



# DOCSIS 3.1 OFDMA Channel Configuration

This document describes the Remote PHY device DOCSIS 3.1 OFDMA channel configuration on the Cisco cBR Series Converged Broadband Router.

## Finding Feature Information

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 the platform support and Cisco software image support. To access Cisco Feature Navigator, go to the link <http://tools.cisco.com/ITDIT/CFN/>. An account at the <http://www.cisco.com/> site is not required.

- [Hardware Compatibility Matrix for Cisco Remote PHY Device, on page 1](#)
- [Information about OFDMA Channel Configuration, on page 2](#)
- [Configure OFDMA Channel, on page 4](#)
- [Support for Line Card High Availability, on page 15](#)
- [Support for Line Card Process Restart, on page 15](#)
- [Feature Information for DOCSIS 3.1 OFDMA Channel Configuration, on page 16](#)

## Hardware Compatibility Matrix for Cisco Remote PHY Device



**Note** Unless otherwise specified, the hardware components introduced in a given Cisco Remote PHY Device Software Release are supported in all subsequent releases.

**Table 1: Hardware Compatibility Matrix for the Cisco Remote PHY Device**

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Node	Cisco 1x2 / Compact Shelf RPD Software 2.1 and Later Releases

Cisco HFC Platform	Remote PHY Device
Cisco GS7000 Super High Output Intelligent Node (iNode)	Cisco 1x2 / Compact Shelf RPD Software 4.1 and Later Releases  Cisco Intelligent Remote PHY Device 1x2 <ul style="list-style-type: none"> <li>• PID—iRPD-1X2=</li> <li>• PID—iRPD-1X2-PKEY=</li> </ul>



**Note** The -PKEY suffix in the PID indicates units that enable the SCTE-55-2 Out-of-Band protocol support.

## Information about OFDMA Channel Configuration

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 96 MHz
- Upstream spectrum 5 – 204 MHz
- 25 KHz and 50 KHz subcarrier spacing

## 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.

Modulation Order	Support
BPSK	Yes
QPSK	Yes
8-QAM	Yes
16-QAM	Yes
32-QAM	Yes
64-QAM	Yes
128-QAM	Yes
256-QAM	Yes
512-QAM	Yes

Modulation Order	Support
1024-QAM	Yes
2048-QAM	Yes
4096-QAM	No

## 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 the exclusion band. So the legacy SC-QAM channel can be placed in this band. OFDMA channel does not use frequencies in the unused band set by **ofdma-frequency-unused-band** command for data traffic, but can send probes in them.

## TLV66 OFDMA Configuration Read

When the RPD receives a TLV66 read-request for the configured OFDMA channels, it sends a TLV66 read-response message for the following OFDMA attributes.

If the OFDMA channel that is specified in the read-request is invalid or not configured, the RPD sends a read-response with error code and error message.

- AdminState(66.1)
- SubcarrierZeroFreq(66.3)
- FirstActiveSubcarrierNum(66.4)
- LastActiveSubcarrierNum(66.5)
- RollOffPeriod(66.6)
- CyclicPrefix(66.7)
- SubcarrierSpacing(66.8)
- NumSymbolsPerFrame(66.9)
- NumActiveSubcarriers(66.10)
- StartingMinislot(66.11)
- PreambleString(66.12)
- TargetRxPowerAdjust(66.13)
- EnableFlowTags(66.14)
- ScramblerSeed(66.15)
- ConfigMultiSectionTimingMer(66.16)
- BwReqAggrControlOfdma(66.17)

- UsChanId(66.18)
- ConfigChangeCount(66.19)
- DsChanId(66.20)
- BroadcastImRegionDuration(66.21)
- UnicastImRegionDuration(66.22)

## Configure OFDMA Channel

### Configure 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 425
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 192
Router(config-ofdma-mod-profile)# data-iuc 5 modulation 2048-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 6 modulation 1024-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 9 modulation 256-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 10 modulation 128-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 11 modulation 64-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 12 modulation 32-QAM pilot-pattern 11
Router(config-ofdma-mod-profile)# data-iuc 13 modulation 16-QAM pilot-pattern 11

Router# enable
Router# configure terminal
Router(config)# cable mod-profile-ofdma 451
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 472
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.
- Modulation profiles 421 and 461 are the default modulation profiles for 25 KHz and 50 KHz subcarrier spacing respectively. You can add additional modulation profiles. The modulation profile range is between 401-500.
- You must configure subcarrier spacing, ranging, and data IUC 13 before applying modulation profile to a upstream channel.
- Regular pilot patterns (1-4/8-11) and boosted pilot patterns (5-7/12-14) cannot co-exist on the same upstream channel.
- We recommend to not change subcarrier spacing, ranging, and data IUC configuration of a modulation profile that is applied to a channel.

