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Amended Set of Claims 1 to 40

1. A method of encoding video data comprising:
 - determining a quantization matrix that includes a plurality of values;
 - downsampling a first set of values in the quantization matrix by a first downsampling factor to generate a first set of downsampled values, wherein the first set of values includes only the value at location (0,0) of the quantization matrix, and wherein the first downsampling factor is 1;
 - determining a second downsampling factor based on a location of a second set of values in the quantization matrix, wherein the second downsampling factor is determined to be one of 2 and 4;
 - downsampling the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and
 - generating a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.
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4. The method of claim 1,
 - wherein the quantization matrix has a size of 16x16 or 32x32.
5. The method of claim 1, further comprising:
 - determining a first transition point in the quantization matrix, wherein values located between the first transition point and an origin of the quantization matrix are not downsampled;
 - determining a second transition point in the quantization matrix, wherein the first set of values in the quantization matrix are located between the first transition point and the second transition point;
 - determining a third transition point in the quantization matrix, wherein the second set of values in the quantization matrix are located between the second transition point and the third transition point; and

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signaling the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

6. The method of claim 1, further comprising:

predicting one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

7. The method of claim 1,

wherein downsampling the second set of values in the quantization matrix comprises averaging a second number of quantization matrix values in the second set of values to generate values in the second set of downsampled values, wherein the second number is determined from the second downsampling factor.

8. The method of claim 1, further comprising:

performing a prediction process on a block of video data to form a block of residual video data;

transforming the residual video data to form a block of transform coefficients;

quantizing values of transform coefficients in the block of transform coefficients according to the quantization matrix to form quantized transform coefficients; and entropy coding the quantized transform coefficients into the coded bitstream.

9. A method of decoding video data comprising:

receiving a quantization matrix coded with downsampled values in a coded bitstream;

upsampling a first set of downsampled values in the quantization matrix by a first upsampling factor to generate a first set of values, wherein the first set of downsampled values includes only the value at location (0,0) of the quantization matrix, and wherein the first upsampling factor is 1;

determining a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix, wherein the second upsampling factor is determined to be one of 2 and 4;

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upsampling the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and
inverse quantizing a block of transform coefficients with the first and second sets of values.

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12. The method of claim 9,
wherein the quantization matrix has a size of 16x16 or 32x32.

13. The method of claim 9, further comprising:
determining a first transition point in the quantization matrix, wherein values of the quantization matrix located between the first transition point and an origin of the quantization matrix are not downsampled;

determining a second transition point in the quantization matrix, wherein the first set of downsampled values in the quantization matrix are located between the first transition point and the second transition point;

determining a third transition point in the quantization matrix, wherein the second set of downsampled values in the quantization matrix are located between the second transition point and the third transition point; and

receiving the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

14. The method of claim 9, further comprising:
predicting each successive one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

15. The method of claim 9,

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wherein upsampling the second set of values in the quantization matrix comprises replicating a downsampled value in the second set of downsampled values for a second number of the second set of values, wherein the second number is determined from the second upsampling factor.

16. The method of claim 9, wherein different upsampling techniques are used to upsample the first and second set of downsampled values.

17. The method of claim 9, wherein at least of the first and second set of values is upsampled using bilinear interpolation.

18. The method of claim 9, further comprising:
inverse transforming the inverse quantized block of transform coefficients to form a residual block of video data; and
performing a prediction process on the residual block of video data to form a decoded block of video data.

19. An apparatus configured to code video data comprising:
a video encoder configured to:
determine a quantization matrix that includes a plurality of values;
downsample a first set of values in the quantization matrix by a first downsampling factor to generate a first set of downsampled values, wherein the first set of values includes only the value at location (0,0) of the quantization matrix, and wherein the first downsampling factor is 1;
determine a second downsampling factor based on a location of a second set of values in the quantization matrix, wherein the second downsampling factor is determined to be one of 2 and 4;
downsample the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values;
and
generate a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.

