

WHAT IS CLAIMED IS:

1. A metal smart card with dual interface capability comprising:
 - a metal layer of thickness D having a top surface and a bottom surface extending generally parallel to each other;
 - an integrated circuit (IC) module having a top region with contacts enabling the IC module to make physical contact to a card reader and said IC module also including means for radio frequency (RF) communication with a card reader; said IC module having a length L1, a width W1 and a thickness of D1, which is less than D;
 - a plug of non RF impeding material having lateral dimensions of L2, equal to or greater than L1, and W2 equal to or greater than W1;
 - an opening in said metal layer extending for the full thickness of said metal layer in which is securely located said IC module mounted on said plug, said IC module and said plug extending in the vertical direction between the top and bottom surfaces of the metal layer, with the contacts of the IC module being positioned along the same horizontal plane as the top surface of the metal layer.
2. A metal smart card with dual interface capability as claimed in claim 1 further including a ferrite layer attached to the bottom surface of the metal layer and a vertical hole formed in the plug and through the ferrite layer for enhancing RF transmission with the IC module via said vertical hole.
3. A metal smart card with dual interface capability as claimed in claim 2 wherein the vertical hole has lateral dimension of L3 and W3, which lateral dimensions are less than the corresponding lateral dimensions, L1 and W1, of the IC module; and further including a booster antenna layer attached to the ferrite layer for enhancing RF transmission with the IC module via said vertical hole.

4. A metal smart card with dual interface capability as claimed in claim 3 wherein the lateral dimensions of the plug L2 and W2 are greater than the lateral dimensions L1 and W1 of the IC module.
5. A metal smart card with dual interface capability as claimed in claim 1 wherein the opening in the metal layer has a first region at and just below its the top surface for accommodating the IC module and a second region below the first region which extends until the bottom surface of the metal layer; in the first region the opening has the lateral dimensions of L1 and W1 for a depth of D1 and in the second region the opening has the lateral dimension of L2 and W2 for a depth of (D-D1) and wherein the IC module fits in and fills the opening in the first region and the plug fits in and fills the opening in the second region; and where L2 and W2 are respectively greater than L1 and W1.
6. A metal smart card with dual interface capability as claimed in claim 5, wherein a ferrite layer is attached to the bottom of the metal layer and a booster antenna layer is formed below the ferrite layer, and wherein a hole is formed in the ferrite layer to enhance RF transmission between the booster antenna layer and the IC module.
7. A metal smart card with dual interface capability as claimed in claim 1 wherein the opening in the metal layer has lateral dimensions of L2 and W2, where L2 and W2 are respectively greater than L1 and W1, and wherein the plug is attached to the metal layer and fills the opening within the metal layer, and wherein the plug has a first cut out region with lateral dimensions of L1 and D1 extending for a depth D1 below the top surface for accommodating the IC module and a second region below the first region which extends until the bottom surface of the metal layer for a depth of (D-D1); and wherein a hole is formed in the second region below the IC module having lateral

dimension of L3 and W3, where L3 is less than L1 and W3 is less than W1.

8. A metal smart card with dual interface capability as claimed in claim 7 further including a masking layer formed over the top metal surface and any exposed plug portion.
9. A card comprising:
 - a metal layer having a top surface and a bottom surfaces extending generally parallel to each other;
 - a first region cut out in said top surface of said metal layer having a depth D1, a length L1 and a width W1;
 - an integrated circuit (IC) module whose dimensions are substantially equal to D1, L1 and W1 is snugly and securely placed within the first cut out region; said IC module having contacts positioned along the top surface of the metal layer and including RF transmission means for enabling contact and contactless operation of the card;
 - a second cut out region extending from said bottom surface of said metal layer until a distance D1 from the top surface, said second cut out region extending vertically below the first cut out region and generally in a symmetrical manner with respect to the first cut out region; said second cut out region having a length L2 greater than L1 and a width W2 greater than W1; and
 - a plug formed of non RF impeding material designed to fit snugly within said second cut out region is securely attached thereto.
10. A card as claimed in claim 9, and said plug has a centrally located opening, said centrally located opening having lateral dimensions of length L3 which is smaller than L1 and width W3 which is less than W1; and wherein said card also includes a layer of ferrite material attached to the bottom side of the metal layer via an adhesive layer; and a booster antenna attached to the ferrite layer; and wherein the centrally located opening in the

plug is extended vertically down through the ferrite layer to enhance RF communication.