## Verify OFDMA Modulation Profile Configuration

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

```
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
```

## Configure OFDMA Channel

To configure the OFDMA channel, follow these steps:

```
enable
configure terminal
cable upstream controller-profile id
us-channel id docsis-mode ofdma
```

```

us-channel id subcarrier-spacing value
us-channel id modulation-profile id
us-channel id frequency-range start-value end-value
us-channel id initial-rng-frequency-start value
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

```

To use QAM modulation in between specific bandwidth, use the **us-channel id data-iuc id band start-value end-value modulation value pilot-pattern value** command.

Here is a configuration example:

```

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

```



#### Note

- A maximum of one OFDMA channel can be configured per controller. For this OFDMA channel, the us-channel index must be set to 12. This corresponds with OFDMA channel 0 on an RPD port.
- Change docsis-mode to **OFDMA** to enable OFDMA configuration options. These options are enabled by default on us-channel 12.
- We recommend that you configure no more than 4 active SC-QAMs while an OFDMA channel is present.
- OFDMA channel can be placed between 5 Mhz and 204 Mhz.
- Values of the options are often interdependent, changing one value may change other values or make them invalid.
- We recommend that you set subcarrier spacing and frequency range first. To achieve a higher OFDMA channel traffic throughput, configure OFDMA channel with 25kHz subcarrier spacing.
- Maximum of 4:1 upstream combining for OFDMA channels is supported.

## Bind Upstream Controllers With RPHY Ports

If the upstream channel profile contains OFDMA channel, you can bind up to four RPD ports with the upstream controller.

```

cable rpd node1
  identifier badb.ad15.1288
  core-interface Te7/1/4
  principal
  rpd-ds 0 downstream-cable 7/0/30 profile 10

```

```

rpd-us 0 upstream-cable 7/0/63 profile 1
rpd-us 1 upstream-cable 7/0/63 profile 1

cable rpd node2
identifier badb.ad15.1290
core-interface Te7/1/4
principal
rpd-ds 0 downstream-cable 7/0/31 profile 10
rpd-us 0 upstream-cable 7/0/63 profile 1
rpd-us 1 upstream-cable 7/0/63 profile 1

```

## Verify 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
Controller RPD US Port List:
DevID RPD ID US Port I/F Name
-----
0 badb.ad13.acfe 0 Tel/1/2 necker-5

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 ( - )),

```

## Verify OFDMA Channel Configuration

```

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 )

```

## Verify the TLV66 OFDMA Configuration Read

```

R-PHY#show ofdma config
OFDMA Channel Configuration
RF Port : 0

```



```

RF channel                : 0
State                    : UP
Starting Minislot        : 2212398931
Target Rx Power Adjust   : 0
Enable Flow Tags         : 1
Max Req Block Enq Timeout : 0
Max Req Block Enq Number : 0
Broadcast Im Region Duration : 6
Unicast Im Region Duration : 6
UCD Message
  UCD fields
    UCID                  : 8
    CCC                   : 78
    DSID                   : 0
    TLV 24 Change Bitmask : 0x0000
    TLV 25 Timestamp Snapshot : 08 3d e8 75 32 25 b7 b2 24
    TLV 26 Cyclic Prefix   : 96
    TLV 27 Rolloff Period  : 64 samples
    TLV 28 Subcarrier Spacing : 25 KHz
    TLV 29 Subcarrier Zero Freq : 36800000 Hz
    TLV 32 Symbols in Frame : 9
    TLV 33 Randomization Seed : 8153946
    TLV 3 Preamble String   : Preamble Superstring
      ff d7 d5 21 26 ec e5 e7 00 78 7f 63 6b 35 2e 29
      00 88 81 a5 bd 5f 72 7b 01 99 82 ee c7 e1 96 8d
      02 aa 87 33 48 22 bb 97 07 ff 89 55 d8 67 cc b9
      00 80 9b fe 68 a8 55 cb 00 18 1a c2 b9 f8 fe 5d
    TLV 6 Preamble String Extension : Preamble Superstring Extension
    TLV 30 Subcarrier Exclusion Band: Excluded Subcarriers
      [0000 - 0147] [1908 - 4095]
    TLV 30 Subcarrier Unused Band : Unused Subcarriers
    TLV 23 Burst Descriptor      : Burst Descriptor
      03 03 02 01 00 04 02 00 00 13 02 00 40
    TLV 23 Burst Descriptor      : Burst Descriptor
      04 03 02 01 00 04 02 00 00 14 02 01 00
    TLV 23 Burst Descriptor      : Burst Descriptor
      05 15 02 a8 6d
    TLV 23 Burst Descriptor      : Burst Descriptor
      09 15 02 98 6d
    TLV 23 Burst Descriptor      : Burst Descriptor
      0d 15 02 88 6d