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21. Cancelled
22. The apparatus of claim 19,
wherein the quantization matrix has a size of 16x16 or 32x32.
23. The apparatus of claim 19, wherein the video encoder is further configured to:
determine a first transition point in the quantization matrix, wherein values
located between the first transition point and an origin of the quantization matrix are not
downsampled;
determine a second transition point in the quantization matrix, wherein the first
set of values in the quantization matrix are located between the first transition point and
the second transition point;
determine a third transition point in the quantization matrix, wherein the second
set of values in the quantization matrix are located between the second transition point
and the third transition point; and
signal the first, second, and third transition points, and the first and second
downsampling factors in the coded bitstream.
24. The apparatus of claim 19, wherein the video encoder is further configured to:
predict one of the downsampled values along a scan order in the first and second
sets of downsampled values from a previous downsampled value along the scan order in
the first and second sets of downsampled values, wherein downsampled values in the
first set may be used to predict downsampled values in the second set.
25. The apparatus of claim 19,
wherein downsampling the second set of values in the quantization matrix
comprises averaging a second number of quantization matrix values in the second set of
values to generate values in the second set of downsampled values, wherein the second
number is determined from the second downsampling factor.
26. The apparatus of claim 19, wherein the video encoder is further configured to:
perform a prediction process on a block of video data to form a block of residual
video data;

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transform the residual video data to form a block of transform coefficients;
quantize values of transform coefficients in the block of transform coefficients
according to the quantization matrix to form quantized transform coefficients; and
entropy code the quantized transform coefficients into the coded bitstream.

27. A apparatus configured to decode video data comprising:

a video decoder configured to:

receive a quantization matrix coded with downsampled values in a coded
bitstream;

upsample a first set of downsampled values in the quantization matrix by
a first upsampling factor to generate a first set of values, wherein the first set of
downsampled values includes only the value at location (0,0) of the quantization
matrix, and wherein the first upsampling factor is 1;

determine a second upsampling factor based on a location of a second set
of downsampled values in the quantization matrix, wherein the second
upsampling factor is determined to be one of 2 and 4;

upsample the second set of downsampled values in the quantization
matrix by the second upsampling factor to generate a second set of values; and

inverse quantize a block of transform coefficients with the first and
second sets of values.

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30. The apparatus of claim 27,
wherein the quantization matrix has a size of 16x16 or 32x32.

31. The apparatus of claim 27, wherein the video decoder is further configured to:
determine a first transition point in the quantization matrix, wherein values of
the quantization matrix located between the first transition point and an origin of the
quantization matrix are not downsampled;

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determine a second transition point in the quantization matrix, wherein the first set of downsampled values in the quantization matrix are located between the first transition point and the second transition point;

determine a third transition point in the quantization matrix, wherein the second set of downsampled values in the quantization matrix are located between the second transition point and the third transition point; and

receive the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

32. The apparatus of claim 27, wherein the video decoder is further configured to:
predict each successive one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

33. The apparatus of claim 27,
wherein upsampling the second set of values in the quantization matrix comprises replicating a downsampled value in the second set of downsampled values for a second number of the second set of values, wherein the second number is determined from the second upsampling factor.

34. The apparatus of claim 27, wherein different upsampling techniques are used to upsample the first and second set of downsampled values.

35. The apparatus of claim 27, wherein at least of the first and second set of values is upsampled using bilinear interpolation.

36. The apparatus of claim 27, wherein the video decoder is further configured to:
inverse transform the inverse quantized block of transform coefficients to form a residual block of video data; and
perform a prediction process on the residual block of video data to form a decoded block of video data.

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37. An apparatus configured to encode video data comprising:
- means for determining a quantization matrix that includes a plurality of values;
 - means for downsampling a first set of values in the quantization matrix by a first downsampling factor to generate a first set of downsampled values, wherein the first set of values includes only the value at location (0,0) of the quantization matrix, and wherein the first downsampling factor is 1;
 - means for determining a second downsampling factor based on a location of a second set of values in the quantization matrix, wherein the second downsampling factor is determined to be one of 2 and 4;
 - means for downsampling the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and
 - means for generating a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.
38. An apparatus configured to decode video data comprising:
- means for receiving a quantization matrix coded with downsampled values in a coded bitstream;
 - means for upsampling a first set of downsampled values in the quantization matrix by a first upsampling factor to generate a first set of values, wherein the first set of downsampled values includes only the value at location (0,0) of the quantization matrix, and wherein the first upsampling factor is 1;
 - means for determining a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix, wherein the second upsampling factor is determined to be one of 2 and 4;
 - means for upsampling the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and
 - means for inverse quantizing a block of transform coefficients with the first and second sets of values.
39. A computer-readable storage medium storing instructions that, when executed, cause one or more processors of a device configured to encode video data to:
- determine a quantization matrix that includes a plurality of values;
 - downsample a first set of values in the quantization matrix by a first downsampling factor to generate a first set of downsampled values, wherein the first set

