

AN RF DECOY AND METHOD FOR DECEIVING RADAR-BASED MISSILES

FIELD OF THE INVENTION

5 The present invention relates to electronic countermeasures for protecting an aircraft against enemy missile attacks and, more particularly, to an airborne RF decoy that deceives a radar-based missile to track it instead of tracking the aircraft.

BACKGROUND OF THE INVENTION

10 Electronic countermeasures (ECM) are a subsection of electronic warfare (EW) which includes any sort of electrical or electronic device designed to deceive radar, sonar, or other detection systems. Electronic countermeasures may be used both offensively and defensively in any method to deny targeting information to an enemy. For example, ECM may cause the detecting radar system to falsely "identify" many separate targets or make the real target appear and disappear or
15 move about randomly. ECM is used effectively to protect aircraft from guided missiles. Most air forces use them to protect their aircraft from attack.

 Offensive ECM often takes the form of jamming. Defensive ECM includes using chaff and flares against incoming missiles, as well as soids (floating flares that are effective only in the terminal phase of missiles with infrared signature
20 seeker heads), blip enhancement and jamming of missile terminal homers. When employed effectively ECM can keep aircraft from being tracked by search radars, surface-to-air missiles and air-to-air missiles.

 Electronic counter-countermeasures (ECCM) describe a variety of practices which attempt to reduce or eliminate the effect of ECM on electronic sensors aboard
25 vehicles, ships and aircraft and weapons such as missiles. ECCM is also referred to as Electronic Protective Measures (EPM), chiefly in Europe.

 ECM is practiced by nearly all military units—land, sea or air. Aircraft are the primary weapons in the ECM battle because they can "see" a larger patch of

earth than a sea or land-based unit. When employed effectively ECM can keep aircraft from being tracked by search radars, surface-to-air missiles and air-to-air missiles.

Modern radar-based threat systems with advanced Electronic Counter-
5 Counter Measures capabilities are immune to existing on-board ECM techniques and pose a real threat to airborne platforms. Several methods for off-board protecting means had been suggested in the past. US Patent 5,333,814 describes a towed body aimed to intercept or collide with incoming threats but without any ECM capability. US Patent 6,492,931 describes an expendable decoy that operates
10 off-board but is dependent on the equipment residing in the protected platform. This decoy is not a stand-alone jammer that can work autonomously against multiple targets and it poses major limitations on the flight envelope of the platform after the launching. Israeli Patent Application 109841 describes a towed decoy jammer that also acts in close dependence with the protected platform, both electrically and
15 mechanically. This decoy also limits the aircraft maneuvers and lowers the efficiency of other protective measures.

US Patent 6,429,800 deals with a true off-board expendable jammer. However, this decoy has no "receive" capability and/or any independent recognition of the enemy threats. It has no Digital Radio Frequency Memory (DRFM)-based
20 equipment that can optimize the deceiving technique, nor any updating mechanism. It has no mechanical and aerodynamical detailed design. The spatial coverage and the frequency coverage are not explicitly described, thus the efficiency against multiple type threats arising from all directions is not proved.

SUMMARY OF THE INVENTION

25 The present invention provides an airborne Radio Frequency (RF) decoy that answers to the modern threats which overcomes the above mentioned limitations with full off-board and stand alone capabilities. The goal of the airborne RF decoy of the invention is to "pull/steal" the tracking of the missile and/or radar away from the protected airborne platform and towards the off-board decoy. The decoy thus

causes the enemy attacking missile to explode at a sufficiently large distance from the protected airborne platform.

The airborne RF decoy of the invention can cope with multiple threats coming from any direction. The decoy does not require intimate knowledge of the technical details of the threats, thus providing a robust ECM solution.

The airborne RF decoy of the invention is an expendable, stand-alone, off-board Electronic Counter-Measure (ECM) system aimed to provide airborne platforms with protection against multiple radar-based threats including Air-to-Air (AA) and Surface-to-Air (SAM) missiles both active and semi-active ones. The airborne RF decoy is a stand-alone system that includes a receiver, a transmitter, a digital RF memory (DRFM), a power source and one or more omnidirectional EW antennas, all of which operate dependently of the equipment residing in the protected platform itself.

