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(54) **Microwave module**

said enclosure, **characterized in that** a plurality of spring contacts are placed between said back and said cover, and by comprising a waveguide flange. (Fig. 1)

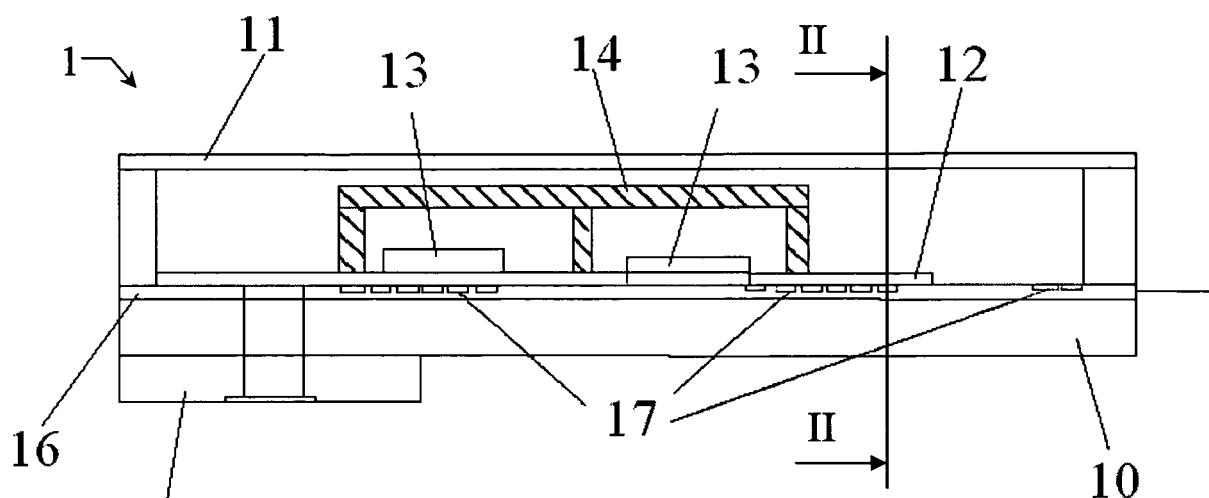


Fig. 1

Description

[0001] The present invention relates to a new Microwave Module eventually Firmware Controllable (MMfc), with hermetic sealing capability.

[0002] Modern microwave systems and subsystems find everyday new applications and become more and more consumer oriented, spreading across several fields of applications like radio, automotive, medical, satellites, measurements, sensors, industrial controls, process controls, domotic controls etc.

[0003] Manufacturers of this kind of equipment or sub equipment are always called to provide the best coexistence of very different technologies: the first very expensive, containing microwave circuitry and the second much cheaper, containing low frequency, digital processing, supply and service circuitry.

[0004] The last one is generally mounted onto a low cost mother board, while the microwave circuitry, that is very critical, needs dedicated and more expensive approach.

[0005] The Applicant, realizing that the total cost of this kind of equipment is mainly affected by the microwave assembly, is presenting this invention with the purpose of minimizing production cost and simplifying maintainability, without losing the typical characteristics of microwave devices, like the possibility of hermetically sealing the enclosure to accept mounting of bare chips on low loss substrate.

[0006] These and further objects are attained according to the present invention by a Microwave Module in the form of an enclosure comprising: a back of said enclosure, a cover of said enclosure, characterized in that a plurality of spring contacts are placed between said back and said cover, and by comprising a waveguide flange.

[0007] Further characteristics of the invention are described in the dependent claims.

[0008] To reach the proposed aims, the new MMfc, which includes all microwave active and passive parts and the relevant digital control circuitry, is arranged as a single super-component to be mounted onto the low cost mother-board without solder joints, bondings, pin and/or coax connectors, while maintaining the RF (Radio Frequency) interconnection through a built in waveguide flange.

[0009] This MMfc performs the dual functions of being inexpensively manufactured and comfortably mounted even in mass production, with the important feature of being easily replaceable in the field for maintenance purpose.

[0010] At the same time, if bare chip components are mounted inside, the enclosure may be closed in controlled atmosphere and hermetically sealed.

[0011] The solution herewith described gives the possibility to obtain a sealed metal or plastic enclosure in the form of a macro package containing all microwave circuitry, like active chips, both naked or packaged, passive

components, low loss substrate, bondings, RF shielding, RF absorbers, all digital control circuitry, and finally integrated waveguide flange, ready to be mounted on a low cost motherboard without use of soldering, bonding and pin and/or coax connectors.

[0012] In particular, this module is intended to be inserted and fastened by means of screws directly onto the mother board supporting the equipment.

[0013] This module is also eventually Firmware Controllable, by mounting on board a memory for storing any useful information needed to control the other circuits of the module, through an external microprocessor.