OFDMA Channel Configuration
RF Port                  : 1
RF channel                : 0
State                    : UP
Starting Minislot        : 2212522598
Target Rx Power Adjust   : 0
Enable Flow Tags         : 1
Max Req Block Enq Timeout : 0
Max Req Block Enq Number : 0
Broadcast Im Region Duration : 5
Unicast Im Region Duration : 5
UCD Message
  UCD fields
    UCID                  : 9
    CCC                   : 82
    DSID                   : 0
    TLV 24 Change Bitmask : 0x0000
    TLV 25 Timestamp Snapshot : 08 3e 06 a6 64 87 a8 59 d4
    TLV 26 Cyclic Prefix   : 512
    TLV 27 Rolloff Period  : 224 samples
    TLV 28 Subcarrier Spacing : 25 KHz
    TLV 29 Subcarrier Zero Freq : 1800000 Hz

```

```

TLV 32 Symbols in Frame      : 9
TLV 33 Randomization Seed   : 8153946
TLV 3 Preamble String       : Preamble Superstring
    ff d7 d5 21 26 ec e5 e7 00 78 7f 63 6b 35 2e 29
    00 88 81 a5 bd 5f 72 7b 01 99 82 ee c7 e1 96 8d
    02 aa 87 33 48 22 bb 97 07 ff 89 55 d8 67 cc b9
    00 80 9b fe 68 a8 55 cb 00 18 1a c2 b9 f8 fe 5d
TLV 6 Preamble String Extension : Preamble Superstring Extension
TLV 30 Subcarrier Exclusion Band: Excluded Subcarriers
    [0000 - 0147] [0688 - 1768] [3308 - 4095]
TLV 30 Subcarrier Unused Band  : Unused Subcarriers
    [0676 - 0687] [3305 - 3307]
TLV 23 Burst Descriptor      : Burst Descriptor
    03 03 02 00 80 04 02 00 00 13 02 00 20
TLV 23 Burst Descriptor      : Burst Descriptor
    04 03 02 00 c0 04 02 00 00 14 02 00 c0
TLV 23 Burst Descriptor      : Burst Descriptor
    05 15 02 b8 80
TLV 23 Burst Descriptor      : Burst Descriptor
    06 15 02 a8 80
TLV 23 Burst Descriptor      : Burst Descriptor
    09 15 02 98 80
TLV 23 Burst Descriptor      : Burst Descriptor
    0a 15 02 88 80
TLV 23 Burst Descriptor      : Burst Descriptor
    0b 15 02 78 80
TLV 23 Burst Descriptor      : Burst Descriptor
    0c 15 02 68 80
TLV 23 Burst Descriptor      : Burst Descriptor
    0d 15 02 48 80

```

## Configure Exclusion / Unused Bands

An OFDMA channel never uses frequencies that are located in exclusion bands. OFDMA probes are sent on frequencies that are 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 these steps:

```

enable
configure terminal
cable upstream controller-profile id
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)# cable upstream controller-profile 33
Router(config-controller-profile)# cable ofdma-frequency-exclusion-band 48000000 54200000
Router(config-controller-profile)# cable ofdma-frequency-unused-band 50000000 52000000
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 frequency-range 45000000 70000000
Router(config-controller-profile)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 12 symbols-per-frame 18

```

## Verify Exclusion / Unused Bands

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

```
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 Modulation Profile Per Channel