The airborne RF decoy has the mechanical outline of standard chaff and flare decoys and is safely ejected from any platform by pyrotechnic elements. It is compatible with all existing industry dispensers so that no structural or aerodynamical changes are required to the airborne RF decoy, and the operational deployment process is straight forward, that is, identical to the process of ejecting a chaff or a flare.

The basic concept of operation of the airborne RF decoy of the invention uses a robust technique to deceive enemy radar-based threats as follows: immediately after its ejection from the protected airborne platform, the airborne RF decoy activates an energy source, stabilizes its path, acquires illuminating signals and analyzes threat parameters. Then the decoy alters the received signals to generate an authentic false target and transmits a deceiving signal towards the radar threat. The radar threats locks on the decoy and follow its path. Thus the threat course is diverted from the protected airborne platform and a large miss distance of the attacking missile (tens to hundreds of meters) is assured.

The airborne RF decoy of the invention operates in accordance with a Pre-Flight-Data (PFD) file which defines the most probable threat in the arena. The pre-

flight-data file is loaded prior to the mission to each specific decoy by an external data loader via a dedicated connector that is embedded in the decoy. The decoy's data file can be updated by several methods: before ejection by a wire/proximity link, after ejection via a medium-range wireless link, or via a long-range wireless link with the protected airborne platform.

Once a long-range wireless link to the protected airborne platform is established, it can be used for synchronization purposes with the equipment on-board the platform. For example, it can be used for time synchronization with the platform's radars and self protection suit by blanking the airborne RF decoy at specific time intervals. Alternatively, it can be used for cooperative jamming by blinking between deceiving signals coming from the platform and from the decoy.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows the protected aircraft ejecting 3 airborne RF decoys, from 3 separate dispensers, towards different directions.

Fig. 2 shows the ejected airborne RF decoy attracting an approaching enemy missile towards itself.

Fig. 3 illustrates the principle of synchronization/blinking between airborne RF decoy radars of the invention and a protected airborne platform's radars, via a long range wireless link.

Fig. 4 illustrates a physical layout of an airborne RF decoy of the invention.

Fig. 5 is an electrical block diagram of an airborne RF decoy of the invention.

Fig. 6 depicts a layout of the RF board inside an airborne RF decoy of the invention.

Fig. 7 depicts a layout of the digital board inside an airborne RF decoy of the invention.

Fig. 8 is a schematic diagram of the battery inside an airborne RF decoy of the invention.

Fig. 9 is a schematic diagram of EW antennas of the airborne RF decoy of the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of various embodiments, reference is made to the accompanying drawings that form a part thereof, and in which are shown by way of illustration specific embodiments in which the invention may be practiced. It is understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

The present invention relates to an airborne RF decoy adapted for protecting an airborne platform against multiple enemy radar-based threats, said airborne RF decoy comprising:

- 10 (i) means for receiving a plurality of radar signals from one or more directions;
- (ii) means for storing said plurality of radar signals;
- (iii) means for analyzing said plurality of radar signals to identify threat parameters;
- 15 (iv) means for altering said plurality of radar signals in order to deceive said multiple enemy radar-based threats;
- (v) means for transmitting the altered radar signals; and
- (vi) an independent power supply source.

The airborne RF decoy of the invention is an independent, stand-alone, autonomous flying body. It is not attached to the protected airborne platform by a cable or similar attaching mechanisms, rather the airborne RF decoy flies on its own means, using its own power supply source.

The term "airborne platform" as used herein includes fighter aircraft, wide-body transport aircraft, wide-body passenger aircraft, unmanned air vehicles (UAV), unmanned combat aircraft (UCA) and balloons.

The installation of the airborne RF decoy of the invention on board of a typical airborne platform is shown in **Fig. 1**. The protected airborne platform **10** may eject at any instant one or several airborne RF decoys **20**. The magazine of RF decoys **30** can be installed at various locations on the airborne platform **10** and the ejection can be directed towards any desired direction. **Fig. 1** shows 3 ejected

airborne RF decoys **20**, one in the direction of the flight, a second one ejected sideways and the third airborne RF decoys **20** ejected at the rear of the aircraft, against the flight direction of the airborne platform **10**. In one embodiment of the present invention, the ejection is done using pyrotechnic dispensers. A clear and
5 fluent jettison process ensures the safety of the ejection in any flight positions and speeds of the protected platform. The airborne RF decoy **20** can be ejected by an automatic alert sent either from the on-board Missile Warning System (MWS) or from the Radar Warning Receiver (RWS) or by a manual command of the aircrew.