11. A card as claimed in claim 10, wherein said card also includes a magnetic stripe, a signature panel and a hologram.
12. A card as claimed in claim 9, wherein said metal layer is one of stainless steel, iron, tantalum, aluminum, brass, copper, or any alloy and wherein said plug is made of any non-metallic substance or a metal such as tungsten which does not impede RF transmission.
13. A card as claimed in claim 9, wherein the dimensions of the length, width and thickness of the card are, respectively, in the range of 3.3 inches, 2.2 inches and 0.03 inches; wherein the thickness of the IC module may range from less than 0.005 inches to more than 0.02 inches; and wherein the length and width of the metal layer extends for the full length and width of the card and its thickness ranges from less than 0.01 inches to more than 0.02 inches.
14. A method of making a dual interface card which includes an integrated circuit (IC) module having contacts along its top surface and including RF transmission means for enabling contact and contactless operation of the card, and said IC module having a depth of D1, a length of L1 and a width of W1, the method comprising the steps of:
 - selecting a metal layer having a top surface and a bottom surface extending generally parallel to each other and a depth D which is greater than D1;
 - cutting out a plug region in said metal layer starting from said bottom surface of said metal layer for a distance D-D1 from the bottom surface of said metal layer, said plug region having lateral dimensions of length L2 equal to or greater than L1 and width W2 equal to or greater than W1;
 - securely attaching a plug formed of non RF impeding material within said plug region, said plug designed to fit in and fill the plug cut out region;

cutting out a module region in said top surface of said metal layer overlying said plug region; said module cut out region being disposed symmetrically with respect to the plug region; said module region having a depth D1 and a length L1 and a width W1;

inserting and securely attaching said IC module within said module region with the contacts of the IC module positioned along the same horizontal plane as the top surface of the metal layer.

15. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer; and forming an opening in said plug and said ferrite layer, said opening having lateral dimensions of length L3 which is less than L1 and width W3 which is less than W1.
16. A method as claimed in claim 15 further including a layer including a booster antenna and attaching said booster antenna layer to the ferrite layer.
17. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer and a booster antenna layer to the ferrite layer and laminating the metal layer, the ferrite layer and the booster antenna layer.
18. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer and a booster antenna layer to the ferrite layer and a signature panel and magnetic stripe to the booster antenna layer.
19. A method as claimed in claim 14 wherein said metal layer is selected from stainless steel, iron, tantalum, aluminum, brass, copper, or any alloy; and wherein said plug is made of any non-metallic substance or a metal such as tungsten which does not impede RF transmission.
20. A method as claimed in claim 14 wherein L2 is greater than L1 and W2 is greater than W1.

21. A method of making a dual interface card which includes an integrated circuit (IC) module having contacts along its top surface and which includes RF transmission means for enabling contact and contactless operation of the card and said IC module having a depth of D1, a length of L1 and a width of W1, the method comprising the steps of:

- selecting a metal layer having a top surface and a bottom surface extending generally parallel to each other, and said metal layer having a depth D which is greater than D1;

- forming a plug region in said metal layer having lateral dimensions of length L2 equal to or greater than L1 and width W2 equal to or greater than W1 and extending vertically from the bottom surface a distance D-D1;

- securely attaching a plug formed of non RF impeding material within said plug region, said plug designed to fit in and fill the plug region;

- forming a module region extending within said metal layer overlying said plug region; said module region being disposed symmetrically with respect to the plug region; said module region having a depth D1 and a length L1 and a width W1; and

- inserting said IC module within said module region and securely attaching said IC module to said plug with the contacts of the IC module positioned along the same horizontal plane as the top surface of the metal layer.