[0014] The characteristics and advantages of the present invention will be apparent from the ensuing description of a practical embodiment thereof, illustrated by way of nonlimiting example in the accompanying drawings, in which:

- Figure 1 is a longitudinal section schematic view of the MMfc according to the present invention;
- Figure 2 is a transversal section schematic view of the MMfc according to the present invention;
- Figure 3 is a schematic upper view of a portion of the MMfc according to the present invention.

[0015] Referring to the figures the MMfc 1, according to the invention, has the form of an enclosure and comprises a metal back 10, to ensure good thermal and electrical conduction, and an electromagnetical dissipative plastic cover 11 to be placed over the back 10 to perform the function of sealing the enclosure, by means of epoxy glue, and reducing the RF leakage.

[0016] The dimensions of the microwave module 1 in the shown embodiment are about 30 mm x 70 mm x 10 mm.

[0017] The back 10, when thermal conduction is not critical, can be made of metallized plastic.

[0018] The cover 11 is manufactured by using RF absorbing plastic, obtained by adding suitable amount of graphite powder or ferromagnetic powder to the melting compound, in a way that the leakage radiation from the MMfc is minimized.

[0019] Further, to reduce hysteresis, to enhance thermal behaviour, and to improve long term stability, a LCP (Liquid Crystal Polymer) kind of plastic has been used.

[0020] A microwave substrate 12 is placed over said back 10 and fastened to it by means of epoxy conductive glue or screws.

[0021] The microwave substrate 12 may be made of alumina or any type of suitable microwave soft board.

[0022] One or more circuit blocks 13 made of active or passive components are placed on the substrate 12.

[0023] Circuit blocks 13 can be of every kind. Can be of analogue or digital kind, and in particular can be programmable or however can have some settable parameters, for example obtained during calibration phase.

[0024] A programmable circuit can be, for example, a

gain programmable amplifier wherein a programmable 1 to n multiplexer connects the amplifier to n weighting resistors, and the gain of the amplifier depends on the value of the selected weighting resistor. The selected weighting resistor can be chosen during the calibration of the microwave module 1 or during the calibration of the microwave system.

[0025] The multiplexer comprises a digital address input for selecting the right resistor. The address can be stored on a memory placed on the substrate 12.

[0026] Therefore, the microwave module 1 comprises one or more circuit blocks 13, among them there is a memory that stores any useful information for the other circuits of the module.

[0027] Each circuit 13, when necessary, is surrounded by a radio frequency dumping cell 14, to minimize unwanted electromagnetic coupling.

[0028] These dumping cells are mainly used when microwave circuit blocks have amplifying chains with intrinsic high gain and consequently high probability to have unpredictable coupling with associated odd responses in frequency, or even self oscillation of the circuits.

[0029] In addition, dumping cells will improve circuits behaviour when the electrical function needs low noise operation.

[0030] Dumping cells 14 are preferably made of a graphite loaded silicon rubber, vacuum degassed to avoid chip contamination. To better perform the action of absorbing microwave energy flowing between stages and from inside to outside, dumping cells 14 are made of flexible moulded absorbing material in the way that there are one or more cavities surrounding the active device or devices and the softness of the material takes into account the working tolerances by self adapting between the retention mechanical clips located on the plastic cover and the upper layer of the substrate. This gives absolute protection against any self oscillation and any band response flatness problem, while reducing environment noise coupled to the circuit.

[0031] For handling reasons the cells 14 are preferably mechanically connected to the cover 11 and extend to the substrate 12. Each cell 14 surrounds completely each circuit 13 that needs to be dumped.

[0032] In the other side of the back 10 there is a hole 15 electromagnetically coupled to the microwave circuit in a way that it has a shape suitable to propagate microwaves in waveguide modes.

[0033] This hole and the surrounding plane with threaded holes forms a flange to be connected to an external waveguide to allow microwave energy transfer through it.

[0034] A plastic membrane at the waveguide flange 15, transparent to travelling microwaves, provides the sealing on the same waveguide hole.

[0035] The waveguide flange 15 is the means for connecting an external waveguide to the substrate 12 and consequently to the circuits 13.

[0036] A frame 16, with a plurality of spring contacts

17, is placed in between the back 10 and the cover 11. The spring contacts 17 are moulded into a rib 21 of the frame 16.

[0037] The frame 16 has two lateral ribs, wherein the contacts 17 are placed, connected together by two small transversal bars to form the frame. The frame 16 is preferably made of LCP plastic.

[0038] The spring contacts 17 are connected to the circuits 13 by means of bonding connections 20.

[0039] The spring contacts 17 are placed on the lateral ribs of the frame 16 and held by the bars 21, leaving an inner part free for bonding and an outer part forming an arc with sliding edge 22 to make a resistant node on the spring itself to increase the connection force of the contact without losing softness of the spring. In this way any false or instable contact is avoided.