The basic concept of operation uses a generic, robust and coherent technique
10 to deceive the radar-based threats as follows. Once the airborne RF decoy **20** is activated it emits radio frequency (RF) signals that are very similar and coherent to radar signals that are scattered from the protected airborne platform **10** and produce coherent false targets to the enemy radar. **Fig. 2** shows a radar-based threat, which is usually a radar-based missile **40** or a similar flying body, detecting the deceiving
15 signal coming from the airborne RF decoy **20**. The radar-based missile **40** interprets the deceiving signal as a legitimate target and “locks” its attack trajectory **50** towards the airborne RF decoy **20**. Since the airborne RF decoy’s **20** trajectory **60** differs from the trajectory of the protected airborne platform **10**, the radar-based missile **40** hits or flies by (and explodes) the airborne RF decoy **20** at a distance of
20 typically several hundreds of meters from the protected airborne platform **10**.

Enemy radar-base threats usually include: air-to-air missiles **40** (both semi active and active), air-to-air fire-control radars (FCR), surface-to-air missiles (SAM) **40**, surface-to-air radars or any combination thereof.

The airborne RF decoy **20** emits its deceiving signals within a broad spatial
25 coverage both in azimuth and in elevation. Thus, it can effectively deceive threats coming from all directions.

In one embodiment of the present invention, the airborne RF decoy **20** includes means to control the distance between said airborne RF decoy **20** and said airborne platform **10**. For example, the use of rocket propulsion mounted inside the
30 airborne RF decoy **20** can control the relative distance between the protected

airborne platform **10** and the airborne RF decoy **20**. In some cases the airborne RF decoy **20** can move in a higher speed than the airborne platform **10** thus operating in front of the airborne platform **10** rather than at its back. The distance between the airborne RF decoy **20** and the airborne platform **10** ranges from tens to hundreds of meters in both range and altitude.

The airborne RF decoy **20** opens a large distance of tens to hundreds of meters from the protected airborne platform **10** both in range and in altitude thus any hit of a radar-based threat **40** occurs at a safe range from the airborne platform **10**.

The airborne RF decoy **20** can handle multiple radar-based threats **40** simultaneously coming from many directions, thanks to one or more omnidirectional antennas embedded inside the airborne RF decoy **20**. The omnidirectional antenna can receive a plurality of radar signals. The omnidirectional antenna or antennas are implemented without any erection mechanisms or moving parts. In order to improve the probability of deception, the airborne RF decoy **20** operates in accordance with a Pre Flight Data (PFD) file that defines the most probable radar-based threats **40** in the arena. The PFD file is loaded prior to the mission to each individual airborne RF decoy **20** by an external data loader via a dedicated connector.

In another embodiment of the present invention, the airborne RF decoy **20** includes means to communicate with the airborne platform **10**. These communication means (links) include: (i) a wire or proximity link; (ii) a short-range wireless link; (iii) a long-range wireless link; or any combination thereof. The proximity link serves a distance of a few centimeters. The short-range link serves typically a distance of a few meters, while the long-range link can operate in a distance of hundreds of meters.

The airborne RF decoy **20** PFD can be updated by several methods: the first method is before ejection by a wire or proximity link; the second method is after ejection via a medium-range wireless link; and the third method is via a long-range wireless link with the protected platform. **Fig. 3** illustrates the airborne RF decoy **20**

including a wireless radio link module **70** which transmits/receives with the protected airborne platform's **10** wireless radio link **80** via a line of sight communication channel **90**. This long-range communication link provides updating instructions to the airborne RF decoy **20** concerning the actual parameters of the threat such as frequency, bandwidth, transmit power, Pulse Repetition Frequency (PRF), Doppler shift, low frequency modulation (LFM) of the RF signal and others, to ensure the optimal generation of the false target transmission. It should be emphasized that although the airborne RF decoy **20** has the capability to receive and analyze the incoming signal threats, its deception is efficient against all various types of radar-guided threats (active and semi-active) without the need for intimate knowledge of their technical details. This inherent efficiency stems from the physical spatial separation between the airborne RF decoy **20** and the protected airborne platform **10**.

In one embodiment of the present invention, the RF decoy **20** includes means for minimizing interferences between the airborne RF decoy **20** and the on-board equipment of the airborne platform **10**.

