CLAIMS

1.- Integrated mode converter and multiplexer, comprising:

- at least a first monomode input waveguide (401) adapted to receive a first input zero-order signal (410) and a second monomode input waveguide (402) adapted to receive a second zero-order signal (420);
- a multimode output waveguide (501) adapted to transmit at least a first zero-order output signal (510) and a second first-order output signal (520); and
- a multimode interference coupler (100) configured to equally split optical signals from a first input (101) and a second input (102) into a first output (111) and a second output (112), and to induce a first phase shift of 90º between the first output (111) and second output (112);

characterized in that the integrated mode converter and multiplexer further comprises:

- a first phase-shifter (200) connected to the first output (111) and second output (112), configured to induce a second phase shift between the first output (111) and second output (112), wherein the first phase-shifter (200) further comprises a first waveguide (202) and a second waveguide (201) with different widths, wherein the first phase-shifter (200) further comprises a first delay (221) with a third width (w3) and a second delay (222) with a fourth width (w4), the first delay (221) and the second delay (222) further comprising arrangements of periodically alternated sections of a core material and of a cladding material, wherein the period of the arrangements of periodically alternated sections is smaller than a value of the shortest wavelength in a bandwidth of the integrated mode converter and multiplexer;
- one symmetrical Y-junction (300) arranged next to the first phase-

shifter (200), configured to combine outputs of the first phase-shifter (200) into the multimode output waveguide (501); and

in that the multimode interference coupler (100) further comprises:

- one region in the multimode interference coupler (100) comprising an arrangement of periodically alternated sections of the core material and of the cladding material, with a period smaller than a value of the shortest wavelength in the bandwidth of the integrated mode converter and multiplexer; and

in that the first input (101), second input (102), first output (111) and second output (112) further comprise:

- mode adapters (130), each mode adapter (130) comprising a progressively varying waveguide width while periodically alternating sections of the core material and of the cladding material.

2.- Integrated mode converter and multiplexer according to claim 1, characterized in that the first phase-shifter (200) further comprises a plurality of mode adapters (220, 222, 230, 232) progressively varying waveguide width while periodically alternating sections of the core material and of the cladding material.

3.- Integrated mode converter and multiplexer according to any of the previous claims, characterized in that the first phase-shifter (200) comprises at least one phase-loading waveguide segment (250) located at a side of the first waveguide (201).

4.- Integrated mode converter and multiplexer according to claim 3, characterized in that the at least one phase-loading waveguide segment (250) comprises a region with periodically alternating sections of the core material and of the cladding material.

5.- Integrated mode converter and multiplexer according to any one of the preceding claims, characterized in that:

- the first monomode input waveguide (401) is connected to the first input (101) of the multimode interference coupler (100),
- the second monomode input waveguide (402) is connected to the second input (102) of the multimode interference coupler (100), and
- the second phase shift is 90º.

6.- Integrated mode converter and multiplexer according to any one preceding claims 1-4, further comprising a third monomode input waveguide (403) adapted to receive a third input zero-order signal (430), and being the multimode output waveguide (501) adapted to further transmit a third output second-order signal (530), being the integrated mode converter and multiplexer characterized in that the first monomode input waveguide (401) is connected to the first input (101) of the multimode interference coupler (100), the second monomode input waveguide (402) is connected to the second input (102) of the multimode interference coupler (100), and the multimode interference coupler (100) further comprises a third input (103), a fourth input (104), a third output (113) and a fourth output (114); wherein the integrated mode converter and multiplexer further comprises:

- a symmetrical Y-junction (300) connecting the second monomode input waveguide (402) to the second input (102) and third input (103);
- a second phase-shifter (200) configured to induce a third phase shift between the third output (113) and fourth output (114); and
- a third phase-shifter (200) configured to induce a fourth phase shift between the second input (102) and third input (103).

7.- Integrated mode converter and multiplexer according to claim 6, characterized in that the second phase shift is 45º, the third phase shift is 135º and the fourth phase shift is 90º.

8.- Integrated mode converter and multiplexer according to any of the previous claims, characterized in that the at least one phase-shifter (200) is a controllable phase-shifter (200), externally switched between a first phase shift value and a second phase shift value.