[0040] The spring contacts 17 are preferably made of gold plated berillium copper. They have a total length of about 10 mm, width of about 0,5 mm, thickness of 0,1 mm, and a pitch of about 1 mm.

[0041] They have the shape, in the inner part substantially flat, and in the outer part for about half of their length (in the direction of the inner part) again substantially flat, and for the other half of their length (in the direction of the outer part) a half circle arc shape (with circle diameter of about 2 mm.). and terminate with a small sliding edge 22 or foot at the end.

[0042] The arc of the contact form the elastic spring part of the contact itself to be coupled to a suitable gold plated pad on the mother-board.

[0043] The back 10, the frame 16 and the cover 11 are designed in a way that they can be assembled to form hermetically closed enclosures.

[0044] All parts of the module 1 are tightened by means of epoxy glue to provide high protection to the semiconductor circuits mounted inside.

[0045] To allow heat dissipation, the module 1 is, preferably, fixed into a hole of the mother board (not showed), leaving a thermal path to the external enclosure and pressing the spring contacts 17 against the corresponding pads arranged on the mother board itself, in order to make the electrical connections. In this way the microwave module 1 is mechanically connected to both the mother board and the external metal enclosure by means of fixing screws through hole 23 provided in the frame 16 and in the back 10.

Claims

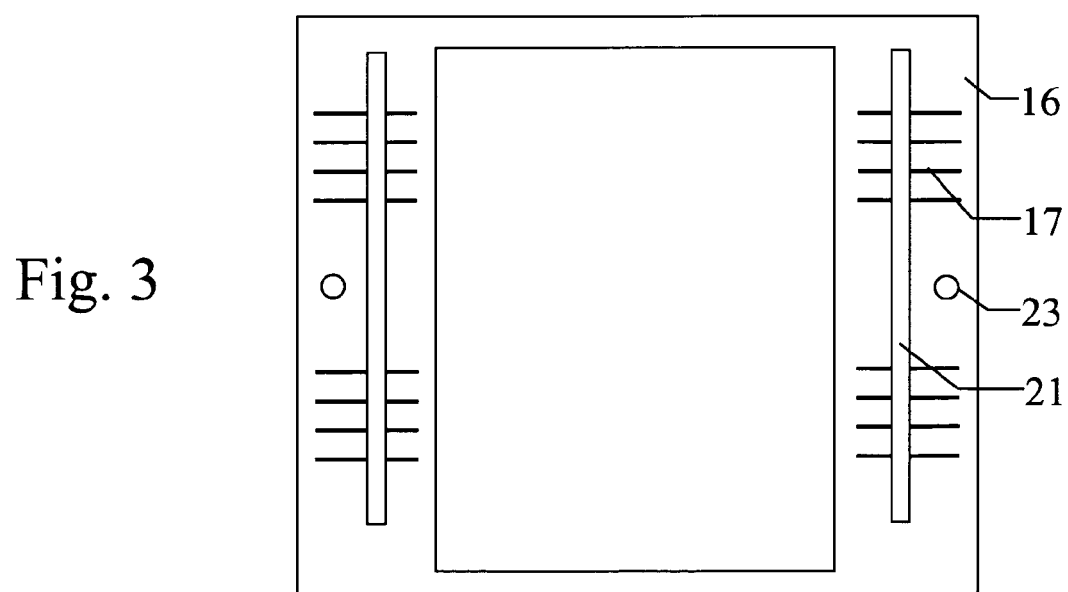
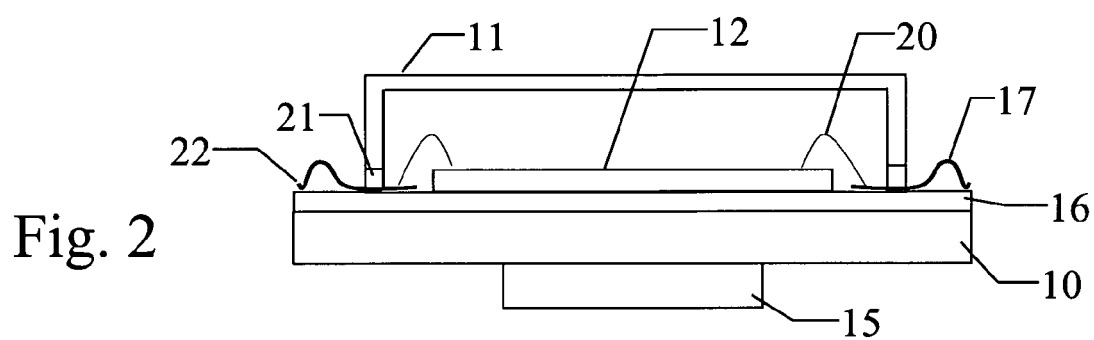
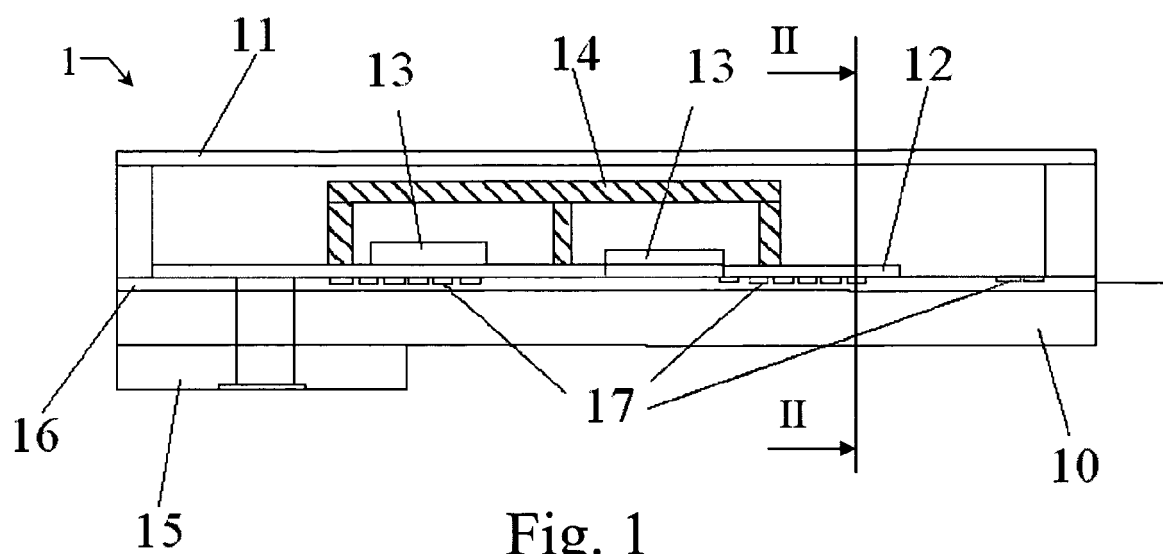
1. A Microwave Module in the form of an enclosure comprising: a back of said enclosure, a cover of said enclosure, **characterized in that** a plurality of spring contacts are placed between said back and said cover, and by comprising a waveguide flange.
2. A Microwave Module as claimed in claim 1, **characterized by** comprising a substrate placed between