In a further embodiment of the present invention, said means for minimizing interferences include either blanking of said airborne RF decoy **20** so it does not interfere with on-board equipment of the airborne platform **10** when operation of said on-board equipment has higher priority; or blanking on-board systems of the airborne platform **10** that interfere with said airborne RF decoy **20** when operation of said airborne RF decoy **20** has higher priority.

Once a long-range wireless link to the protected airborne platform **10** is established it can be used for cooperative jamming with the EW/ECM equipment on-board the airborne platform **10**. For example, it enables generation of combined synchronized blinking between deceiving signals coming from the airborne platform **10** and from the airborne RF decoy **20**. In addition, it can be used for time synchronization by blanking some systems, thus minimizing interferences between the airborne RF decoy **20** and the on-board equipment. **Fig. 3** depicts a possible time sharing between the transmissions from the airborne RF decoy **20** and the

transmissions from the radar installed on board of the protected airborne platform
10.

The spatial orientation of the airborne RF decoy **20**, after the ejection from the airborne platform **10**, can be stabilized in the roll plane, in one embodiment, or
5 it is not stabilized in the roll plane, in another embodiment, making use of different embedded antenna polarizations. In most cases the radar-based threats **40** operate in a linear polarization. If the airborne RF decoy **20** is stabilized in the roll plane, its antenna is linear polarized. If the airborne RF decoy **20** is not stabilized in the roll plane, its antenna is circular polarized and has radiation capabilities in all roll
10 angles.

In one embodiment of the present invention, said embedded antenna takes the form of a small monopole, an array of two monopoles or an array of three conformal radiating elements when said antenna operates in a linear polarization.

In another embodiment of the present invention, said embedded antenna
15 takes the form of helical antennas when said antenna operates in a circular polarization.

The aerodynamical stabilization of the airborne RF decoy **20** is achieved by vertical and horizontal wings that are opened automatically after the ejection from the airborne platform **10**. In order to improve the stabilization process, the wings are
20 opened in two steps: a mechanical opening of the wings immediately after ejection followed by a pyrotechnic mechanism, which brings the wings to their final position. In a further embodiment of the present invention, a gas propulsion mechanism can be added to the airborne RF decoy **20**, which enables to accelerate its path and contributes to its flight stability.

25 **Fig. 4** shows the physical layout of the airborne RF decoy **20**. An electric battery **110** provides the current and the voltage required for the entire period of operation of the airborne RF decoy **20**. The preferred battery **110** is a thermal battery **110** that can be maintenance-free for a period of at least 10-15 years, being rechargeable or replaceable afterwards. The thermal battery **110** is activated at the

instance of the ejection in by an appropriate mechanism **120**. Alternatively, an alkaline battery **110** may be used instead of the thermal battery **110**.

The power supply unit **130** is a DC to DC converter which accepts the voltage of the battery (at a nominal value of 12V) and transforms it to several regulated voltages (such as 8V, 5V, 3.3V, 1.8V, 1.2V etc). The RF board **140** includes a microwave low noise receiver operating at a direct conversion technology, a microwave high power transmitter, a frequency synthesizer and a T/R switch (or an isolator). The RF board **140** is connected to an EW antenna **160** mounted on the external envelope of the airborne RF decoy **20** and to a digital board **170** which includes a DRFM with a real time coherent memory and digital control components.

The entire body **100** of the airborne RF decoy **20** is stabilized during its flight by horizontal and vertical stabilization wings **180** and possibly by an additional propulsion mechanism.

In one embodiment of the present invention, said airborne RF decoy **20** has the external form of a standard chaff decoy or a standard flare decoy. The ejection of the airborne RF decoy **20** can thus be performed by pyrotechnic dispensing mechanisms that are identical to those of standard chaff or flare decoys. The airborne RF decoy **20** can thus be ejected from the airborne platform **10** via a standard housing of chaff or flare dispensers. The RF decoy **20** can thus be implemented in a Mobile Jettison Unit (MJU) such as an MJU-7 envelope (1x2x8 inches) or an MJU-10 envelope (2x2x8 inches).

In another embodiment of the present invention, the airborne RF decoy **20** is ejected via a dedicated housing.

In addition, the physical layout of the airborne RF decoy **20** may include a standard connector **200** for software loading and tests, a wire/proximity communication module **210**, a medium range communication module **220** and the long-range wireless communication link module **70**.

