# Claims

[Claim 1] A method for processing a broadcast signal, the method comprising:

when the broadcast signal is received in a frame that includes a plurality of combined bands divided along a frequency domain, determining a position of reserved tones in each combined band of the frame at a receiver; and

extracting broadcast data from the broadcast signal in consideration of the determined position of the reserved tones at the receiver.

[Claim 2] The method of claim 1, wherein the position of the reserved tones includes an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14595, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18288, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

[Claim 3] The method of claim 1 or 2, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

[Claim 4] The method of any one of claims 1 to 3, wherein the position of the reserved tones is extended through an equation:

$$[k \bmod (8 \cdot K_{L1})] - D_X(l \bmod D_Y) \in S_0,\ 0 \le l < L_{DATA}$$

where 'k' represents an index of a subcarrier, $K_{L1}$ represents a number of subcarriers by channel bands, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.

[Claim 5] A method for processing a broadcast signal, preferably a method as

claimed in any one of claims 1 to 4, further comprising:
determining the position of the reserved tones in each of the combined bands of the frame at a transmitter; and
inserting the reserved tones and broadcast data into the broadcast signal in consideration of the determined position of the reserved tones at the transmitter.

[Claim 6] An apparatus for processing a broadcast signal, the apparatus comprising:
a position determining unit configured to determine a position of reserved tones in each combined band of a frame when the broadcast signal is received in the frame that includes the combined bands divided along a frequency domain at a receiver; and
a broadcast data processing unit configured to extract broadcast data from the broadcast signal in consideration of the determined position of the reserved tones at the receiver.

[Claim 7] The apparatus of claim 6, wherein the position of the reserved tones includes an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14555, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18285, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

[Claim 8] The apparatus of claim 6 or 7, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

[Claim 9] The apparatus of any one of claims 6 to 8, wherein the position of the reserved tones is extended through an equation:

$$[k \bmod (8 \cdot K_{L1})] - D_X (l \bmod D_Y) \in S_0,\ 0 \le l < L_{DATA}$$

where 'k' represents an index of a subcarrier, $K_{LI}$ represents a number of subcarriers by channel bands, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.

[Claim 10] An apparatus for processing a broadcast signal, preferably an apparatus according to any one of claims 6 to 9, the apparatus further comprising:

a symbol builder configured to determine the position of the reserved tones in each of the combined bands of the frame at a transmitter; and

a broadcast signal generating unit configured to insert the reserved tones and broadcast data into the broadcast signal in consideration of the determined position of the reserved tones at the transmitter.

# CLAIMS

1. A method for receiving a broadcast signal, the method comprising:

if the broadcast signal is received in a frame that includes a plurality of combined bands divided along a frequency domain, determining a position of reserved tones wherein reserved tone patterns are repeated at every band; and

extracting broadcast data from the broadcast signal in consideration of the determined position of the reserved tones.

2. The method of claim 1, wherein the determining of the position of the reserved tones in the frame is performed using an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14555, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18285, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

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3. The method of claim 1 or 2, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

4. The method of claim 1, wherein the position of the reserved tones in each combined band is determined so that the position complies with conditions determined through an equation:

$$[k \bmod (8 \cdot K_{LI})] - D_X(l \bmod D_Y) \in S_0, \quad 0 \le l < L_{DATA},$$

where 'k' represents an index of a subcarrier, $K_{LI}$ represents a number of subcarriers by channel band, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.

5. A method for transmitting a broadcast signal, the method comprising:

determining a position of reserved tones so that reserved tone patterns are repeated at every combined bands of a frame that includes the combined bands divided along a frequency domain; and

inserting the reserved tones and broadcast data into the broadcast signal in consideration of the determined position of the reserved tones.

6. A receiver for receiving a broadcast signal, the receiver comprising:

a position determining unit configured to determine a position of reserved tones wherein reserved tone patterns are repeated at every combined band of a frame if the broadcast signal is received in the frame that includes the combined bands divided along a frequency domain; and

a broadcast data processing unit configured to extract broadcast data from the broadcast signal in consideration of the determined position of the reserved tones.

7. The receiver of claim 6, wherein the position determining unit is configured to determine the position of the reserved tones in the frame using an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14555, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18285, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

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8. The receiver of claim 6 or 7, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

9. The receiver of claim 6, wherein the position of the reserved tones in each combined band is determined so that he position complies with conditions determined through an equation:

$$[k \bmod (8 \cdot K_{L1})] - D_X(l \bmod D_Y) \in S_0, \quad 0 \le l < L_{DATA},$$

where 'k' represents an index of a subcarrier, $K_{L1}$ represents a number of subcarriers by channel band, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the

pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.