22. A method as claimed in claim 21 wherein L2 is greater than L1 and W2 is greater than W1 and wherein said plug region has an additional region which extends the full depth of the metal layer around the IC module.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A metal smart card with dual interface capability comprising:
 - a metal layer of thickness D having a top surface and a bottom surface extending parallel to each other;
 - an integrated circuit (IC) module having a top region with contacts enabling the IC module to make physical contact to a card reader and said IC module also including means for radio frequency (RF) communication with a card reader; said IC module having a length L1, a width W1 and a thickness of D1, which is less than D;
 - a plug of non RF impeding material having lateral dimensions of L2, equal to or greater than L1, and W2 equal to or greater than W1;
 - an opening in said metal layer extending for the full thickness of said metal layer in which is securely located said IC module mounted on said plug, said IC module and said plug extending in the vertical direction between the top and bottom surfaces of the metal layer, with the contacts of the IC module being positioned along the same horizontal plane as the top surface of the metal layer.
2. A metal smart card with dual interface capability as claimed in claim 1 further including a ferrite layer attached to the bottom surface of the metal layer and a vertical hole formed in the plug and through the ferrite layer for enhancing RF transmission with the IC module via said vertical hole.
3. A metal smart card with dual interface capability as claimed in claim 2 wherein the vertical hole has lateral dimension of L3 and W3, which lateral dimensions are less than the corresponding lateral dimensions, L1 and W1, of the IC module; and further including a booster antenna layer attached to the ferrite layer for enhancing RF transmission with the IC module via said vertical hole.

4. A metal smart card with dual interface capability as claimed in claim 3 wherein the lateral dimensions of the plug L2 and W2 are greater than the lateral dimensions L1 and W1 of the IC module.
5. A metal smart card with dual interface capability as claimed in claim 1 wherein the opening in the metal layer has a first region at and just below its the top surface for accommodating the IC module and a second region below the first region which extends until the bottom surface of the metal layer; in the first region the opening has the lateral dimensions of L1 and W1 for a depth of D1 and in the second region the opening has the lateral dimension of L2 and W2 for a depth of (D-D1) and wherein the IC module fits in and fills the opening in the first region and the plug fits in and fills the opening in the second region; and where L2 and W2 are respectively greater than L1 and W1.
6. A metal smart card with dual interface capability as claimed in claim 5, wherein a ferrite layer is attached to the bottom of the metal layer and a booster antenna layer is formed below the ferrite layer, and wherein a hole is formed in the ferrite layer to enhance RF transmission between the booster antenna layer and the IC module.
7. A metal smart card with dual interface capability as claimed in claim 1 wherein the opening in the metal layer has lateral dimensions of L2 and W2, where L2 and W2 are respectively greater than L1 and W1, and wherein the plug is attached to the metal layer and fills the opening within the metal layer, and wherein the plug has a first cut out region with lateral dimensions of L1 and D1 extending for a depth D1 below the top surface for accommodating the IC module and a second region below the first region which extends until the bottom surface of the metal layer for a depth of (D-D1); and wherein a hole is formed in the second region below the IC module having lateral

dimension of L3 and W3, where L3 is less than L1 and W3 is less than W1.

8. A metal smart card with dual interface capability as claimed in claim 7 further including a masking layer formed over the top metal surface and any exposed plug portion.
9. A card comprising:
 - a metal layer having a top surface and a bottom surfaces extending generally parallel to each other;
 - a first region cut out in said top surface of said metal layer having a depth D1, a length L1 and a width W1;
 - an integrated circuit (IC) module whose dimensions are substantially equal to D1, L1 and W1 is snugly and securely placed within the first cut out region; said IC module having contacts positioned along the top surface of the metal layer and including RF transmission means for enabling contact and contactless operation of the card;
 - a second cut out region extending from said bottom surface of said metal layer until a distance D1 from the top surface, said second cut out region extending vertically below the first cut out region and generally in a symmetrical manner with respect to the first cut out region; said second cut out region having a length L2 greater than L1 and a width W2 greater than W1; and
 - a plug formed of non RF impeding material designed to fit snugly within said second cut out region is securely attached thereto.
10. A card as claimed in claim 9, and said plug has a centrally located opening, said centrally located opening having lateral dimensions of length L3 which is smaller than L1 and width W3 which is less than W1; and wherein said card also includes a layer of ferrite material attached to the bottom side of the metal layer via an adhesive layer; and a booster antenna attached to the ferrite layer; and wherein the centrally located opening in the

plug is extended vertically down through the ferrite layer to enhance RF communication.