The electrical block diagram sketched in **Fig. 5** illustrates the functionality of the airborne RF decoy **20**. The EW antenna **160** receives the RF signals coming

from the radar-based threat. The T/R (transmit/receive) switch or the circulator **300** transfer the received signals to a low noise amplifier (receiver) **310** and then the signal is converted into Base band and processed in the Digital RF Memory (DRFM) **320**. The specific EW technique generates a false target, and transfers it to the High Power Transmitter **330**. This false target is then transmitted to the air through the same EW antenna **160**. Additional items of wire/proximity module **210**, medium range module **220**, long-range link module **70** and software loading/test standard connector **200**, all connected to the digital board **170**, are also shown in **Fig. 5**. The airborne RF decoy **20** also includes an independent power supply source **340**. The power supply source **340** can be a standard alkaline battery or a thermal battery that is activated during the ejection of the airborne RF decoy **20** from the airborne platform **10**.

In another aspect of the present invention, a method is provided for protecting an airborne platform **10** against multiple enemy radar-based threats by deceiving an enemy to follow a false target, comprising:

- (i) ejecting an airborne RF decoy **20** from the airborne platform **10**;
- (ii) receiving in the airborne RF decoy **20** a plurality of radar signals from one or more directions;
- (iii) storing said plurality of radar signals on the airborne RF decoy **20**;
- (iv) analyzing said plurality of radar signals by the airborne RF decoy **20** to identify threat parameters;
- (v) altering said plurality of radar signals by said airborne RF decoy **20** in order to deceive said multiple radar-based threats; and
- (vi) transmitting the altered radar signals by said airborne RF decoy **20**.

The airborne RF decoy **20** starts its life cycle by "listening" to said plurality of radar signals in order to identify possible radar-based threats, and acquire the specific active radar-based threats. The plurality of radar signals can be stored in DRFM memory **320** or in any memory with similar functionality. Once the existence of the radar-based threat is confirmed, the airborne RF decoy **20** starts to transmit the deceiving signals.

In one embodiment of the present invention, the airborne RF decoy **20** stops transmitting altered signals from time to time and instead analyzes the received radar signals to confirm if each enemy radar-based threat still exists or if the previously identified threat parameters have changed. Threat parameters include frequency, bandwidth, transmission power, pulse repetition frequency (PRF),
5 Doppler shift, low frequency modulation (LMF) of the RF signal, or any combination thereof. The DRFM **320** shown in **Fig. 5** updates the false targets accordingly.

The layout of the RF board **140** is further detailed in **Fig. 6**. The Receive
10 channel includes a switch or a circulator **300**, a low noise amplifier **410**, a band pass filter **430** and a balanced mixer **450**. The transmit channel includes a balanced mixer **451**, a phase shifter **440**, a band pass filter **431**, a high power amplifier **420** and the same switch or circulator **300**. The synthesizer unit **460** generates accurate frequency carriers that down convert the signals into low frequency. The RF signals
15 are sampled by I/Q modulator **470** and then transferred unto the DRFM **320**.

Fig. 7 shows the layout of the Digital Board **170** including DRFM **320** comprising a digital signal processor (DSP) **482**, a field programmable gate array (FPGA) **484**, a DRFM memory unit **486** connected to the DSP **482** and to the FPGA **484**, and a smaller DSP memory unit **488** connected to the DSP **482**. The Digital
20 Board **170** also includes an analog to digital converter **490**, digital to analog converter **492** and a standard connector **200** for software and tests. The real time software that controls the mission of the airborne RF decoy **20** resides in this Digital Board **170**.

In yet another embodiment of the present invention, the airborne RF decoy
25 **20** enters automatically into an "end of life" mode with self-destruction capability and complete memory erase for sensitive components that carry data.

Fig. 8 shows the layout of a thermal battery **110** including the activation mechanism **120** and the connecting positive port **510**, negative port **520**, and ground port **530**.

