how to configure the path selecion on the Cisco cBR Series Converged Broadband Router.

- Information about Path Selection, on page 21
- How to Configure Path Selection, on page 21
- Additional References, on page 25
- Feature Information for DOCSIS 3.1 Path Selection, on page 25

Information about Path Selection

DOCSIS 3.1 Path Selection feature is enhanced to support OFDM downstream channels and OFDMA upstream channels. The RCC selection process is enhanced to include OFDM channels. The TCC selection process is enhanced to include OFDMA channels.

How to Configure Path Selection

Configuring Downstream Bonding Group with OFDM Channel

To configure the downstream bonding group with OFDM channel, follow the steps below:

```
enable
configure terminal
interface wideband-cable slot/subslot/bay:wideband-channel
description text
cable bundle id
cable rf-channels channel-list grouplist bandwidth-percent percentage-bandwidth
```

Note Channel 158 to 162 are specified as OFDM channel.

Verifying Downstream Bonding Group with OFDM Channel Configuration

To display the details of the downstream bonding group with OFDM channel, use the **show running-config interface** command as shown in the example below:

```
Router# show running-config interface wideband-cable 3/0/0:13

Building configuration...

Current configuration : 212 bytes
!
interface Wideband-Cable3/0/0:13
 description D31-DSBG: 1 SC-QAM plus 1 OFDM
 cable bundle 1
 cable rf-channels channel-list 8 bandwidth-percent 30
 cable rf-channels channel-list 158 bandwidth-percent 25
end
```

Configuring Upstream Bonding Group with OFDMA Channel

To configure the upstream bonding group with OFDMA channel, follow the steps below:

```
enable
configure terminal
interface cable slot/subslot/bay
cable upstream bonding-group id
upstream id
```

Verifying Upstream Bonding Group with OFDMA Channel Configuration

To display the details of the upstream bonding group with OFDMA channel, use the **show running-config interface** command as shown in the example below:

```
Router# show running-config interface cable 6/0/3
Building configuration...

Current configuration : 212 bytes
!
interface Cable6/0/3
 load-interval 30
 downstream Integrated-Cable 6/0/1 rf-channel 158
 upstream 0 Upstream-Cable 1/0/0 us-channel 0
 upstream 1 Upstream-Cable 1/0/0 us-channel 1
 upstream 2 Upstream-Cable 1/0/0 us-channel 2
 upstream 3 Upstream-Cable 1/0/0 us-channel 3
 upstream 6 Upstream-Cable 1/0/0 us-channel 12
 cable upstream balance-scheduling
 cable upstream bonding-group 2
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
 cable bundle 1
 cable privacy accept-self-signed-certificate
!
```

Verifying the Path Selection Status

To display the path selection status of a cable modem, use the **show cable modem path-sel** command as shown in the example below:

```
router#show cable modem 38c8.5cfe.efa6 path-sel

CM 38c8.5cfe.efa6 Path-Sel Info: 07:20

RCS Filter Result: Succeed
Candidate RCS List: 2
  RCC-Id   Owner-Id   Preliminary  RCP      TLV-56   LBG      SF-Attr   CM-Attr
  1        1 :12289   Pass         Pass      --      Pass     Pass      Pass
  2        1 :12290   Pass         Pass      --      Pass     Pass      Pass

TCS Filter Result: Succeed
TCS Info:
  TCS in CGD            : 0x7         UCID: 1 2 3
  TCS in Freq Range     : 0x7         UCID: 1 2 3
  TCS Impaired          : 0x0
TCS Passed filters:
  Preliminary           : 0x7         UCID: 1 2 3
  LB Group              : 0x7         UCID: 1 2 3
  SF Attr Mask          : 0x7         UCID: 1 2 3
  CM Attr Mask          : 0x7         UCID: 1 2 3

Candidate US-BG List: 4
  UBG-Id   Chan-Mask    Preliminary  TLV-56   LBG      SF-Attr   CM-Attr
  1        0x7          Pass          --      Pass     Pass      Pass
  65537    0x2          Pass          --      Pass     Pass      Pass
  65538    0x4          Pass          --      Pass     Pass      Pass
  65536    0x1          Pass          --      Pass     Pass      Pass

Primary DS Chan Result: Skipped
Candidate Primary DS Chan List: 0

Primary US Chan Result: Skipped
Candidate Primary US Chan List: 0
```

Clearing the Path Selection Status

To clear the path selection status for all CMs, use the **clear cable modem all path-sel** command as shown in the example below:

```
Router# clear cable modem all path-sel

Router# show cable modem c8fb.26a6.c46a path-sel

CM c8fb.26a6.c46a Path-Sel Info: N/A
Path-Sel status has been cleared after register online.
```

Verifying the RCC Configuration

To verify the runtime RCCs on a cable interface, use the **show cable mac-domain rcc** command as shown in the example below:

```
Router# show cable mac-domain cable 7/0/0 rcc
```

```
RCC-ID   RCP               RCs MD-DS-SG CMs   WB/RCC-TMPL      D3.0 D3.1
4        00 00 00 00 00    16  0        1     WB (Wi7/0/0:0)   Y    Y
5        00 00 00 00 00    25  0        2     WB (Wi7/0/0:1)   N    Y
6        00 10 00 00 08    8   0        0     RCC-TMPL(3:1)    Y    N
7        00 00 00 00 00    4   0        0     WB (Wi7/0/0:4)   Y    Y
```

To display the detailed information for only DOCSIS 3.1 capable RCC, use the **show cable mac-domain rcc simplified** command as shown in the example below:

```
router#show cable mac-domain cable 7/0/0 rcc 5 simplified

RCC ID                 : 5
Created Via            : Wideband - Wi7/0/0:1
CM attribute mask      : 0x80000000

Primary Receive Channel List:
  Chan Idx   RF Chan         DCID  Freq
  1          In7/0/0:0       1     453000000

Non-Primary Receive Channel List:
  Chan Idx   RF Chan         DCID  Freq
  2          In7/0/0:1       2     459000000
  3          In7/0/0:2       3     465000000
  4          In7/0/0:3       4     471000000
  5          In7/0/0:4       5     477000000
  6          In7/0/0:5       6     483000000
  7          In7/0/0:6       7     489000000
  8          In7/0/0:7       8     495000000
  9          In7/0/0:8       9     501000000
  10         In7/0/0:9       10    507000000
  11         In7/0/0:10      11    513000000
  12         In7/0/0:11      12    519000000
  13         In7/0/0:12      13    525000000
  14         In7/0/0:13      14    531000000
  15         In7/0/0:14      15    537000000
  16         In7/0/0:15      16    543000000
  17         In7/0/0:16      17    549000000
  18         In7/0/0:17      18    555000000
  19         In7/0/0:18      19    561000000
  20         In7/0/0:19      20    567000000
  21         In7/0/0:20      21    573000000
  22         In7/0/0:21      22    579000000
  23         In7/0/0:22      23    585000000
  24         In7/0/0:23      24    591000000
  25         In7/0/0:158     159   663000000

OFDM Receive Channel List:
  Chan Idx   RF Chan         DCID  PLC-Freq        Profiles
  25         In7/0/0:158     159   663000000       0 1 2
```

Additional References

Related Document

Document Title	Link
Cisco cBR Converged Broadband Routers Layer 2 and DOCSIS 3.0 Configuration Guide	http://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_cbr_layer2_docsis30.html

MIBs

MIBs	MIBs Link
• DOCS-IF31-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

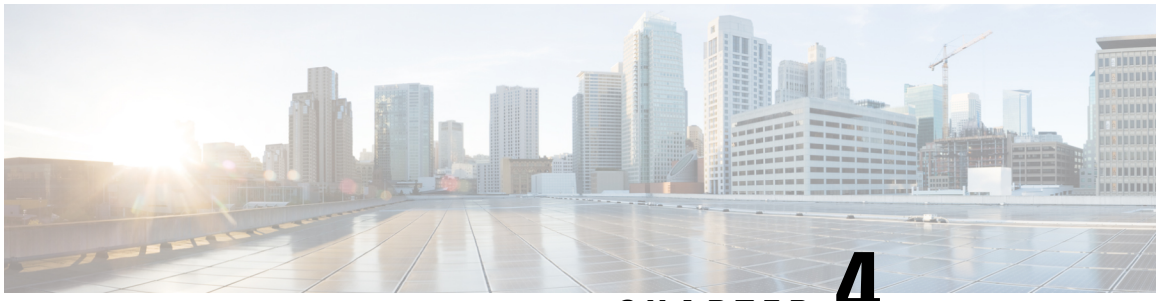
Feature Information for DOCSIS 3.1 Path Selection

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 5: Feature Information for DOCSIS 3.1 Path Selection

Feature Name	Releases	Feature Information
DOCSIS 3.1 Path Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 Upstream Path Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 4

DOCSIS 3.1 Downstream Profile Selection

First Published: July 13, 2016

DOCSIS 3.1 introduces the concept of downstream profiles for OFDM channels.

Contents

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 27
- Information about Downstream Profiles, on page 28
- How to Configure Profiles, on page 29
- Additional References, on page 31
- Feature Information for Downstream Profile Selection, on page 31

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 6: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about Downstream Profiles

A profile is a list of modulation orders that are defined for each of the subcarriers within an OFDM channel. The CMTS can define multiple profiles for use in an OFDM channel, where the profiles differ in the modulation orders assigned to each subcarrier.

You can use the following commands to view the profiles:

- To display the profiles associated with the cable modems (CMs), use the **show cable modem** *[ip-address| mac-address| cable| {slot | subslot | cable-interface-index}]* **phy ofdm-profile** command.
- To display detailed profile management data associated with specific cable modem, use the **show cable modem** *[ip-address| mac-address]* **prof-mgmt** command.

The CMTS can assign different profiles for different groups of CMs.

Default Data Profile

The first time a CM registers, it is assigned a default data profile. The default data profile is "profile-data 1". If "profile-data 1" is not configured, "profile-control" is assigned to the CM.

Note Profile A, with profile ID 0, is also referred to as the control profile.

Recommended Profile

Based on the Receive Modulation Error Ratio (RxMER) values collected from a modem using the **cable modem** *ip* **opt0** command, and collected automatically and periodically in the background, the CMTS finds among the existing profiles the one that may provide the highest speed, and yet at the same time may have sufficient Signal to Noise Ratio (SNR) margin for the modem to receive code words with acceptable error. This profile is called the recommended profile for that CM. The **show cable modem phy ofdm-profile** command displays the recommended profile for each CM.

Internal PMA is enabled by default on the cBR-8. If external PMA is enabled, internal PMA is disabled and can be enabled by running the following config command on the cBR-8:

```
no cable downstream ofdm-prof-mgmt prof-upgrade-pma
```

In external PMA, the cBR-8 does not automatically upgrade a CM's profile to the recommended profile. In internal PMA, the profile can be upgraded to the recommended profile in the next OFDM Profile Test (OPT) cycle.

A user configurable age is associated with each recommended profile, which can be configured as follows:

```
Router (config)#cable downstream ofdm-prof-mgmt recommend-profile-age age-in-minutes
```

If the recommended profile exceeds this age, it is no longer valid for that CM.