11. A card as claimed in claim 10, wherein said card also includes a magnetic stripe, a signature panel and a hologram.
12. A card as claimed in claim 9, wherein said metal layer is one of stainless steel, iron, tantalum, aluminum, brass, copper, or any alloy and wherein said plug is made of any non-metallic substance or a metal such as tungsten which does not impede RF transmission.
13. A card as claimed in claim 9, wherein the dimensions of the length, width and thickness of the card are, respectively, in the range of 3.3 inches, 2.2 inches and 0.03 inches; wherein the thickness of the IC module may range from less than 0.005 inches to more than 0.02 inches; and wherein the length and width of the metal layer extends for the full length and width of the card and its thickness ranges from less than 0.01 inches to more than 0.02 inches.
14. A method of making a dual interface card which includes an integrated circuit (IC) module having contacts along its top surface and including RF transmission means for enabling contact and contactless operation of the card, and said IC module having a depth of D1, a length of L1 and a width of W1, the method comprising the steps of:
 - selecting a metal layer having a top surface and a bottom surface extending parallel to each other and a depth D which is greater than D1;
 - cutting out a plug region in said metal layer starting from said bottom surface of said metal layer for a distance D-D1 from the bottom surface of said metal layer, said plug region having lateral dimensions of length L2 equal to or greater than L1 and width W2 equal to or greater than W1;
 - securely attaching a plug formed of non RF impeding material within said plug region, said plug designed to fit in and fill the plug cut out region;

cutting out a module region in said top surface of said metal layer overlying said plug region; said module cut out region being disposed symmetrically with respect to the plug region; said module region having a depth D1 and a length L1 and a width W1;

inserting and securely attaching said IC module within said module region with the contacts of the IC module positioned along the same horizontal plane as the top surface of the metal layer.

15. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer; and forming an opening in said plug and said ferrite layer, said opening having lateral dimensions of length L3 which is less than L1 and width W3 which is less than W1.
16. A method as claimed in claim 15 further including a layer including a booster antenna and attaching said booster antenna layer to the ferrite layer.
17. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer and a booster antenna layer to the ferrite layer and laminating the metal layer, the ferrite layer and the booster antenna layer.
18. A method as claimed in claim 14 further attaching a ferrite layer to the bottom surface of the metal layer and a booster antenna layer to the ferrite layer and a signature panel and magnetic stripe to the booster antenna layer.
19. A method as claimed in claim 14 wherein said metal layer is selected from stainless steel, iron, tantalum, aluminum, brass, copper, or any alloy; and wherein said plug is made of any non-metallic substance or a metal such as tungsten which does not impede RF transmission.
20. A method as claimed in claim 14 wherein L2 is greater than L1 and W2 is greater than W1.

21. A method of making a dual interface card which includes an integrated circuit (IC) module having contacts along its top surface and which includes RF transmission means for enabling contact and contactless operation of the card and said IC module having a depth of D1, a length of L1 and a width of W1, the method comprising the steps of:

selecting a metal layer having a top surface and a bottom surface extending parallel to each other, and said metal layer having a depth D which is greater than D1;

forming a plug region in said metal layer having lateral dimensions of length L2 equal to or greater than L1 and width W2 equal to or greater than W1 and extending vertically from the bottom surface a distance D-D1;

securely attaching a plug formed of non RF impeding material within said plug region, said plug designed to fit in and fill the plug region;

forming a module region extending within said metal layer overlying said plug region; said module region being disposed symmetrically with respect to the plug region; said module region having a depth D1 and a length L1 and a width W1; and

inserting said IC module within said module region and securely attaching said IC module to said plug with the contacts of the IC module positioned along the same horizontal plane as the top surface of the metal layer.

22. A method as claimed in claim 21 wherein L2 is greater than L1 and W2 is greater than W1 and wherein said plug region has an additional region which extends the full depth of the metal layer around the IC module.