In yet another embodiment of the present invention, more than one EW antenna **160** is installed in the airborne RF decoy **20**. **Fig. 9** illustrates a schematic diagram with up to three EW antennas **160**. In this case, one EW antenna **160** serves to receive signals while the other one serves to transmit signals. It is even possible to include a third antenna **160** mounted in the front of the airborne RF decoy **20**. All the antennas **160** are fed by the RF Board **140** and receive/transmit to the air in a broad spatial coverage (up to 360 degrees in azimuth and at least 90 degrees in elevation). The antenna **160** can be built to operate in a linear polarization while the airborne RF decoy's **20** body **100** is stabilized in the roll plane or in a circular polarization while the airborne RF decoy's **20** body **100** is not stabilized in the roll plane. Thus the antenna **160** enables the airborne RF decoy **20** to operate against multiple enemy radar-based missiles **40** that approach the airborne platform **10** from different directions. The implementation of the antenna can take the form of a small monopole **610**, an array of two monopoles, an conformal array of three radiating elements **620** or a helix structure. The monopole antenna **610** is connected to an antenna feed **600**. An electric layer **630** connects all the antennas **160**. All antenna **160** implementations are mounted on the airborne RF decoy **20** without any erection mechanisms or moving parts. The broad coverage is achieved by a unique combination of scattering by the metallic airborne RF decoy's **20** body **100** itself, such that the body **100** acts as an antenna.

Although the invention has been described in detail, nevertheless changes and modifications, which do not depart from the teachings of the present invention, will be evident to those skilled in the art. Such changes and modifications are deemed to come within the purview of the present invention and the appended claims.

CLAIMS

1. A stand-alone airborne RF decoy adapted for protecting an airborne platform against multiple enemy radar-based threats, said airborne RF decoy comprising:

(i) means for receiving a plurality of radar signals from one
5 or more directions;

(ii) means for storing said plurality of radar signals;

(iii) means for analyzing said plurality of radar signals to
identify threat parameters;

(iv) means for altering said plurality of radar signals in order
10 to deceive said multiple enemy radar-based threats;

(v) means for transmitting the altered radar signals; and

(vi) an independent power supply source.

2. An airborne RF decoy according to claim 1, wherein said airborne RF decoy stops transmitting altered signals from time to time and instead analyzes the
15 received radar signals to confirm if each enemy radar-based threat still exists or if the previously identified threat parameters have changed.

3. An airborne RF decoy according to claim 1 or 2, wherein said means for receiving a plurality of radar signals are an omnidirectional antenna embedded inside the airborne RF decoy, said omnidirectional antenna being implemented
20 without any erection mechanisms or moving parts.

4. An airborne RF decoy according to claim 3, wherein said embedded antenna takes the form of a small monopole, an array of two monopoles or a conformal array of three radiating elements when said antenna operates in a linear polarization.

5. An airborne RF decoy according to claim 3, wherein said embedded antenna takes the form of helical antennas when said antenna operates in a circular polarization.
6. An airborne RF decoy according to any of claims 1 to 4, wherein said threat parameters include: frequency, bandwidth, transmission power, pulse repetition frequency (PRF), Doppler shift, low frequency modulation (LMF) of the RF signal, or any combination thereof.
7. An airborne RF decoy according to any of claims 1 to 6, adapted to being ejected from the airborne platform.
- 10 8. An airborne RF decoy according to claim 7, wherein said airborne RF decoy is ejected from the airborne platform via pyrotechnic dispensers.
9. An airborne RF decoy according to claim 7 or 8, wherein said airborne RF decoy has the external form of a standard chaff decoy or a standard flare decoy and is ejected from the airborne platform via a standard housing of chaff or flare
15 dispensers.
10. An airborne RF decoy according to claim 7, wherein said airborne RF decoy is ejected from the airborne platform via a dedicated housing.
11. An airborne RF decoy according to any of claims 1 to 10, wherein said enemy radar-base threats include: air-to-air missiles, air-to-air fire-control radars, surface-to-air missiles and surface-to-air and radars.
20
12. An airborne RF decoy according to any of claims 1 to 11, wherein said airborne platform includes: fighter aircraft, wide-body transport aircraft, wide-body passenger aircraft, unmanned air vehicles, unmanned combat aircraft and balloons.
13. An airborne RF decoy according to any of claims 1 to 12, further including
25 means to control the distance between said airborne RF decoy and said airborne platform.

14. An airborne RF decoy according to claim 13, wherein said means to control the distance include rocket propulsion.

15. An airborne RF decoy according to any of claims 1 to 14, wherein said distance between the airborne RF decoy and the airborne platform ranges from tens
5 to hundreds of meters in both range and altitude.