Unfit Profile

When the CMTS receives CM-STATUS Event 16 (DS OFDM Profile Failure), the profile indicated in the CM-STATUS message is marked as 'unfit profile' for this modem.

A user configurable maximum age is associated with each unfit profile, which can be configured as follows:

```
Router (config)#cable downstream ofdm-prof-mgmt unfit-profile-age age-in-minutes
```

If the unfit profile for a modem exceeds this age, it is no longer valid.

How to Configure Profiles

Configuring Profile Downgrade

A CM sends a CM-STATUS Event 16 message to indicate a DS OFDM profile failure. When this indication is received by the CMTS, it takes immediate action to downgrade the modem to a lower profile, as per the profile ordering displayed by the following command:

```
Router# show controllers integrated-Cable 2/0/3 rf-channel 158 prof-order
```

The following table, extracted from [DOCSIS 3.1 MULPI], lists the CM-Status events that will trigger a profile downgrade:

Table 7: Table: CM-Status Events for Profile Downgrade

Event Type	Event Condition	Status Report Events		Parameters reported by CM	
		Trigger event to "on"	Trigger event to "off"	DCID	Profile ID
16	DS OFDM profile failure	Loss of FEC lock on one of the assigned downstream OFDM profiles of a channel	Re-establishment of FEC lock for that OFDM profile; OR Removal of the channel from the active channel list in the primary channel MDD; OR Removal of the channel from the CM's Receive Channel set via DBC-REQ	Yes	Yes

To disable the automatic profile downgrade, use the following command in global configuration mode:

```
Router (config)#no cable downstream ofdm-prof-mgmt prof-dwngrd-auto
```

Configuring RxMER to Bit Loading Mapping

There are many ways to map the Receive Modulation Error Ratio (RxMER) values to bit loading values. We use the following mapping recommended in [DOCSIS 3.1 OSSI], as our baseline mapping:

RxMER (in ¼ DB)	QAM	Bit Loading
60	16	4
84	64	6
96	128	7
108	256	8
122	512	9
136	1024	10
148	2048	11

RxMER (in ¼ DB)	QAM	Bit Loading
164	4096	12
184	8192	13
208	16384	14

- To configure a margin to adjust the RxMER to bit loading mapping, use the following command:

  ```
  Router(config)# cable downstream ofdm-prof-mgmt mer-margin-qdb interval-in-minutes
  ```

  This configured value (*quarter-DB*) is added to the RxMER values collected by CMTS before using the above mapping table, thus giving a user more control in selecting the recommended profiles.
- To specify the percentage of subcarriers that can be ignored in the recommended profile calculation, use the following command:

  ```
  Router(config)# cable downstream ofdm-prof-mgmt exempt-sc-pct percent
  ```

  This provides a way to specify the extent that the outliers can be ignored.
- To configure the RxMER poll interval, use the following command:

  ```
  Router(config)# cable downstream ofdm-prof-mgmt rxmer-poll-interval interval-in-minutes
  ```

  The CMTS uses OPT message with bit-0 option to collect RxMER data from CMs, after the initial CM registration and periodically thereafter. The collected RxMER data is used to compute the recommended profile for each CM.

Additional References

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

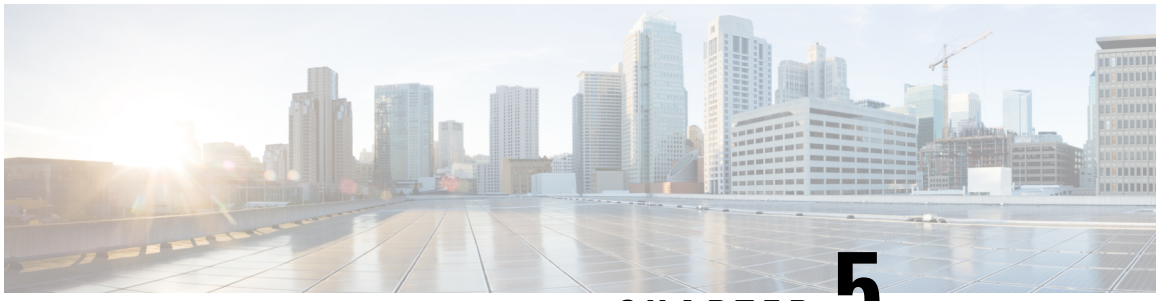
Feature Information for Downstream Profile Selection

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 8: Feature Information for Downstream Profile Selection

Feature Name	Releases	Feature Information
Downstream Profile Selection	Cisco IOS XE Everest 16.6.1	This feature was integrated into Cisco IOS XE Everest 16.6.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 5

DOCSIS 3.1 Commanded Power for Upstream SC-QAMs

This guide describes commanded power for upstream SC-QAMs on the Cisco cBR Router.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 33
- Information About Commanded Power Feature for Upstream SC-QAMs, on page 34
- Feature TLVs, on page 35
- Additional References, on page 36
- Feature Information for Commanded Power for US SC-QAMs, on page 36

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 9: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information About Commanded Power Feature for Upstream SC-QAMs

To view the new commanded power levels pr upstream, use the following command:

```
Router# show cable modem [ ip-address | mac-address | cable {slot /subslot
/cable-interface-index}] verbose
```

Note DOCSIS 3.1 Commanded Power feature is enabled by default.

Feature TLVs

TLVs Affected by Commanded Power for US SC-QAMs

The following table lists the TLVs affected by the DOCSIS 3.1 Ranging Response (RNG-RSP) Commanded Power for upstream SC-QAMs:

Name	Type	DOCSIS 3.1 Value
Power Level Adjust	2	TX Power offset adjustment (signed 8-bit, 1/4-dB units)
Power Offset	12.4.4	TX Power offset adjustment (signed 8-bit, 1/4-dB units)
Dynamic Range Window Upper Edge	14	The upper edge of the Dynamic Range Window expressed in units 1/4 dB below the max allowable setting (Phi) [DOCSIS PHYv3.0].
Commanded Power	17	This TLV contains the Dynamic Range Window value, P1.6load_min_set as well as the Transmit Power Level for each of the channels in the CM's Transmit Channel Set, expressed in units of quarter dBmV.

Commanded Power Sub-TLVs

The following table lists the sub-TLVs for DOCSIS 3.1 Commanded Power:

Name	Type (1 byte)	Length (1 byte)	Value (Variable Length)
Commanded Power	17	5 + 3*N	
Dynamic Range Window	17.1	1	The range, in decibels, of the maximum difference in power per 1.6 MHz between multiple transmitters in a cable modem’s Transmit Channel Set.

Name	Type (1 byte)	Length (1 byte)	Value (Variable Length)
List of Upstream Channel IDs and Corresponding Transmit Power Levels	17.2	3*N	Values for each channel in the TCS: • Bits 23 to 16: UCID • Bits 15 to 0: Transmit Power Level (quarter dBmV)

Additional References

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

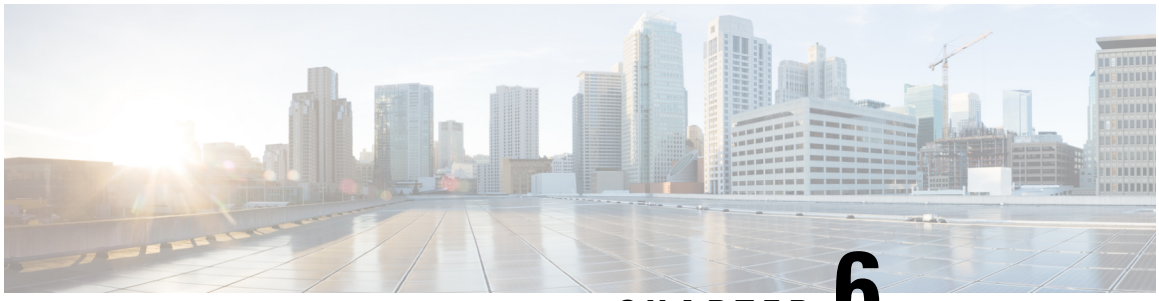
Feature Information for Commanded Power for US SC-QAMs

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 10: Feature Information for Commanded Power Feature

Feature Name	Releases	Feature Information
DOCSIS 3.1 Commanded Power for US SC-QAMs	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 6

DOCSIS3.1 Downstream Resiliency for OFDM channel

This document describes how to configure the DOCSIS3.1 Downstream Resiliency for OFDM channel on the Cisco cBR Series Converged Broadband Router.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 37
- Information about DOCSIS3.1 Downstream Resiliency for OFDM Channel, on page 38
- How to Configure DOCSIS3.1 Downstream Resiliency for OFDM Channel, on page 39
- Feature Information for DOCSIS3.1 Downstream Resiliency for OFDM Channel, on page 41

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 11: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about DOCSIS3.1 Downstream Resiliency for OFDM Channel

When DOCSIS3.1 CM reports non-primary RF channel failure for SCQAM or OFDM channel, actions performed by downstream resiliency is the same as DOCSIS3.0 CM. In other words, if RF channel impairment is below the resiliency threshold, CMs service flows are moved to Resiliency Bonding Group (RBG) or Narrow Band (NB) interface. If RF channel impairment is above the resiliency threshold, the impaired RF channel is temporarily removed from the bonding group.

The following table summarizes the CM-STATUS events for OFDM channel, and the action to be taken by the downstream resiliency module:

Table 12: CM-STATUS events for OFDM channel

Event Type Code	Event Description	DS Resiliency Action
1	MDD timeout	Move CM's service flows to RBG/NB or suspend RF from BG.

Event Type Code	Event Description	DS Resiliency Action
2	FEC lock failure	Move CM's service flows to RBG/NB or suspend RF from BG.
4	MDD recovery	Move CM's service flows back to original BG.
5	FEC lock recovery	Move CM's service flows back to original BG.
16	DS OFDM profile failure. A loss of FEC lock on one of the assigned downstream OFDM profiles of a channel.	DS OFDM Profile Manager will handle this event and take action.
20	NCP profile failure. Loss of FEC lock on NCP.	Move CM's service flows to RBG/NB or suspend RF from BG.
21	Loss of FEC lock on the PLC.	Move CM's service flows to RBG/NB or suspend RF from BG.
22	NCP profile recovery.	Move CM's service flows back to original BG.
23	FEC recovery on PLC channel.	Move CM's service flows back to original BG.
24	FEC recovery on OFDM profile.	Recovery of impairment reported by event 16. DS OFDM Profile Manager will handle this event and take action.

How to Configure DOCSIS3.1 Downstream Resiliency for OFDM Channel

Configuring DOCSIS3.1 Downstream Resiliency for OFDM Channel

User must configure the command **cable rf-change-trigger percent** *value* **count** *number* to enable the downstream resiliency functionality.

To configure the trigger thresholds specific to OFDM RF impairment, follow the steps below:

```
enable
configure terminal
cable ofdm-rf-change-trigger percent value counter number [no-ncp-plc]
```

Trigger thresholds *value* and *number* apply globally to the non-primary OFDM RF channels. If this command is not configured, the trigger thresholds configured by the command **cable rf-change-trigger percent** *value* **count** *number* will be used for the non-primary OFDM channels.