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of values includes only the value at location (0,0) of the quantization matrix, and wherein the first downsampling factor is 1;

determine a second downsampling factor based on a location of a second set of values in the quantization matrix, wherein the second downsampling factor is determined to be one of 2 and 4;

downsample the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and

generate a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.

40. A computer-readable storage medium storing instructions that, when executed, cause one or more processors of a device configured to decode video data to:

receive a quantization matrix coded with downsampled values in a coded bitstream;

upsample a first set of downsampled values in the quantization matrix by a first upsampling factor to generate a first set of values, wherein the first set of downsampled values includes only the value at location (0,0) of the quantization matrix, and wherein the first upsampling factor is 1;

determine a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix, wherein the second upsampling factor is determined to be one of 2 and 4;

upsample the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and

inverse quantize a block of transform coefficients with the first and second sets of values.

CLAIMS

1. A method of encoding video data by hardware comprising:
 - determining a quantization matrix that includes a plurality of values, wherein the quantization matrix is used to quantize transform coefficients;
 - determining a first downsampling factor based on a location of a first set of values in the quantization matrix, wherein the first set of values includes the value at location (0,0) of the quantization matrix;
 - determining a second downsampling factor based on a location of a second set of values in the quantization matrix;
 - downsampling the first set of values in the quantization matrix by the first downsampling factor to generate a first set of downsampled values;
 - downsampling the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and
 - generating a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.
2. The method of claim 1,
 - wherein the quantization matrix has a size of 16x16 or 32x32.
3. The method of claim 1, wherein the first downsampling factor is determined to be 1, and wherein the second downsampling factor is determined to be one of 2 and 4.
4. The method of claim 1, further comprising:
 - determining a first transition point in the quantization matrix, wherein values located between the first transition point and an origin of the quantization matrix are not downsampled;
 - determining a second transition point in the quantization matrix, wherein the first set of values in the quantization matrix are located between the first transition point and the second transition point;

determining a third transition point in the quantization matrix, wherein the second set of values in the quantization matrix are located between the second transition point and the third transition point; and

signaling the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

5. The method of claim 1, further comprising:

predicting one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

6. The method of claim 1, wherein downsampling the first set of values in the quantization matrix comprises averaging a first number of quantization matrix values in the first set of values to generate values in the first set of downsampled values, wherein the first number is determined from the first downsampling factor, and
wherein downsampling the second set of values in the quantization matrix comprises averaging a second number of quantization matrix values in the second set of values to generate values in the second set of downsampled values, wherein the second number is determined from the second downsampling factor.

7. The method of claim 1, further comprising:

performing a prediction process on a block of video data to form a block of residual video data;

transforming the residual video data to form a block of transform coefficients;

quantizing values of transform coefficients in the block of transform coefficients according to the quantization matrix to form quantized transform coefficients; and

entropy coding the quantized transform coefficients into the coded bitstream.

8. A method of decoding video data by hardware comprising:
 - receiving a quantization matrix coded with downsampled values in a coded bitstream;
 - determining a first upsampling factor based on a location of a first set of downsampled values in the quantization matrix, wherein the first set of downsampled values includes the value at location (0,0) of the quantization matrix;
 - determining a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix;
 - upsampling the first set of downsampled values in the quantization matrix by the first upsampling factor to generate a first set of values;
 - upsampling the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and
 - inverse quantizing a block of transform coefficients with the first and second sets of values.
9. The method of claim 8,
 - wherein the quantization matrix has a size of 16x16 or 32x32.
10. The method of claim 8, wherein the first upsampling factor is determined to be 1, and wherein the second upsampling factor is determined to be one of 2 and 4.
11. The method of claim 8, further comprising:
 - determining a first transition point in the quantization matrix, wherein values of the quantization matrix located between the first transition point and an origin of the quantization matrix are not downsampled;
 - determining a second transition point in the quantization matrix, wherein the first set of downsampled values in the quantization matrix are located between the first transition point and the second transition point;
 - determining a third transition point in the quantization matrix, wherein the second set of downsampled values in the quantization matrix are located between the second transition point and the third transition point; and

receiving the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

12. The method of claim 8, further comprising:

predicting each successive one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