16. An airborne RF decoy according to any of claims 1 to 15, wherein said airborne RF decoy operates within a broad spatial coverage of up to 360 degrees in azimuth and at least 90 degrees in elevation.

17. An airborne RF decoy according to any of claims 1 to 16, wherein the spatial
10 orientation of the airborne RF decoy, after ejection from the airborne platform, is stabilized in the roll plane.

18. An airborne RF decoy according to any of claims 1 to 16, wherein the spatial orientation of the airborne RF decoy, after ejection from the airborne platform, is not stabilized in the roll plane.

15 19. An airborne RF decoy according to any of claims 1 to 18, wherein after ejection from the airborne platform, the aerodynamical stabilization of the airborne RF decoy is achieved initially by vertical and horizontal wings that are opened automatically immediately after ejection, followed by a pyrotechnic mechanism that brings the wings to their final position.

20 20. An airborne RF decoy according to any of claims 1 to 19, further including means to communicate with the airborne platform.

21. An airborne RF decoy according to claim 20, wherein said means include one or more of the following communication links: (i) a wire or proximity link; (ii) short-range wireless link; and (iii) long-range wireless link.

25 22. An airborne RF decoy according to any of claims 1 to 21, wherein said airborne RF decoy operates in accordance with a pre-flight data instruction file.

23. An airborne RF decoy according to claim 22, wherein said pre-flight data instruction file is loaded by an external data loader via a dedicated connector that is embedded in the decoy, and data loading is done on the ground prior to the flight mission.

5 24. An airborne RF decoy according to claim 22 or 23, wherein said pre-flight data instruction file is updated before ejection by a wire/proximity link, after ejection via a short-range wireless link, via a long-range wireless link, or any combination thereof.

10 25. An airborne RF decoy according to any of claims 1 to 24, adapted to work together with electronic warfare and electronic countermeasure systems on board of said airborne platform.

15 26. An airborne RF decoy according to claim 25, wherein said airborne RF decoy and electronic warfare and electronic countermeasure systems on board of said airborne platform cooperate in the use of their jamming resources in order to prevent enemy radar-based threats to track the airborne platform.

27. An airborne RF decoy according to claim 25, including generation of combined synchronization between deceiving signals coming from the airborne platform and deceiving signals coming from the airborne RF decoy.

20 28. An airborne RF decoy according to any of claims 1 to 27, further including means for minimizing interferences between the airborne RF decoy and the on-board equipment of the airborne platform.

25 29. An airborne RF decoy according to claim 28, wherein said means for minimizing interferences include either blanking of said airborne RF decoy so it does not interfere with on-board equipment of the airborne platform when operation of said on-board equipment has higher priority; or blanking of on-board systems of the airborne platform that interfere with said airborne RF decoy when operation of said airborne RF decoy has higher priority.

30. An airborne RF decoy according to any of claims 1 to 29, wherein said means for storing said plurality of radar signals are Digital Radio Frequency Memory.

31. An airborne RF decoy according to any of claims 1 to 30, further including
5 means to automatically enter into an "end of life" mode with self-destruction capability and complete memory erasure of sensitive components.

32. An airborne RF decoy according to any of claims 1 to 31, wherein said airborne RF decoy is ejected automatically after an alert from the missile warning system on board of the airborne platform.

10 33. An airborne RF decoy according to any of claims 1 to 32, wherein said airborne RF decoy is ejected after a manual command of the airborne platform's aircrew.

34. An airborne RF decoy according to any of claims 1 to 31, wherein said power supply is a standard alkaline battery or a thermal battery that is activated
15 during ejection of said airborne RF decoy from the airborne platform.

35. A method for protecting an airborne platform against multiple enemy radar-based threats by deceiving an enemy to follow a false target, comprising:

- (i) ejecting an airborne RF decoy from the airborne platform;
- 20 (ii) providing an independent power supply to the airborne RF decoy.
- (iii) receiving in the airborne RF decoy a plurality of radar signals from one or more directions;
- (iv) storing said plurality of radar signals on the airborne RF
25 decoy;

- (v) analyzing said plurality of radar signals by the airborne RF decoy to identify threat parameters;
- (vi) altering said plurality of radar signals by said airborne RF decoy in order to deceive said multiple radar-based threats; and
- (vii) transmitting the altered radar signals by said airborne RF decoy.