With **no-ncp-plc** configured in the command, this feature will not take any action when CM reports CM-STATUS-EVENT 20 or 21.

Note The **cable rf-change-trigger percent** *value* **count** *number* command is optional and the configured trigger thresholds apply to non-primary OFDM channels only.

Displaying OFDM Specific CM-STATUS Events

To display the statistics of the OFDM specific CM-STATUS events, use the **show cable modem wideband rcs-status** command as shown in the example below:

```
router#show cable modem 4800.33ea.7072 wideband rcs-status verbose
CM  : 4800.33ea.7072
RF  : 3/0/0 0
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  Flaps                   : 0
  Flap Duration           : 00:00
RF  : 3/0/0 1
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  Flaps                   : 0
  Flap Duration           : 00:00
RF  : 3/0/0 159
  Status                  : UP
  FEC/QAM Failure         : 0
  Dup FEC/QAM Failure     : 0
  FEC/QAM Recovery        : 0
  Dup FEC/QAM Recovery    : 0
  MDD Failure             : 0
  Dup MDD Failure         : 0
  MDD Recovery            : 0
  Dup MDD Recovery        : 0
  NCP PROF Failure        : 2         May 8  15:14:24
  Dup NCP PROF Failure    : 0
  NCP PROF Recovery       : 1         May 8  15:15:18
  Dup NCP PROF Recovery   : 0
  PLC Lock Failure        : 1         May 8  15:14:47
  Dup PLC Lock Failure    : 0
  PLC Lock Recovery       : 1         May 8  15:15:46
  Dup PLC Lock Recovery   : 0
  Flaps                   : 0
  Flap Duration           : 00:00
  OFDM Profile Id : 2
```

```
Status                  : UP
Profile Failure         : 1         May 8  15:16:18
DUP Profile Failure     : 0
Profile Recovery        : 1         May 8  15:16:44
DUP Profile Recovery    : 0
```

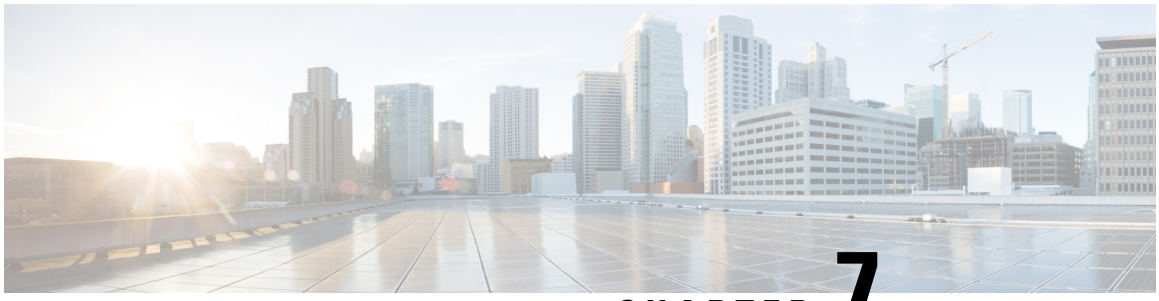
Feature Information for DOCSIS3.1 Downstream Resiliency for OFDM Channel

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 13: Feature Information for DOCSIS3.1 Downstream Resiliency for OFDM Channel

Feature Name	Releases	Feature Information
DOCSIS3.1 Downstream Resiliency for OFDM Channel	Cisco IOS XE Everest 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 7

DOCSIS 3.1 OFDMA Channel Configuration

This document describes how to configure the OFDMA channel on the Cisco cBR Series Converged Broadband Router.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 43
- Information about OFDMA Channel Configuration, on page 44
- How to Configure OFDMA Channel, on page 45
- Feature Information for DOCSIS 3.1 OFDMA Channel Configuration, on page 54

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 14: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about OFDMA Channel Configuration

OFDMA Channels

DOCSIS 3.1 introduces modes for higher throughput and higher spectral efficiency while still allowing backward compatibility to DOCSIS 3.0. Orthogonal Frequency Division Multiple Access (OFDMA) channel has following features:

- Frequency-range up to 80 MHz—The Cisco IOS XE Fuji 16.7.x supports the configuration of up to 80 MHz OFDMA channel on every port of a line card.
- Upstream spectrum 5 – 85 MHz
- 50 kHz subcarrier spacing
- 25 kHz subcarrier spacing

For a specific subcarrier spacing, the number of subcarriers on an OFDMA channel depends on the channel width.

Channel Width	50 kHz	25 kHz
48 MHz	960	1920
96 MHz	1920	3840

Note When the OFDMA is configured with SC-QAMs on the same port pair, it is recommended to configure no more than 45 MHz OFDMA per port, or 90 MHz per port pair in Cisco IOS XE Everest 16.6.1.

Modulation Profile

A globally configured OFDMA modulation profile defines modulation orders and pilot patterns for different interval usage codes (IUC). It is also used to assign parameters for initial ranging and fine ranging.

OFDMA Channel Exclusion Band

Ranges of frequencies can be excluded from all OFDMA channels on a port using the **ofdma-frequency-exclusion-band** command.

Exclusion and unused bands apply to OFDMA channels only. OFDMA channel never use frequencies in exclusion band. So the legacy SC-QAM channel can be placed in this band. OFDMA channel does not use frequencies in unused band set by **ofdma-frequency-unused-band** command for data traffic, but can send probes in them.

How to Configure OFDMA Channel

Configuring OFDMA Modulation Profile

The OFDMA modulation profile is used to configure initial ranging, fine ranging and data IUC parameters. To define the ofdma modulation profile to be applied to OFDMA channels, follow the steps below:

```
enable
configure terminal
cable mod-profile-ofdma id
subcarrier-spacing value
initial-rng-subcarrier value
fine-rng-subcarrier value
data-iuc id modulation value pilot-pattern value
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# cable mod-profile-ofdma 466
Router(config-ofdma-mod-profile)# subcarrier-spacing 50KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 1024-QAM pilot-pattern 2
```

```
Router(config-ofdma-mod-profile)# exit
Router(config)# cable mod-profile-ofdma 423
Router(config-ofdma-mod-profile)# subcarrier-spacing 25KHz
Router(config-ofdma-mod-profile)# initial-rng-subcarrier 64
Router(config-ofdma-mod-profile)# fine-rng-subcarrier 128
Router(config-ofdma-mod-profile)# data-iuc 6 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 9 modulation 1024-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 10 modulation 512-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 11 modulation 256-QAM pilot-pattern 8
Router(config-ofdma-mod-profile)# data-iuc 12 modulation 128-QAM pilot-pattern 9
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 64-QAM pilot-pattern 9
```

Note Subcarrier spacing must match the subcarrier spacing of each channel profile in which it is configured.

Verifying OFDMA Modulation Profile Configuration

To display the OFDMA modulation profile details, use the **show cable modulation-profile ofdma** command as shown in the example below:

```
Router# show cable modulation-profile ofdma
Mod  Subc     IUC type   Act  Preamble  Bit       Pilot
     Spacing             subc Symbols   Loading   Pattern
421  25KHz    3  (IR)    64      4
              4  (FR)    192     1
              13 (data)                 16-QAM    8

423  25KHz    3  (IR)    64      4
              4  (FR)    128     1
              6  (data)                 1024-QAM  8
              10 (data)                 512-QAM   8
              11 (data)                 256-QAM   8
              12 (data)                 128-QAM   9
              13 (data)                 64-QAM    9

461  50KHz    3  (IR)    32      4
              4  (FR)    192     1
              13 (data)                 16-QAM    1

466  50KHz    3  (IR)    64      4
              4  (FR)    128     1
              13 (data)                 1024-QAM  2
```

Configuring OFDMA Channel

To configure the OFDMA channel, follow the steps below:

```
enable
configure terminal
controller Upstream-Cable slot/subslot/port
us-channel id docsis-mode ofdma
us-channel id subcarrier-spacing value
us-channel id frequency-range start-value end-value
us-channel id modulation-profile id
```