13. The method of claim 8, wherein upsampling the first set of values in the quantization matrix comprises replicating a downsampled value in the first set of downsampled values for a first number of the first set of values, wherein the first number is determined from the first upsampling factor, and

wherein upsampling the second set of values in the quantization matrix comprises replicating a downsampled value in the second set of downsampled values for a second number of the second set of values, wherein the second number is determined from the second upsampling factor.

14. The method of claim 8, wherein different upsampling techniques are used to upsample the first and second set of downsampled values.

15. The method of claim 8, wherein at least of the first and second set of values is upsampled using bilinear interpolation.

16. The method of claim 8, further comprising:

inverse transforming the inverse quantized block of transform coefficients to form a residual block of video data; and

performing a prediction process on the residual block of video data to form a decoded block of video data.

17. An apparatus configured to code video data comprising:
 - a memory configured to store the video data; and
 - a video encoder configured to:
 - determine a quantization matrix that includes a plurality of values, wherein the quantization matrix is used to quantize transform coefficients;
 - determine a first downsampling factor based on a location of a first set of values in the quantization matrix, wherein the first set of values includes the value at location (0,0) of the quantization matrix;
 - determine a second downsampling factor based on a location of a second set of values in the quantization matrix;
 - downsample the first set of values in the quantization matrix by the first downsampling factor to generate a first set of downsampled values;
 - downsample the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values;
 - and
 - generate a coded bitstream related to the video data that includes the first set of downsampled values and the second set of downsampled values.
18. The apparatus of claim 17,
 - wherein the quantization matrix has a size of 16x16 or 32x32.
19. The method of claim 17, wherein the first downsampling factor is determined to be 1, and wherein the second downsampling factor is determined to be one of 2 and 4.
20. The apparatus of claim 17, wherein the video encoder is further configured to:
 - determine a first transition point in the quantization matrix, wherein values located between the first transition point and an origin of the quantization matrix are not downsampled;
 - determine a second transition point in the quantization matrix, wherein the first set of values in the quantization matrix are located between the first transition point and the second transition point;

determine a third transition point in the quantization matrix, wherein the second set of values in the quantization matrix are located between the second transition point and the third transition point; and

signal the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

21. The apparatus of claim 17, wherein the video encoder is further configured to:
predict one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

22. The apparatus of claim 17, wherein downsampling the first set of values in the quantization matrix comprises averaging a first number of quantization matrix values in the first set of values to generate values in the first set of downsampled values, wherein the first number is determined from the first downsampling factor, and
wherein downsampling the second set of values in the quantization matrix comprises averaging a second number of quantization matrix values in the second set of values to generate values in the second set of downsampled values, wherein the second number is determined from the second downsampling factor.

23. The apparatus of claim 17, wherein the video encoder is further configured to:
perform a prediction process on a block of video data to form a block of residual video data;
transform the residual video data to form a block of transform coefficients;
quantize values of transform coefficients in the block of transform coefficients according to the quantization matrix to form quantized transform coefficients; and
entropy code the quantized transform coefficients into the coded bitstream.

24. An apparatus configured to decode video data comprising:
a memory configured to store the video data; and
a video decoder configured to:

receive a quantization matrix coded with downsampled values in a coded bitstream of the video data;

determine a first upsampling factor based on a location of a first set of downsampled values in the quantization matrix, wherein the first set of downsampled values includes the value at location (0,0) of the quantization matrix;

determine a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix;

upsample the first set of downsampled values in the quantization matrix by the first upsampling factor to generate a first set of values;

upsample the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and

inverse quantize a block of transform coefficients with the first and second sets of values.