10. The transmitter for transmitting a broadcast signal, the transmitter comprising:

a symbol builder configured to determine a position of reserved tones so that reserved tone patterns are repeated at every combined band of a frame that includes the combined bands divided along a frequency domain; and

a broadcast signal generating unit configured to insert the reserved tones and broadcast data into the broadcast signal in consideration of the determined position of the reserved tones.

11. The method of claim 5, wherein the determining of the position of the reserved tones is performed using an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14555, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18285, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

12. The method of claim 5 or 11, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

13. The method of claim 5, wherein the position of the reserved tones in each combined band is determined so that he position complies with conditions determined through an equation:

$$[k \bmod (8 \cdot K_{LI})] - D_X(l \bmod D_Y) \in S_0, \quad 0 \le l < L_{DATA},$$

where 'k' represents an index of a subcarrier, $K_{LI}$ represents a number of subcarriers by channel band, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.

14. The transmitter of claim 10, wherein the symbol builder is configured to determine the position of the reserved tones in the frame using an index combination of subcarriers according to a table:

| Position Combination of Reserved Tones |
|---|
| 161, 243, 296, 405, 493, 584, 697, 741, 821, 934, 1021, 1160, 1215, 1312, 1417, 1462, 1591, 1693, 1729, 1845, 1910, 1982, 2127, 2170, 2339, 2365, 2499, 2529, 2639, 2745, 2864, 2950, 2992, 3119, 3235, 3255, 3559, 3620, 3754, 3835, 3943, 3975, 4061, 4210, 4270, 4371, 4417, 4502, 4640, 4677, 4822, 4904, 5026, 5113, 5173, 5271, 5317, 5426, 5492, 5583, 5740, 5757, 5839, 5935, 6033, 6146, 6212, 6369, 6454, 6557, 6597, 6711, 6983, 7047, 7173, 7202, 7310, 7421, 7451, 7579, 7666, 7785, 7831, 7981, 8060, 8128, 8251, 8326, 8369, 8445, 8569, 8638, 8761, 8873, 8923, 9017, 9104, 9239, 9283, 9368, 9500, 9586, 9683, 9782, 9794, 9908, 9989, 10123, 10327, 10442, 10535, 10658, 10739, 10803, 10925, 11006, 11060, 11198, 11225, 11326, 11474, 11554, 11663, 11723, 11810, 11902, 11987, 12027, 12117, 12261, 12320, 12419, 12532, 12646, 12676, 12808, 12915, 12941, 13067, 13113, 13246, 13360, 13426, 13520, 13811, 13862, 13936, 14073, 14102, 14206, 14305, 14408, 14527, 14555, 14650, 14755, 14816, 14951, 15031, 15107, 15226, 15326, 15392, 15484, 15553, 15623, 15734, 15872, 15943, 16043, 16087, 16201, 16299, 16355, 16444, 16514, 16635, 16723, 16802, 16912, 17150, 17285, 17387, 17488, 17533, 17603, 17708, 17793, 17932, 18026, 18081, 18159, 18285, 18356, 18395, 18532, 18644, 18697, 18761, 18874, 18937, 19107, 19119, 19251, 19379, 19414, 19522, 19619, 19691, 19748, 19875, 19935, 20065, 20109, 20261, 20315, 20559, 20703, 20737, 20876, 20950, 21069, 21106, 21231, 21323, |

| |
|---|
| 21379, 21494, 21611, 21680, 21796, 21805, 21958, 22027, 22091, 22167, 22324, 22347, 22459, 22551, 22691, 22761, 22822, 22951, 22981, 23089, 23216, 23290, 23402, 23453, 23529, 23668, 23743, 24019, 24057, 24214, 24249, 24335, 24445, 24554, 24619, 24704, 24761, 24847, 24947, 25089, 25205, 25274, 25352, 25474, 25537, 25612, 25711, 25748, 25874, 25984, 26078, 26155, 26237, 26324, 26378, 26545, 26623, 26720, 26774, 26855, 26953, 27021, 27123 |

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15. The transmitter of claim 10 or 14, wherein each of the combined bands is divided into eight channel bands along the frequency domain and each of the channel bands is formed of 3,408 subcarriers.

16. The transmitter of claim 10, wherein the position of the reserved tones in each combined band is determined so that he position complies with conditions determined through an equation:

$$[k \bmod (8 \cdot K_{L1})] - D_X(l \bmod D_Y) \in S_0, \quad 0 \le l < L_{DATA},$$

where 'k' represents an index of a subcarrier, $K_{L1}$ represents a number of subcarriers by channel band, $D_X$ represents a frequency gap between pilots in the frame, 'l' represents an index of a symbol in the frame, $D_Y$ represents a symbol gap between the pilots in the frame, $L_{DATA}$ represents a number of data symbols in the frame, and $S_0$ represents the position of the reserved tones.