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

```
enable
configure terminal
cable upstream controller profile id
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)# cable upstream controller profile 33
Router(config-controller-profile)# us-channel 12 docsis-mode ofdma
Router(config-controller-profile)# us-channel 12 subcarrier-spacing 25KHz
Router(config-controller-profile)# us-channel 12 modulation-profile 423
Router(config-controller-profile)# us-channel 12 frequency-range 28000000 70000000
Router(config-controller-profile)# us-channel 12 cyclic-prefix 96 roll-off-period 64
Router(config-controller-profile)# us-channel 12 symbols-per-frame 18
Router(config-controller-profile)# us-channel 12 data-iuc 6 band 60000000 65000000 modulation
128-QAM pilot-pattern 9
Router(config-controller-profile)# no us-channel 12 shutdown
```



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

## Verify Override Configuration

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

```
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	-	-
<b>6 (data)</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1024-QAM</b>	<b>8</b>
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
<b>6</b>	<b>60.0</b>	<b>65.0</b>	<b>1408</b>	<b>1608</b>	<b>128-QAM</b>	<b>9</b>

```
Calculated Data burst profile:
```

IUC	Group	Bit	Pilot	Start	Consec
		Loading	Pattern	Mslot	Mslot
<b>6</b>	<b>0</b>	<b>1024-QAM</b>	<b>8</b>	<b>0</b>	<b>61</b>
<b>6</b>	<b>1</b>	<b>128-QAM</b>	<b>9</b>	<b>62</b>	<b>11</b>
<b>6</b>	<b>2</b>	<b>1024-QAM</b>	<b>8</b>	<b>74</b>	<b>10</b>
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

```
.....
```

## Bind OFDMA Channel Profile to Controller

To bind OFDMA channel profile to a controller, follow this example:

```
cable virtual-service-group sg-upstream-7-0-63 upstream-cable 7/0/63 profile 1

cable rpd node1
  identifier badb.ad15.1288
  core-interface Te7/1/4
  principal
    rpd-ds 0 downstream-cable 7/0/30 profile 10
    rpd-us 1 upstream-cable 7/0/63 profile 1
```



### Note

We recommend using separate channel profiles to debug issues on specific RPD port.

## Bind OFDMA Upstream to Cable Interface

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

```
enable
configure terminal
```

```

interface Cable slot/subslot/interface
upstream id Upstream-Cable slot/subslot/interface us-channel id
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 following example:

```

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 following example:

```

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)  (dB)  (dB)  Prov
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 following example:

```
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 following example:

```
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
```

## Verify DOCSIS 3.1 Upstream OFDMA Channel Bonding Across DOCSIS 3.0 ATDMA Channels

DOCSIS 3.1 Upstream OFDMA channel can be bonded with DOCSIS 3.0 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. 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
```

## Support for Line Card High Availability

N+1 line card high availability (LCHA) is supported for modems that are assigned OFDMA upstream channels. If LCHA is enabled, the modems remain active after switchover and revert.

### Configure Line Card High Availability

For information on configuring for Line Card High Availability, go through the *Cable Line Card Process Restart* content in the topic *Consolidated Packages and SubPackages Management* in the document [Cisco cBR Converged Broadband Routers Basic Configuration Guide for Cisco IOS XE](#).

## Support for Line Card Process Restart

Linecard IOSd and linecard US-Scheduler (CDMAN) process restart (LCPR) is supported for modems that are assigned OFDMA upstream channels. If LCPR is enabled, remote phy devices remain active after process restarts.

### Configure Line Card Process Restart

For information on configuring for Line Card Process Restart, go through the *Cable Line Card Process Restart* content in the topic *Consolidated Packages and SubPackages Management* in the document [Cisco cBR Converged Broadband Routers Basic Configuration Guide for Cisco IOS XE](#).

# 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://cfng.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 OFDMA Channel Configuration*

Feature Name	Releases	Feature Information
Remote PHY DOCSIS 3.1 OFDMA Channel Configuration	Cisco 1x2 / Compact Shelf RPD Software 5.1 Cisco IOS XE Fuji 16.9.1	This feature was introduced on the Cisco Remote PHY Device and Cisco cBR Series Converged Broadband Routers.
Support for Line Card High Availability	Cisco 1x2 / Compact Shelf RPD Software 6.1 Cisco IOS XE Gibraltar 16.10.1	This feature was introduced on the Cisco Remote PHY Device and Cisco cBR Series Converged Broadband Routers.
Support for Line Card Process Restart	Cisco 1x2 / Compact Shelf RPD Software 6.1 Cisco IOS XE Gibraltar 16.10.1	This feature was introduced on the Cisco Remote PHY Device and Cisco cBR Series Converged Broadband Routers.