25. The apparatus of claim 24,
wherein the quantization matrix has a size of 16x16 or 32x32.
26. The method of claim 24, wherein the first upsampling factor is determined to be 1, and wherein the second upsampling factor is determined to be one of 2 and 4.
27. The apparatus of claim 24, wherein the video decoder is further configured to:
 - determine a first transition point in the quantization matrix, wherein values of the quantization matrix located between the first transition point and an origin of the quantization matrix are not downsampled;
 - determine a second transition point in the quantization matrix, wherein the first set of downsampled values in the quantization matrix are located between the first transition point and the second transition point;
 - determine a third transition point in the quantization matrix, wherein the second set of downsampled values in the quantization matrix are located between the second transition point and the third transition point; and

receive the first, second, and third transition points, and the first and second downsampling factors in the coded bitstream.

28. The apparatus of claim 24, wherein the video decoder is further configured to:
predict each successive one of the downsampled values along a scan order in the first and second sets of downsampled values from a previous downsampled value along the scan order in the first and second sets of downsampled values, wherein downsampled values in the first set may be used to predict downsampled values in the second set.

29. The apparatus of claim 24, wherein upsampling the first set of values in the quantization matrix comprises replicating a downsampled value in the first set of downsampled values for a first number of the first set of values, wherein the first number is determined from the first upsampling factor, and
wherein upsampling the second set of values in the quantization matrix comprises replicating a downsampled value in the second set of downsampled values for a second number of the second set of values, wherein the second number is determined from the second upsampling factor.

30. The apparatus of claim 24, wherein different upsampling techniques are used to upsample the first and second set of downsampled values.

31. The apparatus of claim 24, wherein at least of the first and second set of values is upsampled using bilinear interpolation.

32. The apparatus of claim 24, wherein the video decoder is further configured to:
inverse transform the inverse quantized block of transform coefficients to form a residual block of video data; and
perform a prediction process on the residual block of video data to form a decoded block of video data.

33. An apparatus configured to encode video data comprising:
- means for determining a quantization matrix that includes a plurality of values, wherein the quantization matrix is used to quantize transform coefficients;
 - means for determining a first downsampling factor based on a location of a first set of values in the quantization matrix, wherein the first set of values includes the value at location (0,0) of the quantization matrix;
 - means for determining a second downsampling factor based on a location of a second set of values in the quantization matrix;
 - means for downsampling the first set of values in the quantization matrix by the first downsampling factor to generate a first set of downsampled values;
 - means for downsampling the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and
 - means for generating a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.
34. An apparatus configured to decode video data comprising:
- means for receiving a quantization matrix coded with downsampled values in a coded bitstream;
 - means for determining a first upsampling factor based on a location of a first set of downsampled values in the quantization matrix, wherein the first set of downsampled values includes the value at location (0,0) of the quantization matrix;
 - means for determining a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix;
 - means for upsampling the first set of downsampled values in the quantization matrix by the first upsampling factor to generate a first set of values;
 - means for upsampling the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and
 - means for inverse quantizing a block of transform coefficients with the first and second sets of values.

35. A computer-readable storage medium storing instructions that, when executed, cause one or more processors of a device configured to encode video data to:

- determine a quantization matrix that includes a plurality of values, wherein the quantization matrix is used to quantize transform coefficients;

- determine a first downsampling factor based on a location of a first set of values in the quantization matrix, wherein the first set of values includes the value at location (0,0) of the quantization matrix;

- determine a second downsampling factor based on a location of a second set of values in the quantization matrix;

- downsample the first set of values in the quantization matrix by the first downsampling factor to generate a first set of downsampled values;

- downsample the second set of values in the quantization matrix by the second downsampling factor to generate a second set of downsampled values; and

- generate a coded bitstream that includes the first set of downsampled values and the second set of downsampled values.

36. A computer-readable storage medium storing instructions that, when executed, cause one or more processors of a device configured to decode video data to:

- receive a quantization matrix coded with downsampled values in a coded bitstream;

- determine a first upsampling factor based on a location of a first set of downsampled values in the quantization matrix, wherein the first set of downsampled values includes the value at location (0,0) of the quantization matrix;

- determine a second upsampling factor based on a location of a second set of downsampled values in the quantization matrix;

- upsample the first set of downsampled values in the quantization matrix by the first upsampling factor to generate a first set of values;

- upsample the second set of downsampled values in the quantization matrix by the second upsampling factor to generate a second set of values; and

- inverse quantize a block of transform coefficients with the first and second sets of values.