us-channel *id* **cyclic-prefix** *value* **roll-off-period** *value*
us-channel *id* **symbols-per-frame** *value*
us-channel *id* **data-iuc** *id* **band** *start-value end-value* **modulation** *value* **pilot-pattern** *value*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/4
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 frequency-range 40000000 85000000
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 cyclic-prefix 640 roll-off-period 224
Router(config-controller)# us-channel 12 symbols-per-frame 9
Router(config-controller)# us-channel 12 data-iuc 9 band 50000000 60000000 modulation 512-QAM
 pilot-pattern 8
Router(config-controller)# no us-channel 12 shutdown
```

Note

- OFDMA use us-channel range 12 – 15.
- Change docsis-mode to **ofdma** to enable OFDMA configuration options. These options are enabled by default on us-channel 12 – 15.
- It is recommended to configure no more than 4 active SC-QAMs while an OFDMA channel is present.
- A maximum of one OFDMA channel can be configured per controller.
- OFDMA channel must be placed between 40 and 85 Mhz.
- Values of the options are often interdependent, changing one value may change other values or make them invalid.
- It is recommended to set subcarrier spacing and frequency range first. Frequency range must be increment of 50 kHz.
- Overlapping frequencies between SC-QAM and OFDMA are not currently allowed.

Verifying OFDMA Channel Configuration

To display the OFDMA channel configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/4 us-channel 12
USPHY OFDMA support: FULL


Controller 1/0/4 upstream 12  AdminState:UP OpState: UP
  ofdma mode enabled
  Channel Freq Range 35.500 MHz to 79.500 MHz
  Channel Subcarrier Index Range Cfg: 74, 953 Op: 74, 953
  Channel SC0 Freq Cfg: 31.800 MHz Op: 31.800 MHz
  #Excl bands: 2
  (   0,   73), ( 954, 2047),
  #Unused bands: 0
  Cyclic Prefix Size 96,  Rolloff Period Size 64
```

```
Subcarrier Spacing 50KHz,  Symbols Per Frame 18 Subcarrier Per Minislot: 8

Modulation Profile (ID 466, Subcarrier Spacing 50KHz)
  IUC type   Cfg   Act  Preamble Bit       Pilot
             subc  subc Symbols  Loading   Pattern
  3  (IR)    64    64     4       -         -
  4  (FR)    128   128    1       -         -
  13 (data)  -     -      -     1024-QAM    2
Calculated Data burst profile:
IUC  Group   Bit       Pilot   Start  Consec
             Loading   Pattern Mslot  Mslot
13   0       1024-QAM  2       0       109

#Total mslots:110 #Fine Rng capable:95 #Initial Rng capable:103
 Initial Rng - Freq 50.000MHz mslotOffset:36 #mslot in frame:8
Minislot mapping:  mslot#(start_sc start_freq(Mhz) end_sc end_freq(Mhz)
 mslot type(E-Edge; B-Body; S-Share with SCQAM;
 I-Initial rng capable; F-Fine rng capable)
 (next Fine Rng capable minislot if current is not capable))
0  (  74, 35.500,   81, 35.850, EIF ( - )), 1  (  82, 35.900,   89, 36.250, BIF ( - )),
2  (  90, 36.300,   97, 36.650, BIF ( - )), 3  (  98, 36.700,  105, 37.050, BIF ( - )),
4  ( 106, 37.100,  113, 37.450, BIF ( - )), 5  ( 114, 37.500,  121, 37.850, BIF ( - )),
6  ( 122, 37.900,  129, 38.250, BIF ( - )), 7  ( 130, 38.300,  137, 38.650, BIF ( - )),
8  ( 138, 38.700,  145, 39.050, BIF ( - )), 9  ( 146, 39.100,  153, 39.450, BIF ( - )),
10 ( 154, 39.500,  161, 39.850, BIF ( - )), 11 ( 162, 39.900,  169, 40.250, BIF ( - )),
12 ( 170, 40.300,  177, 40.650, BIF ( - )), 13 ( 178, 40.700,  185, 41.050, BIF ( - )),
14 ( 186, 41.100,  193, 41.450, BIF ( - )), 15 ( 194, 41.500,  201, 41.850, BIF ( - )),
16 ( 202, 41.900,  209, 42.250, BIF ( - )), 17 ( 210, 42.300,  217, 42.650, BIF ( - )),
18 ( 218, 42.700,  225, 43.050, BIF ( - )), 19 ( 226, 43.100,  233, 43.450, BIF ( - )),
20 ( 234, 43.500,  241, 43.850, BIF ( - )), 21 ( 242, 43.900,  249, 44.250, BIF ( - )),
22 ( 250, 44.300,  257, 44.650, BIF ( - )), 23 ( 258, 44.700,  265, 45.050, BIF ( - )),
24 ( 266, 45.100,  273, 45.450, BIF ( - )), 25 ( 274, 45.500,  281, 45.850, BIF ( - )),

26 ( 282, 45.900,  289, 46.250, BIF ( - )), 27 ( 290, 46.300,  297, 46.650, BIF ( - )),
28 ( 298, 46.700,  305, 47.050, BIF ( - )), 29 ( 306, 47.100,  313, 47.450, BIF ( - )),
30 ( 314, 47.500,  321, 47.850, BIF ( - )), 31 ( 322, 47.900,  329, 48.250, BIF ( - )),
32 ( 330, 48.300,  337, 48.650, BIF ( - )), 33 ( 338, 48.700,  345, 49.050, BIF ( - )),
34 ( 346, 49.100,  353, 49.450, BIF ( - )), 35 ( 354, 49.500,  361, 49.850, BIF ( - )),
36 ( 362, 49.900,  369, 50.250, BIF ( - )), 37 ( 370, 50.300,  377, 50.650, BIF ( - )),
38 ( 378, 50.700,  385, 51.050, BIF ( - )), 39 ( 386, 51.100,  393, 51.450, BIF ( - )),
40 ( 394, 51.500,  401, 51.850, BIF ( - )), 41 ( 402, 51.900,  409, 52.250, BIF ( - )),
42 ( 410, 52.300,  417, 52.650, BIF ( - )), 43 ( 418, 52.700,  425, 53.050, BIF ( - )),
44 ( 426, 53.100,  433, 53.450, BIF ( - )), 45 ( 434, 53.500,  441, 53.850, BIF ( - )),
46 ( 442, 53.900,  449, 54.250, BIF ( - )), 47 ( 450, 54.300,  457, 54.650, BIF ( - )),
48 ( 458, 54.700,  465, 55.050, BIF ( - )), 49 ( 466, 55.100,  473, 55.450, BIF ( - )),
50 ( 474, 55.500,  481, 55.850, BIF ( - )), 51 ( 482, 55.900,  489, 56.250, BIF ( - )),
52 ( 490, 56.300,  497, 56.650, BIF ( - )), 53 ( 498, 56.700,  505, 57.050, BIF ( - )),
54 ( 506, 57.100,  513, 57.450, BIF ( - )), 55 ( 514, 57.500,  521, 57.850, BIF ( - )),
56 ( 522, 57.900,  529, 58.250, BIF ( - )), 57 ( 530, 58.300,  537, 58.650, BIF ( - )),
58 ( 538, 58.700,  545, 59.050, BIF ( - )), 59 ( 546, 59.100,  553, 59.450, BIF ( - )),
60 ( 554, 59.500,  561, 59.850, BIF ( - )), 61 ( 562, 59.900,  569, 60.250, BIF ( - )),
62 ( 570, 60.300,  577, 60.650, BIF ( - )), 63 ( 578, 60.700,  585, 61.050, BIF ( - )),
64 ( 586, 61.100,  593, 61.450, BIF ( - )), 65 ( 594, 61.500,  601, 61.850, BIF ( - )),
66 ( 602, 61.900,  609, 62.250, BIF ( - )), 67 ( 610, 62.300,  617, 62.650, BIF ( - )),
68 ( 618, 62.700,  625, 63.050, BIF ( - )), 69 ( 626, 63.100,  633, 63.450, BIF ( - )),
70 ( 634, 63.500,  641, 63.850, BIF ( - )), 71 ( 642, 63.900,  649, 64.250, BIF ( - )),
72 ( 650, 64.300,  657, 64.650, BIF ( - )), 73 ( 658, 64.700,  665, 65.050, BIF ( - )),
74 ( 666, 65.100,  673, 65.450, BIF ( - )), 75 ( 674, 65.500,  681, 65.850, BIF ( - )),
76 ( 682, 65.900,  689, 66.250, BIF ( - )), 77 ( 690, 66.300,  697, 66.650, BIF ( - )),
78 ( 698, 66.700,  705, 67.050, BIF ( - )), 79 ( 706, 67.100,  713, 67.450, BIF ( - )),
80 ( 714, 67.500,  721, 67.850, BIF ( - )), 81 ( 722, 67.900,  729, 68.250, BIF ( - )),
82 ( 730, 68.300,  737, 68.650, BIF ( - )), 83 ( 738, 68.700,  745, 69.050, BIF ( - )),
84 ( 746, 69.100,  753, 69.450, BIF ( - )), 85 ( 754, 69.500,  761, 69.850, BIF ( - )),
86 ( 762, 69.900,  769, 70.250, BIF ( - )), 87 ( 770, 70.300,  777, 70.650, BIF ( - )),
```

```
88 ( 778, 70.700,  785, 71.050, BIF ( - )), 89 ( 786, 71.100,  793, 71.450, BIF ( - )),
90 ( 794, 71.500,  801, 71.850, BIF ( - )), 91 ( 802, 71.900,  809, 72.250, BIF ( - )),
92 ( 810, 72.300,  817, 72.650, BIF ( - )), 93 ( 818, 72.700,  825, 73.050, BIF ( - )),
94 ( 826, 73.100,  833, 73.450, BIF ( - )), 95 ( 834, 73.500,  841, 73.850, BI  (0  )),
96 ( 842, 73.900,  849, 74.250, BI  (0  )), 97 ( 850, 74.300,  857, 74.650, BI  (0  )),
98 ( 858, 74.700,  865, 75.050, BI  (0  )), 99 ( 866, 75.100,  873, 75.450, BI  (0  )),
100( 874, 75.500,  881, 75.850, BI  (0  )), 101( 882, 75.900,  889, 76.250, BI  (0  )),
102( 890, 76.300,  897, 76.650, BI  (0  )), 103( 898, 76.700,  905, 77.050, B   (0  )),
104( 906, 77.100,  913, 77.450, B   (0  )), 105( 914, 77.500,  921, 77.850, B   (0  )),
106( 922, 77.900,  929, 78.250, B   (0  )), 107( 930, 78.300,  937, 78.650, B   (0  )),
108( 938, 78.700,  945, 79.050, B   (0  )), 109( 946, 79.100,  953, 79.450, B   (0  )),

Mapped to connector 4 and receiver 108

Bind to Cable1/0/4 US4
MER(SNR) - Unknown - no modems online.
Spectrum Group is unassigned
Nominal Input Power Level 0 dBmV

UCD procedures on lch 0
UCD ucd-proxy-timeout   (0   ) ucd-proxy-wrong-ack (0   )
```

Configure Exclusion / Unused Bands

An OFDMA channel never use frequencies located in exclusion bands. OFDMA probes will be sent on frequencies located in the unused bands. Therefore exclusion bands must be used to prevent interference with SC-QAM channels. To configure the Exclusion / Unused Bands, follow the steps below:

enable
configure terminal
controller Upstream-Cable *slot/subslot/port*
cable ofdma-frequency-exclusion-band *start-value end-value*
cable ofdma-frequency-unused-band *start-value end-value*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/2
Router(config-controller)# cable ofdma-frequency-exclusion-band 48000000 54200000
Router(config-controller)# cable ofdma-frequency-unused-band 50000000 52000000
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 frequency-range 45000000 70000000
Router(config-controller)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller)# us-channel 12 symbols-per-frame 18
```

Verifying Exclusion / Unused Bands

To display the Exclusion / Unused Band configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
USPHY OFDMA support: FULL

Controller Exclusion Freq List:
( 40.000 MHz, 44.200 MHz),
Controller Unused Freq List:
```

```
( 50.000 MHz, 52.000 MHz),

Controller 1/0/9 upstream 12 AdminState:UP OpState: UP
ofdma mode enabled
Channel Freq Range 28.500 MHz to 69.500 MHz
Channel Subcarrier Index Range Cfg: 148, 1787 Op: 148, 1787
Channel SC0 Freq Cfg: 24.800 MHz Op: 24.800 MHz
#Excl bands: 3
( 0, 147), ( 608, 776), (1788, 4095),
#Unused bands: 3
( 596, 607), (1001, 1088), (1777, 1787),
```

Override OFDMA Profile Per Channel

It is possible to override the modulation and pilot pattern used by a particular IUC on a given OFDMA channel as shown with the command below.

enable
configure terminal
controller Upstream-Cable *slot/subslot/port*
us-channel *id* **data-iuc** *id* **band** *start-value end-value* **modulation** *value* **pilot-pattern** *value*

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# controller Upstream-Cable 1/0/2
Router(config-controller)# us-channel 12 docsis-mode ofdma
Router(config-controller)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller)# us-channel 12 modulation-profile 423
Router(config-controller)# us-channel 12 frequency-range 28000000 70000000
Router(config-controller)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller)# us-channel 12 symbols-per-frame 18
Router(config-controller)# us-channel 12 data-iuc 6 band 60000000 65000000 modulation 128-QAM
 pilot-pattern 9
Router(config-controller)# no us-channel 12 shutdown
```

Note Override values will be removed from US channel when changing modulation profile, including when profile changes due to changes in subcarrier spacing.

Verifying Override Configuration

To display the override configuration, use the **show controllers upstream-Cable us-channel** command as shown in the example below:

```
Router# show controllers upstream-Cable 1/0/2 us-channel 12
 .....
   Modulation Profile (ID 423, Subcarrier Spacing 25KHz)
    IUC type    Cfg   Act  Preamble Bit       Pilot
                subc  subc Symbols  Loading   Pattern
    3   (IR)    64    64     4       -         -
    4   (FR)    128   128    1       -         -
    6   (data)  -     -      -     1024-QAM    8
    10  (data)  -     -      -     512-QAM     8
```

