CLAIMS:

1. An end-fire tapered slot antenna ~~(10)~~ configured for use as an antenna element in a phased array system, comprising:

a conductive ground plane ~~(11)~~ including a pass-through opening ~~(12)~~ recessed therein, the pass-through opening ~~(12)~~ having a predetermined dimension and shape;

a dual tapered slot element (DTSE) ~~(13)~~ passing through the pass-through opening ~~(12)~~ recessed in the conductive ground plane ~~(11)~~, the DTSE ~~(13)~~ comprising:

a substrate ~~(14)~~ having two surfaces ~~(14A, 14B)~~ on opposite sides of the substrate ~~(14)~~, the substrate ~~(14)~~ being made of a nonconductive material;

a radiating portion ~~(17)~~ comprising a first pair of radiating wings ~~(20, 21)~~ symmetrically arranged on the surface ~~(14A)~~ located on one side of the substrate ~~(14)~~, and a second pair of radiating wings symmetrically arranged on the surface ~~(14B)~~, located on another side of the substrate ~~(14)~~, opposite to the first pair of radiating wings ~~(20, 21)~~, the radiating wings ~~(20, 21)~~ having flared inner edges ~~(24A, 24B)~~, flared lower edges ~~(23A, 23B)~~ and outer edges ~~(24A, 24B)~~ orthogonal to the conductive ground plane ~~(11)~~;

a base portion ~~(18)~~ electrically coupled to the radiating portion ~~(17)~~, the base portion ~~(18)~~ comprising:

a first pair of legs ~~(22, 23)~~ arranged on one surface ~~(14A)~~ of the substrate symmetrically with respect to a symmetry axis ~~(O)~~ orthogonal to the conductive ground plane ~~(11)~~, and a second pair of legs symmetrically arranged on another surface ~~(14B)~~ of the substrate ~~(14)~~ opposite to the first pair of legs, the first and second pairs of the legs passing through the pass-through opening ~~(12)~~ of the conductive ground plane ~~(11)~~ and being coupled to a feed line ~~(19)~~ at a downmost part ~~(28)~~ of the base portion ~~(17)~~ on one of the surfaces ~~(14A, 14B)~~, the legs of the first and second pairs having inner edges ~~(25A, 25B)~~ defining a corresponding slot line ~~(31)~~ therebetween on each side of the substrate ~~(14)~~ along the symmetry axis ~~(O)~~ being orthogonal to said conductive ground plane ~~(11)~~, the slot line ~~(31)~~ on each side of the substrate ~~(14)~~ having a tapered shape and extending from a downmost part ~~(28)~~ of the base portion ~~(18)~~ towards the radiating portion ~~(17)~~ gradually increasing a distance between the inner edges ~~(25A, 25B)~~ of the legs ~~(22, 23)~~ in accordance with a predetermined relationship;

a plurality of vias elements ~~(60)~~ arranged at the inner edges ~~(25A, 25B)~~ of the legs ~~(22, 23),~~ and at the flared inner edges ~~(24A, 24B)~~, flared lower edges ~~(23A, 23B)~~ and outer edges ~~(24A, 24B)~~ of the radiating wings ~~(20, 21)~~ in a spaced-apart relationship along an entire perimeter of the radiating wings ~~(20, 21)~~, the vias elements ~~(60)~~ electrically connecting the radiating wings ~~(20, 21)~~ and the legs ~~(22, 23)~~ arranged on the surfaces ~~(14A, 14B)~~ of the opposite sides of the substrate ~~(14)~~, correspondingly; and

at least one pair of electrical shunts ~~(32A, 32B)~~ located on each surface ~~(14A, 14B)~~ of the substrate ~~(14)~~, and configured for connecting the radiating wings ~~(20, 21)~~ of the DTSE ~~(13)~~ to the conductive ground plane ~~(11)~~.

2. The end-fire tapered slot antenna of claim 1, wherein said substrate ~~(14)~~ has a dielectric constant in the range of 2 to 20 and a thickness in the range of $0.135\lambda_0$ to $0.3\lambda_0$.

3. The end-fire tapered slot antenna of claim 1, wherein the shape of the pass-through opening ~~(12)~~ is a circular shape having a predetermined diameter in the range of $0.1\lambda_0$ to $0.2\lambda_0$.

4. The end-fire tapered slot antenna of claim 1, wherein the flared inner edges ~~(24A, 24B)~~ and flared lower edges ~~(23A, 23B)~~ of the radiating wings ~~(20, 21)~~ flare in an exponential manner.