said back and said cover.

3. A Microwave Module as claimed in claim 2, **characterized in that** it comprises at least an electronic circuit placed on said substrate. 5
4. A Microwave Module as claimed in claim 3, **characterized in that** said cover comprises a radio frequency absorbing device placed surrounding said electronic circuit to avoid unwanted interference and coupling between the stages of said electronic circuit. 10
5. A Microwave Module as claimed in claim 4, **characterized in that** said radio frequency absorbing device is flexible. 15
6. A Microwave Module as claimed in claim 4, **characterized in that** said radio frequency absorbing device is made of graphite loaded silicon rubber, vacuum degassed. 20
7. A Microwave Module as claimed in claim 1, **characterized in that** said component is mechanically and electrically connected to a mother board; said electrical connection to said mother board is done by means of only said plurality of spring contacts. 25
8. A Microwave Module as claimed in claim 1, **characterized in that** said cover is a radio frequency absorbing cover. 30
9. A Microwave Module as claimed in claim 1, **characterized in that** said radio frequency absorbing cover comprises a Liquid Crystal Polymer kind of plastic. 35
10. A Microwave Module as claimed in claim 1, **characterized in that** said waveguide flange is placed on said back.
11. A Microwave Module as claimed in claim 1, **characterized in that** said plurality of spring contact are positioned on a plastic frame to be placed between said back and said cover. 40
12. A Microwave Module as claimed in claim 1, **characterized in that** said back is greater than the cover; said plurality of spring contact are positioned on the lateral sides of said back. 45
13. A Microwave Module as claimed in claim 1, **characterized in that** said enclosure is hermetically closed. 50
14. A Microwave Module as claimed in claim 1, **characterized in that** said waveguide flange comprises a plastic membrane, transparent to travelling micro-waves, to sealing the waveguide hole. 55
15. A Microwave Module as claimed in claim 1, **character-**

terized in that said spring contacts comprise an inner part free for bonding and an outer part forming an arc with sliding edge.

- 5 16. A Microwave Module as claimed in claim 1, **characterized in that** said Microwave Module is Firmware Controllable comprising a memory.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 42 5745

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 2006/001129 A1 (STONEHAM EDWARD B [US] ET AL) 5 January 2006 (2006-01-05) * paragraph [0006] - paragraph [0011]; figures 1-3 *	1	
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 April 2008	Examiner Pastor Jiménez, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 42 5745

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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23-04-2008

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