```
   11 (data)  -      -       -      256-QAM      8
   12 (data)  -      -       -      128-QAM      9
   13 (data)  -      -       -      64-QAM       9
  Overwrite Data Profile:
  IUC  Start      End         Start   End     Bit        Pilot
       Freq(MHz)  Freq(MHz)   Subc    Subc    Loading    Pattern
  6      60.0      65.0       1408    1608    128-QAM    9

  Calculated Data burst profile:
  IUC  Group   Bit        Pilot   Start  Consec
               Loading    Pattern Mslot  Mslot
  6    0       1024-QAM   8       0      61
  6    1       128-QAM    9       62     11
  6    2       1024-QAM   8       74     10
  10   0       512-QAM    8       0      84
  11   0       256-QAM    8       0      84
  12   0       128-QAM    9       0      84
  13   0       64-QAM     9       0      84
 ......
```

Apply OFDMA Upstream To Cable Interface

To associate upstream channels with a MAC domain and configure upstream bonding, follow the steps below:

```
enable
configure terminal
interface Cable slot/subslot/interface
cable upstream bonding-group id
upstream id
attributes value
cable bundle id
```

Here is a configuration example:

```
Router# enable
Router# configure terminal
Router(config)# interface Cable 1/0/4
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 0
Router(config-if)# downstream Integrated-Cable 1/0/4 rf-channel 16
Router(config-if)# upstream 0 Upstream-Cable 1/0/0 us-channel 0
Router(config-if)# upstream 1 Upstream-Cable 1/0/0 us-channel 1
Router(config-if)# upstream 2 Upstream-Cable 1/0/0 us-channel 2
Router(config-if)# upstream 3 Upstream-Cable 1/0/0 us-channel 3
Router(config-if)# upstream 6 Upstream-Cable 1/0/0 us-channel 12
Router(config-if)# cable upstream bonding-group 1
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# attributes 80000000
Router(config-upstream-bonding)# exit
Router(config-if)# cable upstream bonding-group 2
Router(config-upstream-bonding)# upstream 0
Router(config-upstream-bonding)# upstream 1
Router(config-upstream-bonding)# upstream 2
Router(config-upstream-bonding)# upstream 3
Router(config-upstream-bonding)# upstream 6
Router(config-upstream-bonding)# attributes 80000000
```

```
Router(config-upstream-bonding)# exit
Router(config-if)# cable bundle 1
```

Determine DOCSIS 3.1 Cable Modems and the Cable Modems Using OFDMA Upstreams

To display the DOCSIS 3.1 cable modem, use the **show cable modem docsis version d31-capable** command as shown in the example below:

```
Router# show cable modem docsis version d31-capable
MAC Address    I/F            MAC              Reg Oper DSxUS DS   RCC    US
                              State            Ver Ver        OFDM ID     OFDMA
4800.33ea.7012 C1/0/0/UB      w-online(pt)     3.1 3.1  33x4  1    5      1
203d.66ae.4169 C1/0/0/UB      w-online(pt)     3.1 3.1  33x4  1    5      1
```

To display DOCSIS PHY layer information for the cable modem, use the **show cable modem phy** command as shown in the example below:

```
Router# show cable modem 5039.5584.5bbe phy
MAC Address    I/F        Sid   USPwr  USMER Timing DSPwr  DSMER  Mode   DOCSIS
                             (dBmV) (SNR) Offset (dBmV) (SNR)         Prov
                                    (dB)                (dB)
5039.5584.5bbe C1/0/0/U0  15    38.75  ----- 2282   0.00   -----  ofdma  1.1
```

To display the cable modem using OFDMA upstream, use the **show cable modem phy** command as shown in the example below:

```
Router# show cable modem phy | include ofdma
5039.5584.5bbe C1/0/0/U0     15    38.75  ----- 2282    0.00  -----  ofdma  1.1
0895.2a9b.26f1 C1/0/0/U0     16    28.00  ----- 2146    0.00  -----  ofdma  1.1
```

To display the OFDMA channel capacity and utilization, use the **show interface cable mac-scheduler** command as shown in the example below:

```
Router# show interfaces cable 1/0/2 mac-scheduler 6
     DOCSIS 1.1 MAC scheduler for Cable1/0/2/U6 : rate 279807192
     Max potential performance for each configured IUC type
     IUC: 6     rate: 279807192
     IUC: 10    rate: 263104848
     IUC: 11    rate: 233779840
     IUC: 12    rate: 203019328
     IUC: 13    rate: 173899376
     wfq:None
     us_balance:OFF
     dpon_mode:OFF
     fairness:OFF
     Queue[Rng Polls] flows 0
     Queue[CIR Grants] flows 0
     Queue[BE(07) Grants] flows 0
     Queue[BE(06) Grants] flows 0
     Queue[BE(05) Grants] flows 0
     Queue[BE(04) Grants] flows 0
     Queue[BE(03) Grants] flows 0
     Queue[BE(02) Grants] flows 0
     Queue[BE(01) Grants] flows 0
     Queue[BE(00) Grants] flows 0
     Req Slots 38510548
     Req/Data Slots 1275
     Init Mtn Slots 47832
     Stn Mtn Slots 0
     IUC 5 Slots 0
     IUC 6 Slots 6378
```

```
IUC 9 Slots 0
IUC 10 Slots 254923830
IUC 11 Slots 220
IUC 12 Slots 4006
IUC 13 Slots 251213508
Avg upstream channel utilization : 0%
Avg upstream channel utilization in 30 sec : 0%
Avg percent contention slots : 96%
Avg percent initial ranging slots : 0%
Avg percent minislots lost on late MAPs : 0%

MAP TSS: lch_state 10, init_retries 0
         late_initial_maps 0, late_ucd_maps 0
         mac-phy tss errors 0, missed ccc 0
```

Verifying DOCSIS3.1 Upstream OFDMA channel bonding across DOCSIS3.0 ATDMA channels

Starting from Cisco IOS XE Everest 16.6.1 release, DOCSIS3.1 Upstream OFDMA channel can be bonded with DOCSIS3.0 ATDMA channel. If the user wants to utilize non-best effort flows, it is recommended to bond the OFDMA channel with one or more ATDMA channels. But be aware that in Cisco IOS XE Everest 16.6.1 release, a maximum of 1 OFDMA channel and 4 ATDMA channels can be bonded together.

Below is an output example showing the bonding group 8 has both OFDMA (channel 12) and ATDMA channels (channel 0, 1, 2, 3).

```
interface Cable6/0/0
downstream Integrated-Cable 6/0/0 rf-channel 1
downstream Integrated-Cable 6/0/0 rf-channel 158
upstream 0 Upstream-Cable 6/0/0 us-channel 0
upstream 1 Upstream-Cable 6/0/0 us-channel 1
upstream 2 Upstream-Cable 6/0/0 us-channel 2
upstream 3 Upstream-Cable 6/0/0 us-channel 3
upstream 6 Upstream-Cable 6/0/0 us-channel 12
cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes 80000000
cable upstream bonding-group 8
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
cable bundle 1
cable privacy accept-self-signed-certificate
end
```

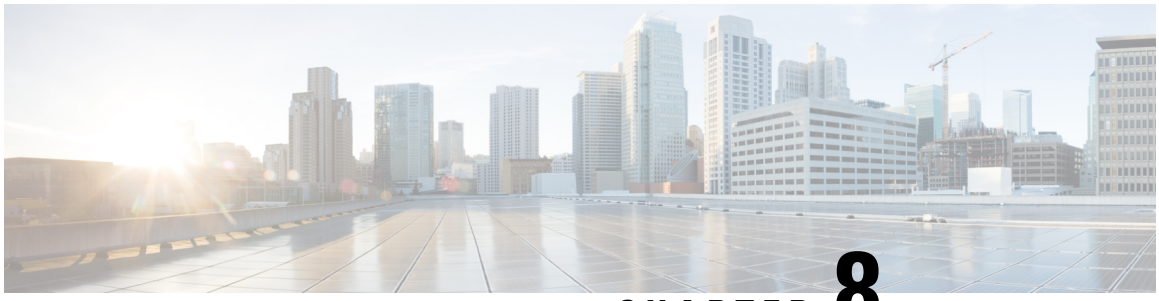
Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 15: Feature Information for DOCSIS 3.1 OFDMA Channel Configuration

Feature Name	Releases	Feature Information
DOCSIS 3. 1 US 16 OFDMA channel support per line card	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.
DOCSIS 3.1 US OFDMA channel bonding across DOCSIS 3.0 ATDMA channels	Cisco IOS XE Fuji 16.7.1	This feature was integrated on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 8

Time and Frequency Division Multiplexing Configuration

This document provides information on the Cisco cBR-8 series routers support for Time and Frequency Division Multiplexing (TaFDM) feature in DOCSIS 3.1 upstream channels.

- Information About TaFDM Support, on page 55
- How to Configure cBR for TaFDM Support, on page 56
- Configuration Example , on page 58
- Feature Information for TaFDM Configuration, on page 59

Information About TaFDM Support

Using the Time and Frequency Division Multiplexing (TaFDM) method, the OFDMA and SCQAM channels, which are allowed to overlap in DOCSIS 3.1, are also allowed to use the upstream at different times. With the implementation of TaFDM, both OFDMA and SC-QAM can simultaneously operate on separate frequencies. They can also operate on the same frequencies, but in different times.

TaFDM enables the OFDMA capability across the entire spectrum, while retaining the backward compatibility with legacy DOCSIS SC-QAM channels.

TaFDM is typically configured at the controller level. However, it is implemented at the Mac Domain level. Overlapping channels cannot be bound to different Mac Domains.

Overlapping SC-QAM and OFDMA channels using TaFDM may be bonded. However, we recommend this bonding only if the modems are provisioned with UGS flows and another non-overlapping SC-QAM is not available.

For a better performance of UGS flows on overlapped SC-QAM channel, configure OFDMA channel with 50kHz subcarrier spacing, lower symbols per frame, and lower cyclic prefix.

To achieve a higher OFDMA channel traffic throughput, configure OFDMA channel with 25kHz subcarrier spacing, and higher pilot pattern.

Prerequisites for Configuring TaFDM Support

The following prerequisite is applicable to configuring TaFDM configuration:

- All overlapped SC-QAM channels and OFDMA channels on the same port must be bound to the same Mac Domain
- Reserve a minimum 0.8–3.2 MHz OFDMA exclusive spectrum with good signal quality to be used for OFDMA channel IM zone

How to Configure cBR for TaFDM Support

Configuring TaFDM Modulation Profile

The TaFDM modulation profile is used to configure initial ranging, fine ranging and data IUC parameters. To define the TaFDM modulation profile, run the configuration commands, as given in the following example:

```
cable mod-profile-ofdma 450
  subcarrier-spacing 25KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 11
  data-iuc 10 modulation 512-QAM pilot-pattern 11
  data-iuc 11 modulation 256-QAM pilot-pattern 8
  data-iuc 12 modulation 128-QAM pilot-pattern 8
  data-iuc 13 modulation 64-QAM pilot-pattern 8

cable mod-profile-ofdma 470
  subcarrier-spacing 50KHz
  initial-rng-subcarrier 64
  fine-rng-subcarrier 192
  data-iuc 9 modulation 1024-QAM pilot-pattern 1
  data-iuc 10 modulation 512-QAM pilot-pattern 1
  data-iuc 11 modulation 256-QAM pilot-pattern 1
  data-iuc 12 modulation 128-QAM pilot-pattern 1
  data-iuc 13 modulation 64-QAM pilot-pattern 1
```

Configuring I/O Controller for TaFDM

The following sample configuration defines a shared region in the areas of the SC-QAM upstream channels.