5. The end-fire tapered slot antenna of claim 1, wherein the flared inner edges ~~(24A, 24B)~~ of the radiating wings ~~(20, 21)~~ define a radiating gap ~~(30)~~ on each side of the substrate, the radiating gap ~~(30)~~ extending from a downmost part ~~(31)~~ of the radiating portion ~~(17)~~ to the distal uppermost part ~~(32)~~ of the radiating portion ~~(17)~~.

6. The end-fire tapered slot antenna of claim 5, wherein the radiating gap ~~(30)~~ on each side of the substrate progressively widens in an exponential manner from the downmost part ~~(31)~~ towards the distal uppermost part ~~(32)~~.

7. The end-fire tapered slot antenna of claim 5, wherein the radiating gap ~~(30)~~ on each side of the substrate is configured to provide an impedance matching between the end-fire tapered slot antenna ~~(10)~~ and a wave impedance in a free-space.

8. The end-fire tapered slot antenna of claim 1, wherein the radiating wings ~~(20, 21)~~ have a predetermined length in the range of $0.35\lambda_0$ to $0.45\lambda_0$, where λ_0 is a free-space operating wavelength of the end-fire tapered slot antenna ~~(10)~~.

9. The end-fire tapered slot antenna of claim 8, wherein the legs ~~(22, 23)~~ have a predetermined length in the range of $0.15\lambda_0$ to $0.25\lambda_0$.

10. The end-fire tapered slot antenna of claim 8, wherein the conductive ground plane ~~(11)~~ is disposed at a predetermined distance *L* from the radiation portion ~~(17)~~, the distance *L* being in the range of $0.025\lambda_0$ to $0.035\lambda_0$.

11. The end-fire tapered slot antenna of claim 1, wherein the legs ~~(22, 23)~~ have bottom edges ~~(27A, 27B)~~ and outer edges ~~(26A, 26B)~~, the outer edges ~~(26A, 26B)~~ flaring in an exponential manner.

12. The end-fire tapered slot antenna of claim 1, wherein the slot line ~~(31)~~ on each side of the substrate at the downmost part ~~(28)~~ of the base portion ~~(18)~~ has a distance D_0 between the inner edges ~~(25A, 25B)~~ of the legs ~~(22, 23)~~ suitable to match an impedance of the slot line on each side of the substrate ~~(31)~~ with an input impedance of the feed line ~~(19)~~.

13. The end-fire tapered slot antenna of claim 1, wherein the predetermined relationship describing the gradual increase of the distance between the inner edges ~~(25A, 25B)~~ of the legs ~~(22, 23)~~ and the symmetry axis ~~(O)~~ is $D = ax + D_0$, where *a* is taper slope of the inner edges of the slot line ~~(31)~~ along the symmetry axis , *x* is a coordinate along the symmetry axis ~~(O)~~ and D_0 is the distance between the inner edges ~~(25A, 25B)~~ of the first and second pair of legs ~~(22, 23)~~ and the symmetry axis ~~(O)~~ at the downmost part of the base portion.

14. The end-fire tapered slot antenna of claim 13, wherein the taper slope of the slot line ~~(31)~~ depends on the dielectric constant ε and the thickness *s* of the substrate ~~(14)~~.

15. The end-fire tapered slot antenna of claim 1, wherein said at least one pair of electrical shunts ~~(32A, 32B)~~ located on each surface ~~(14A, 14B)~~ of the substrate ~~(14)~~ connects any two points selected on the flared lower edges ~~(23A, 23B)~~ of the wings ~~(20, 21)~~ to any two corresponding points selected on the ground plane ~~(11)~~.

16. The end-fire tapered slot antenna of claim 1, wherein the feed line ~~(19)~~ is coupled to the base portion ~~(18)~~ on one of the surfaces ~~(14A, 14B)~~, the feed line ~~(19)~~ including a coaxial cable having a shield conductor ~~(51)~~ coupled to one of the legs ~~(22, 23)~~ located on one of the surfaces ~~(14A, 14B)~~, and a core conductor ~~(52)~~ connected to the other leg.

17. The end-fire tapered slot antenna of claim 1, wherein the plurality of vias elements ~~(60)~~ are arranged at a predetermined distance *d* from the inner edges of the legs along the inner edges ~~(25A, 25B)~~, and from the flared inner edges ~~(24A, 24B)~~, the flared lower edges ~~(23A, 23B)~~ and the outer edges ~~(21A, 21B)~~ of the radiating wings ~~(20, 21)~~ being along an entire perimeter of the radiating wings ~~(20, 21)~~.

18. The end-fire tapered slot antenna of claim 17, wherein the predetermined distance *d* is in the range of $0.01\lambda_o$ to $0.15\lambda_o$.

19. A phased array system including a plurality of the end-fire tapered slot antennas ~~(10)~~ of any one of the preceding claims.