```
controller Upstream-Cable slot/subslot/port
  us-channel 0 frequency 35800000
  us-channel 0 channel-width 6400000 6400000
  us-channel 0 docsis-mode atdma
  us-channel 0 minislot-size 2
  us-channel 0 modulation-profile 221
  us-channel 0 equalization-coefficient
  no us-channel 0 shutdown
  us-channel 1 frequency 29400000
  us-channel 1 channel-width 6400000 6400000
  us-channel 1 docsis-mode atdma
  us-channel 1 minislot-size 2
  us-channel 1 modulation-profile 221
  us-channel 1 equalization-coefficient
  no us-channel 1 shutdown
  us-channel 2 frequency 23000000
  us-channel 2 channel-width 6400000 6400000
  us-channel 2 docsis-mode atdma
  us-channel 2 minislot-size 2
```

```
  us-channel 2 modulation-profile 221
  us-channel 2 equalization-coefficient
  no us-channel 2 shutdown
  us-channel 3 frequency 16600000
  us-channel 3 channel-width 6400000 6400000
  us-channel 3 docsis-mode atdma
  us-channel 3 minislot-size 2
  us-channel 3 modulation-profile 221
  us-channel 3 equalization-coefficient
  no us-channel 3 shutdown
```

Enhancing OFDMA Channel Throughput

The following example shows how to enhance the OFDMA channel throughput:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 25KHz
  us-channel 12 modulation-profile 450
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000    # Specify the preferred start
frequency for IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 9
  no us-channel 12 shutdown
```

Enhancing SC-QAM Channel UGS Flow Performance

The following example shows how to enhance the UGS flow performance of the SC-QAM channel:

```
controller Upstream-Cable 1/0/0
  …
  us-channel 12 docsis-mode ofdma
  us-channel 12 subcarrier-spacing 50KHz
  us-channel 12 modulation-profile 470
  us-channel 12 frequency-range 10000000 85000000    #Overlap with SC-QAM channels
  us-channel 12 initial-rng-frequency-start 50000000   #Specify the preferred frequency for
 IM zone
  us-channel 12 cyclic-prefix 96 roll-off-period 64
  us-channel 12 symbols-per-frame 8
  no us-channel 12 shutdown
```

Configuring Cable Interface-MAC Domain

The following example shows how to configure a cable interface for MAC Domain:

```
interface Cable1/0/0
  load-interval 30

  upstream 0 Upstream-Cable 1/0/0 us-channel 0
  upstream 1 Upstream-Cable 1/0/0 us-channel 1
  upstream 2 Upstream-Cable 1/0/0 us-channel 2
  upstream 3 Upstream-Cable 1/0/0 us-channel 3
  upstream 6 Upstream-Cable 1/0/0 us-channel 12
  cable upstream bonding-group 1
    upstream 0
    upstream 1
```

```
  upstream 2
  upstream 3
  attributes 80000000
cable upstream bonding-group 2
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  upstream 6
  attributes 80000000
cable bundle 1
cable sid-cluster-group num-of-cluster 2     #Maximize single modem throughput
cable sid-cluster-switching max-request 4
cable cm-status enable 3 6-11 16-18 20-27
cable privacy accept-self-signed-certificate
```

Configuring Service Class

The following example shows how to configure service classes:

```
cable service class 198 name mega_up
cable service class 198 upstream
cable service class 198 max-concat-burst 16384
cable service class 198 max-rate 1000000000    # Maximize single modem throughput
cable service class 198 max-burst 250000
cable service class 198 priority 0
cable service class 198 peak-rate 0
```

Excluding a Frequency Band from TaFDM

If you want the SC-QAM to exclusively use a specific frequency range, configure Cisco cBR to exclude the band using the following sample commands.

```
controller Upstream-Cable slot/subslot/port
 cable frequency-exclusion-band 18700000 22100000
```

Verifying TaFDM Configuration

The following example shows how to verify the TaFDM configuration:

```
# show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller

#show controllers upstream-Cable slot/subslot/port us-channel uschan-number-in-controller
cdm-ump

# show interfaces cable slot/subslot/port mac-scheduler uschan-number-in-mac-domain
```

Configuration Example

TaFDM Configuration

```
controller Upstream-Cable 1/0/0
  us-channel 0 frequency 15000000
```

```
us-channel 0 channel-width 3200000 3200000
us-channel 1 frequency 22000000
us-channel 1 channel-width 6400000 6400000
us-channel 2 frequency 29000000
us-channel 2 channel-width 6400000 6400000
us-channel 3 frequency 36000000
us-channel 3 channel-width 6400000 6400000
us-channel 4 frequency 11000000
us-channel 4 channel-width 1600000 1600000
us-channel 12 frequency-range 5000000 85000000
```

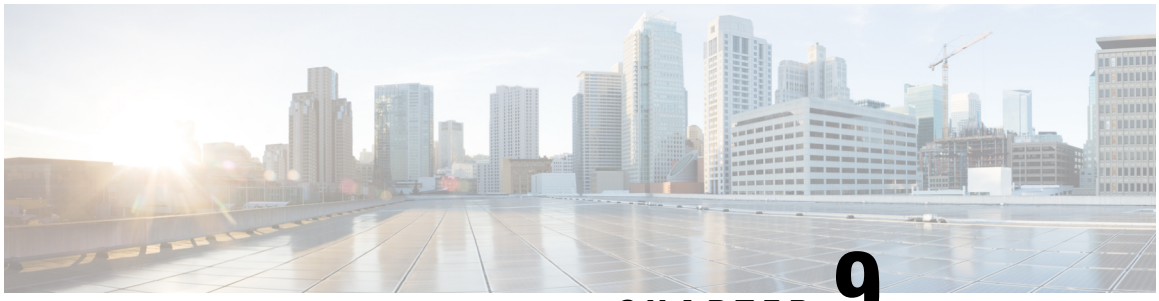
Feature Information for TaFDM Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 16: Feature Information for for TaFDM Configuration

Feature Name	Releases	Feature Information
TaFDM Configuration	Cisco IOS XE Fuji 16.7.1	This feature was introduced on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 9

DOCSIS 3.1 Upstream Profile Selection

DOCSIS 3.1 introduces the concept of uptream profiles for OFDMA channels. This document describes how to configure the DOCSIS 3.1 Upstream Profile Selection on the Cisco cBR Series Converged Broadband Router.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 61
- Information about Upstream Profiles, on page 62
- How to Configure Upstream Profiles, on page 63
- Feature Information for Upstream Profile Selection, on page 64

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 17: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about Upstream Profiles

A modulation profile is a list of interval usage codes (IUCs) that are defined for an OFDMA channel. Each IUC will have a modulation order and pilot pattern. Multiple IUCs within a modulation profile allow for different modulation orders on the same OFDMA channel. The CMTS can define multiple profiles for use in an OFDMA channel, where the profiles differ in the modulation orders assigned to each minislot.

You can use the following commands to view the profiles:

- To display the profiles associated with the cable modems (CMs), use the **show cable modem** *[ip-address| mac-address| cable| {slot | subslot | cable-interface-index}]* **phy ofdm-profile upstream** command.
- To display detailed profile management data associated with specific cable modem, use the **show cable modem** *[ip-address| mac-address]* **prof-mgmt upstream** command.

The CMTS can assign different data IUCs for different groups of CMs.

A DOCSIS 3.1 CM can only have two active OFDMA Upstream Data Profile IUCs on a given channel.

Default Data IUC

Data IUC 13 is intended to be the most robust IUC and able to be used by all cable modems.

Recommended Interval Usage Code (IUC)

Based on the receive modulation error ratio (RxMER) values collected periodically during upstream probing, the CMTS finds among the existing IUCs up to two that provide the highest speed while having sufficient signal to noise ratio (SNR) margin for the CMTS to receive code words with acceptable error rates. The **show cable modem phy ofdm-profile upstream** command displays the one or two recommended IUCs for each CM.

In Cisco IOS XE Everest 16.6.1 release, data IUC 13 will be one of the IUCs assigned to the CM.

To disable the automatic profile downgrade, use **no cable upstream ofdma-prof-mgmt prof-upgrade-auto** command in global configuration mode.

How to Configure Upstream Profiles

Configuring RxMER to Bit Loading Mapping

There are many ways to map the Receive Modulation Error Ratio (RxMER) values to bit loading values. We use the following mapping recommended in DOCSIS 3.1 OSSI, as our baseline mapping:

RxMER (in ¼ DB)	QAM	Bit Loading
60	16	4
84	64	6
96	128	7
108	256	8
122	512	9
136	1024	10
148	2048	11
164	4096	12
184	8192	13
208	16384	14

- To configure a margin to adjust the RxMER to bit loading mapping, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt mer-margin-qdb interval-in-minutes
  ```

  This configured value (*quarter-DB*) is added to the RxMER values collected by CMTS before using the above mapping table, thus giving a user more control in selecting the recommended profiles.

- To specify the percentage of minislot average RxMER that can be ignored in the recommended profile calculation, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt exempt-mslot-pct percent
  ```

  This provides a way to specify the extent that the outliers can be ignored.

- To configure the RxMER poll interval, use the following command:

  ```
  Router(config)# cable upstream ofdma-prof-mgmt rxmer-poll-interval interval-in-minutes
  ```

  The CMTS uses upstream probing to collect RxMER data per CM. This occurs during registration and periodically thereafter. The collected RxMER data is averaged per minislot and used to compute the recommended IUCs for each CM.

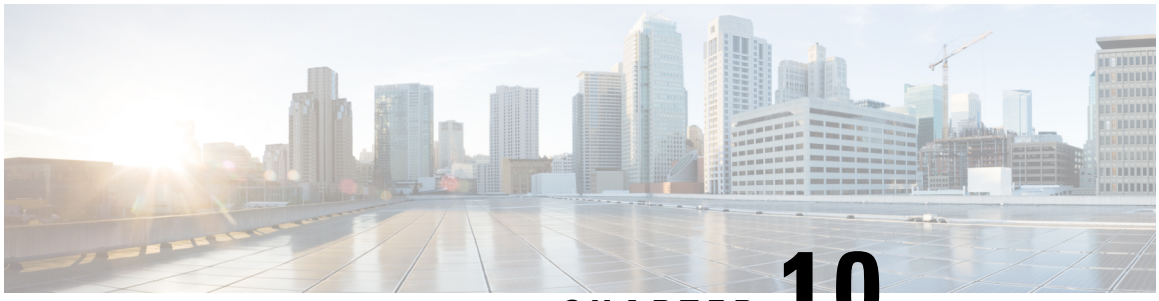
Feature Information for Upstream Profile Selection

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 18: Feature Information for Upstream Profile Selection

Feature Name	Releases	Feature Information
DOCSIS3.1 US Profile Selection	Cisco IOS XE Fuji 16.7.1	This feature was integrated into Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 10

Downstream Power Tilt

The Downstream Power tilt feature is used to correct cable loss in the head-end to produce a flat power spectrum for all channels in the controller port.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 65
- Information about Downstream Power Tilt, on page 66
- How to Configure the Downstream Power Tilt, on page 67
- Feature Information for Downstream Power Tilt, on page 68

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 19: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about Downstream Power Tilt

The downstream power tilt feature is used to correct cable loss in the head-end to produce a flat power spectrum for all channels on the controller port.

Note There may be noise floor degradation on the failover path (following linecard switchover) with this feature enabled.

Restrictions for Configuring Downstream Power Profile

The downstream power tilt feature and OFDM power profile feature are mutually exclusive. They cannot be configured at the same time.

How to Configure the Downstream Power Tilt

Configuring Downstream Power Tilt

Downstream power tilt applies to all the SCQAM or OFDM channels on the downstream. To configure downstream power tilt for a controller port, use the power-tilt configuration command under the downstream controller port.

```
enable
configure terminal
controller Integrated-Cable slot/subslot/port
max-ofdm-spectrum value
max-carrier value
base-channel-power value
power-tilt mode loss max-frequency freq-max
rf-chan start_id [end_id]
type value
rf-output value
power-adjust value
qam-profileid
docsis-channel-idid
ofdm channel-profile id start-frequency value width value [plc value]
```

Below is an example:

```
controller Integrated-Cable 3/0/0
  max-ofdm-spectrum 192000000
  max-carrier 32
  base-channel-power 34
  power-tilt linear 4.0 max-frequency 696000000
  rf-chan 0 31
    type DOCSIS
    frequency 261000000
    rf-output NORMAL
    power-adjust -2.0
    qam-profile 1
    docsis-channel-id 1
  rf-chan 158
    power-adjust 0
    docsis-channel-id 159
    ofdm channel-profile 20 start-frequency 600000000 width 96000000 plc 645000000
```

In the above configuration steps, there is a command **power-tilt** *mode loss* **max-frequency** *freq-max*, where the *mode* represent a formula that calculates the loss of a coax cable at a frequency F, given the loss at *freq-max* is known. It provides two options to select:

- linear: $loss_F = loss_{freq\text{-}max} * (F / freq\text{-}max)$
- cable-loss-approx: $loss_F = loss_{freq\text{-}max} * SQRT((freq\text{-}max - F) / freq\text{-}max)$

loss is the measured cable loss at *freq-max*, specified in 1/10 dB.

Verifying Downstream Power Tilt Configuration

To display the downstream power tilt details, use the **show cable controller integrated-cable** command as given in the following example. This command will display the actual SCQAM and OFDM channel power levels as set by the DS Power Tilt command. For OFDM channels, the power level displayed represents the center frequency 6-MHz band power level.

```
Router# show controller Integrated-Cable 1/0/1 rf-chan 0-162
Chan State Admin Frequency Type   Annex Mod srate Interleaver dcid power output
0    UP    UP    261000000 DOCSIS B     256 5361  I32-J4      1    29.9  NORMAL
1    UP    UP    267000000 DOCSIS B     256 5361  I32-J4      2    30.0  NORMAL
2    UP    UP    273000000 DOCSIS B     256 5361  I32-J4      3    30.0  NORMAL
3    UP    UP    279000000 DOCSIS B     256 5361  I32-J4      4    30.0  NORMAL
4    UP    UP    285000000 DOCSIS B     256 5361  I32-J4      5    30.1  NORMAL
5    UP    UP    291000000 DOCSIS B     256 5361  I32-J4      6    30.1  NORMAL
6    UP    UP    297000000 DOCSIS B     256 5361  I32-J4      7    30.2  NORMAL
7    UP    UP    303000000 DOCSIS B     256 5361  I32-J4      8    30.2  NORMAL
8    UP    UP    309000000 DOCSIS B     256 5361  I32-J4      9    30.2  NORMAL
9    UP    UP    315000000 DOCSIS B     256 5361  I32-J4      10   30.3  NORMAL
10   UP    UP    321000000 DOCSIS B     256 5361  I32-J4      11   30.3  NORMAL
11   UP    UP    327000000 DOCSIS B     256 5361  I32-J4      12   30.3  NORMAL
12   UP    UP    333000000 DOCSIS B     256 5361  I32-J4      13   30.4  NORMAL
13   UP    UP    339000000 DOCSIS B     256 5361  I32-J4      14   30.4  NORMAL
14   UP    UP    345000000 DOCSIS B     256 5361  I32-J4      15   30.4  NORMAL
15   UP    UP    351000000 DOCSIS B     256 5361  I32-J4      16   30.5  NORMAL
16   UP    UP    357000000 DOCSIS B     256 5361  I32-J4      17   30.5  NORMAL
17   UP    UP    363000000 DOCSIS B     256 5361  I32-J4      18   30.5  NORMAL
18   UP    UP    369000000 DOCSIS B     256 5361  I32-J4      19   30.6  NORMAL
19   UP    UP    375000000 DOCSIS B     256 5361  I32-J4      20   30.6  NORMAL
20   UP    UP    381000000 DOCSIS B     256 5361  I32-J4      21   30.6  NORMAL
21   UP    UP    387000000 DOCSIS B     256 5361  I32-J4      22   30.7  NORMAL
22   UP    UP    393000000 DOCSIS B     256 5361  I32-J4      23   30.7  NORMAL
23   UP    UP    399000000 DOCSIS B     256 5361  I32-J4      24   30.7  NORMAL
24   UP    UP    405000000 DOCSIS B     256 5361  I32-J4      25   30.8  NORMAL
25   UP    UP    411000000 DOCSIS B     256 5361  I32-J4      26   30.8  NORMAL
26   UP    UP    417000000 DOCSIS B     256 5361  I32-J4      27   30.8  NORMAL
27   UP    UP    423000000 DOCSIS B     256 5361  I32-J4      28   30.9  NORMAL
28   UP    UP    429000000 DOCSIS B     256 5361  I32-J4      29   30.9  NORMAL
29   UP    UP    435000000 DOCSIS B     256 5361  I32-J4      30   30.9  NORMAL
30   UP    UP    441000000 DOCSIS B     256 5361  I32-J4      31   30.9  NORMAL
31   UP    UP    447000000 DOCSIS B     256 5361  I32-J4      32   31.0  NORMAL

Chan State Admin Mod-Type Start     Width    PLC      Profile-ID dcid power output Frequency

158  UP    UP    OFDM     600000000 96000000 645000000 22         159  33.9         NORMAL
```

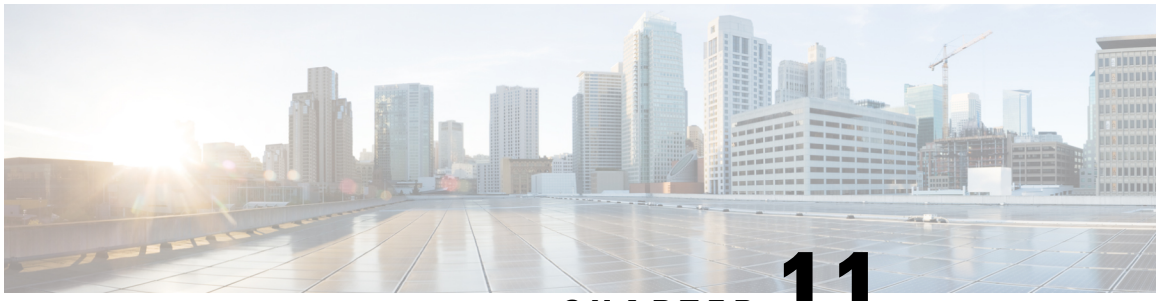
Feature Information for Downstream Power Tilt

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 20: Feature Information for Downstream Power Tilt

Feature Name	Releases	Feature Information
Downstream Power Tilt	Cisco IOS XE Fuji 16.7.1	This feature was introduced on Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 11

Controller Profile Configuration

This document describes how to configure the controller profile on the Cisco cBR Series Converged Broadband Router.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 71
- Information about Controller Profile Configuration, on page 72
- How to Configure the Controller Profile, on page 73
- Feature Information for Controller Profile Configuration, on page 76

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 21: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about Controller Profile Configuration

As density increases with the merging of CMTS and UEQAM functions in the same device, the current controller configuration method becomes too complex and difficult. There are too many identical lines of configuration.

To simplify the controller configuration, a new concept called controller profile is introduced. A controller profile is a group of configuration parameters that apply to downstream and upstream controller, the benefits include:

- Speed up deployment
- Simplify cBR-8 deployment, configuration and troubleshooting
- Common configurations across nodes/regions
- Consistency across Cisco products for common functions

How to Configure the Controller Profile

User configures I-CMTS controllers using legacy controller configuration commands by default. If user wants to use I-CMTS controller profile, needs to enable it first with **cable controller-profile I-CMTS enable** command.

Note

- If user wants to configure controller using profile, it is recommended to start configuration on a "clean" CMTS without any legacy command configured in Integrated-Cable and Upstream-Cable controllers. Do not switch over between legacy configuration and profile.
- When modifying controller profile, all related controllers will be changed. So if user wants to configure a specific controller, for example, modify the base-channel power of a controller, user should not bind this controller to a profile together with other controllers.
- Legacy controller configuration commands are not supported if I-CMTS controller-profile is enabled.
- Legacy controller configuration cannot be shown in running-config if I-CMTS controller-profile is enabled.

Configuring Downstream Controller Profile

To configure downstream controller profile, use the steps below:

```
enable
configure terminal
cable downstream controller-profile id [RPHY|I-CMTS]
base-channel-power value
max-carrier value
freq-profile id
max-ofdm-spectrum value
ofdm-freq-excl-band start-frequency value widthvalue
rf-chan start_id [end_id]
type value
rf-output value
power-adjust value
qam-profileid
docsis-channel-idid
power-profile id
ofdm channel-profile id start-frequency value width value [plc value]

enable
configure terminal
controller integrated-cable slot/subslot/port
profile id
```

Below is an example:

```
cable downstream controller-profile 0 I-CMTS
 max-carrier 32
 base-channel-power 34
```

```
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1

controller integrated-cable 2/0/0
 profile 0
```

Note

- When configure a new I-CMTS controller profile, keyword I-CMTS is needed. If input RPHY or do not input any keyword, the system will consider it as a RPHY controller profile. Once a profile type (RPHY/I-CMTS) is set, it cannot be modified.
- Updating a profile will affect all the controllers bond with it. To delete a profile that bond with controller, user must unbind all the controllers first. All rf-channel configuration in controller will be deleted after unbind.
- At least 8 QAM channels should be configured to get the right power. Single continuous wave (CW) mode is not supported.

Verifying Downstream Controller Profile Configuration

Use the **show cable downstream controller-profile** command to verify the configuration of the downstream controller profile.

```
Router# show cable downstream controller-profile 0
Downstream controller-profile 0, type I-CMTS
Description:
Downstream controller-profile 0 is being used by controller Integrated-Cable:
  2/0/0,
  Admin:  UP
  MaxOfdmSpectrum: 192000000
  MaxCarrier: 128
  BasePower: 33.0 dBmV
  Mode: normal
  Frequency profile: unconfigured
  DS Splitting: No
  OFDM frequency exclusion bands: None

Configured RF Channels:
Chan Admin Frequency  Type        Annex Mod  srate Qam-profile  dcid  power output
 0    UP   213000000  DOCSIS       B    256   5361  1           1     33.0  NORMAL
 1    UP   219000000  DOCSIS       B    256   5361  1           2     33.0  NORMAL
 2    UP   225000000  DOCSIS       B    256   5361  1           3     33.0  NORMAL
 3    UP   231000000  DOCSIS       B    256   5361  1           4     33.0  NORMAL
 4    UP   237000000  DOCSIS       B    256   5361  1           5     33.0  NORMAL
 5    UP   243000000  DOCSIS       B    256   5361  1           6     33.0  NORMAL
```

In the above output, integrated-cable 2/0/0 is bond to profile 0. So the output of the **show controllers integrated-Cable 2/0/0 rf-channel 0 5** should match the above output. See the example below:

```
Router# show controllers integrated-cable 2/0/0 rf-channel 0-5
...
Chan Admin Frequency  Type        Annex Mod  srate Qam-profile  dcid  power output
 0    UP   213000000  DOCSIS       B    256   5361  1           1     33.0  NORMAL
```

```
1    UP   219000000  DOCSIS       B    256   5361  1           2     33.0  NORMAL
2    UP   225000000  DOCSIS       B    256   5361  1           3     33.0  NORMAL
3    UP   231000000  DOCSIS       B    256   5361  1           4     33.0  NORMAL
4    UP   237000000  DOCSIS       B    256   5361  1           5     33.0  NORMAL
5    UP   243000000  DOCSIS       B    256   5361  1           6     33.0  NORMAL
```

To check if the parameters in a profile match with the ones configured, use the **show running-config [all] | section cable downstream controller-profile** command as shown in the example below:

```
Router# show running-config | section downstream controller-profile
cable downstream controller-profile 0 I-CMTS
 max-carrier 32
 base-channel-power 34
 rf-chan 0 3
  type DOCSIS
  frequency 111000000
  rf-output NORMAL
  qam-profile 1
  docsis-channel-id 1
```

Configuring Upstream Controller Profile

To configure upstream controller profile, use the steps below:

```
enable
configure terminal
cable upstream controller-profile id [RPHY|I-CMTS]
us-channel id {chan-class-id id|channel-width {first-choice-width
[last-choice-width]}|docsis-mode{atdma| tdma|
tdma-atdma}|equalization-coefficient|frequencyvalue|hop-priority{frequency
 modulation channel-width| modulation frequency channel-width| frequency
 channel-width modulation}|ingress-nosie-cancellation
interval|maintain-psd|max-logical-chans id|minislot-size
value|modulation-profile
primary-profile-number[secondary-profile-number][tertiary-profile-number]|power-level
value|rng-holdoff priority|specsvl error-adaptive-profile id|spectrum-group
id|threshold {cnr-profiles value [value]|corr-fec value|hysteresis
value|snr-profiles value [value]|corr-fec value}


enable
configure terminal
controller upstream-cable slot/subslot/port
profile id
```

Note

- When configure a new I-CMTS controller profile, keyword I-CMTS is needed. If input RPHY or do not input any keyword, the system will consider it as a RPHY controller profile. Once a profile type (RPHY/I-CMTS) is set, it cannot be modified.
- Updating a profile will affect all the controllers bond with it. To delete a profile that bond with controller, user must unbind all the controllers first.
- OFDMA does not support the use of profile in this release.

Verifying Upstream Controller Profile Configuration

Use the **show cable upstream controller-profile** command to verify the configuration of the upstream controller profile.

```
Router# show cable upstream controller-profile 0
Upstream controller-profile 0, type I-CMTS
Description:
Upstream controller-profile 0 is being used by controller Upstream-Cable:
9/0/0

Controller Upstream-Cable
    ...
  Upstream-channel 0
    chan-class-id                  : 0x0
    channel-width                  : 1600000 1600000
    docsis-mode                    : atdma
    equalization-coefficient       : TRUE
    frequency                      : 5000000
    ...
    modulation-profile             : 221
    ...
    shutdown                       : FALSE
    ...
```

In the above output, upstream-cable 9/0/0 is bond to profile 0. So the output of the **show controllers upstream-Cable 9/0/0 us-channel 0** should match the above output. See the example below:

```
Router# show controllers upstream-Cable 9/0/0 us-channel 0
...
Controller 9/0/0 upstream 0  AdminState:UP OpState: UP
  atdma mode enabled
  Frequency 5.000 MHz, Channel Width 1.600 MHz, Symbol Rate 1.280 Msps
  Modulation Profile Group 221
```

To check if the parameters in a profile match with the ones configured, use the **show running-config [all] | section cable upstream controller-profile** command as shown in the example below:

```
Router# show running-config | s cable upstream controller-profile 0
cable upstream controller-profile 0 I-CMTS
 us-channel 0 channel-width 1600000 1600000
 us-channel 0 docsis-mode atdma
 us-channel 0 minislot-size 4
 us-channel 0 modulation-profile 221
 us-channel 0 shutdown
 ...
```

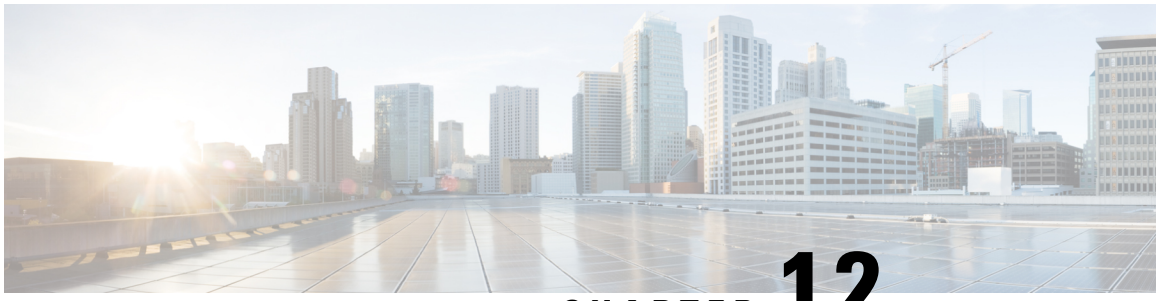
Feature Information for Controller Profile Configuration

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 22: Feature Information for Controller Profile Configuration

Feature Name	Releases	Feature Information
SG Based Config (OpSimp) Phase 2	Cisco IOS XE Fuji 16.7.1	This feature was introduced on Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.



CHAPTER 12

Voltage Thresholds for AC Power Supply Module Mode Control

This document describes how to configure the voltage thresholds for switching modes in AC Power SupplyModule (PSM).

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

- Hardware Compatibility Matrix for the Cisco cBR Series Routers, on page 79
- Information about Voltage Thresholds for AC PSM Mode Control, on page 80
- How to Configure Voltage Thresholds for AC PSM Mode Control, on page 81
- Configuration Examples, on page 82
- Feature Information for Voltage Thresholds for AC PSM Mode Control, on page 82

Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 23: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G • PID—CBR-CCAP-SUP-60G • PID—CBR-SUP-8X10G-PIC	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R Cisco cBR-8 Downstream PHY Modules: • PID—CBR-D30-DS-MOD • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D30-US-MOD • PID—CBR-D31-US-MOD

Information about Voltage Thresholds for AC PSM Mode Control

Configuring voltage thresholds help switch between different modes when power budget provided by AC PSMs is not sufficient to power Field Replaceable Units (FRUs).

Overview of Voltage Thresholds for AC PSM Mode Control

The AC PSM can operate in either 120V or 220V mode.

When the input voltage is between 70V and 197V, the PSM operates in the 120V mode with 1300W power capacity. When input voltage drops below 85V, the PSM powers down completely and its power capacity becomes 0W.

When the input voltage is greater than 197V, the PSM operates in the 220V mode with 3000W power capacity. When input voltage drops below 190V, the PSM switches to the 120V mode and its power capacity decreases to 1300W.

To allow users configure mode switching, two new hystersis thresholds Voff_3000W and Von_3000W have been provided. The hystersis thresholds define when the PSM should switch modes and can be configured using CLI commands.

For example, if *Voff_3000W* is configured as 180V, the PSM switches to the 120V mode with 1300W capacity when input voltage drops below 180V. If *Von_3000W* is configured as 200V, the PSM switches to the 220V mode when input voltage increases to more than 200V.

Table 24: Voltage Thresholds for Mode Control

Threshold	Default Value	Configurable Range
Voff_3000W	190V	The value of Voff_3000W can be 170V or greater. The value of Von_3000W can be 200V or lesser. The value of Voff_3000W must be less than the value of Von_3000W.
Von_3000W	197V	

How to Configure Voltage Thresholds for AC PSM Mode Control

Configuring Voltage Thresholds for AC PSM Mode Control

To configure voltage thresholds, run the **platform power protection ac220v voff von** command as shown below:

```
Router# configure terminal
platform power protection ac220v voff von
```

To use the default voltage thresholds, run the **no platform power protection ac220v** command as shown below:

```
Router# configure terminal
no platform power protection ac220v
```

Note By default, power protection action is disabled to avoid service outage. If protection action is disabled, any online FRU is not powered down in the event of insufficient power budget, but any newly installed line card is not powered up.

To enable the power protection action, run the **platform power protection action shutdown linecard** command:

```
Router# configure terminal
platform power protection action shutdown linecard
```

Verifying Voltage Thresholds for AC PSM Mode Control

To verify the voltage thresholds configuration, use the **sh run** command as shown in the example below:

```
Router# configure terminal
Router (config)# sh run | i protection
platform power protection ac220v 180 200
```

Configuration Examples

This section provides configuration examples for the voltage threshold feature.

Example: Configuring Voltage Thresholds for AC PSM Mode Control

The following example shows how to configure voltage thresholds:

```
Router# configure terminal
platform power protection ac220v 180 200
```

The following example shows how to disable DPS:

```
Router# configure terminal
no platform power protection ac220v
```

Feature Information for Voltage Thresholds for AC PSM Mode Control

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 25: Feature Information for Voltage Thresholds for AC PSM Mode Control

Feature Name	Releases	Feature Information
Voltage Thresholds for AC PSM Mode Control	Cisco IOS XE Fuji 16.7.1	This feature was introduced in Cisco IOS XE Fuji 16.7.1 on the Cisco cBR Series Converged Broadband Routers.