36. A method according to claim 35, wherein said airborne RF decoy stops transmitting altered signals from time to time and instead analyzes the received radar signals to confirm if each enemy radar-based threat still exists or if the previously identified threat parameters have changed.

37. A method according to claim 35 or 36, wherein said plurality of radar signals are received by an omnidirectional antenna embedded inside the airborne RF decoy, said omnidirectional antenna being implemented without any erection mechanisms or moving parts.

38. A method according to claim 37, wherein said embedded antenna takes the form of a small monopole, an array of two monopoles or a conformal array of three radiating elements when said antenna operates in a linear polarization.

39. A method according to claim 37, wherein said embedded antenna takes the form of helical antennas when said antenna operates in a circular polarization.

40. A method according to any of claims 35 to 38, wherein said threat parameters include: frequency, bandwidth, transmission power, pulse repetition frequency, Doppler shift, or any combination thereof.

41. A method according to any of claims 35 to 40, adapted to being ejected from the airborne platform.

42. A method according to claim 41, wherein said airborne RF decoy is ejected from the airborne platform via pyrotechnic dispensers.

43. A method according to claim 41 or 42, wherein said airborne RF decoy has the external form of a standard chaff decoy or a standard flare decoy and is ejected
5 from the airborne platform via a standard housing of chaff or flare dispensers.

44. A method according to claim 41, wherein said airborne RF decoy is ejected from the airborne platform via a dedicated housing.

45. A method according to any of claims 35 to 44, wherein said enemy radar-base threats include: air-to-air missiles, air-to-air fire-control radars, surface-to-air
10 missiles and surface-to-air and radars.

46. A method according to any of claims 35 to 45, wherein said airborne platform includes: fighter aircraft, wide-body transport aircraft, wide-body passenger aircraft, unmanned air vehicles, unmanned combat aircraft and balloons.

47. A method according to any of claims 35 to 46, wherein said airborne RF
15 decoy controls the distance between the airborne RF decoy and said airborne platform.

48. A method according to claim 47, wherein said distance is controlled by rocket propulsion on said airborne RF decoy.

49. A method according to any of claims 35 to 48, wherein said distance
20 between the airborne RF decoy and the airborne platform ranges from tens to hundreds of meters in both range and altitude.

50. A method according to any of claims 35 to 49, wherein said airborne RF decoy operates within a broad spatial coverage of up to 360 degrees in azimuth and at least 90 degrees in elevation.

51. A method according to any of claims 35 to 50, wherein the spatial orientation of the airborne RF decoy, after ejection from the airborne platform, is stabilized in the roll plane.

52. A method according to any of claims 35 to 50, wherein the spatial orientation
5 of the airborne RF decoy, after ejection from the airborne platform, is not stabilized in the roll plane.

53. A method according to any of claims 35 to 52, wherein after ejection from the airborne platform, the aerodynamical stabilization of the airborne RF decoy is achieved by vertical and horizontal wings that are opened automatically by a
10 mechanical opening of the wings followed by a pyrotechnic mechanism that brings the wings to their desired position.

54. A method according to any of claims 35 to 53, wherein the airborne RF decoy communicates with the airborne platform.

55. A method according to claim 54, wherein the airborne RF decoy
15 communicates with said airborne platform by at least one of the following ways: (i) a wire or proximity link; (ii) short-range wireless link; or (iii) long-range wireless link.

56. A method according to any of claims 35 to 55, wherein said airborne RF decoy operates in accordance with a pre-flight data instruction file.

20 57. A method according to claim 56, wherein said pre-flight data instruction file is loaded by an external data loader via a dedicated connector that is embedded in the decoy, and data loading is done on the ground prior to the flight mission.

58. A method according to any of claims 35 to 57, wherein said pre-flight data instruction file is updated before ejection by a wire/proximity link, after ejection via
25 a short-range wireless link, via a long-range wireless link, or any combination thereof.

59. A method according to any of claims 35 to 58, wherein said airborne RF decoy works together with electronic warfare and electronic countermeasure systems on board of the airborne platform.

60. A method according to claim 59, wherein said airborne RF decoy and
5 electronic warfare and electronic countermeasure systems on board of said airborne platform cooperate in the use of their jamming resources in order to prevent enemy radar-based threats to track the airborne platform.

61. A method according to claim 59, including generation of combined
10 synchronized between deceiving signals coming from the airborne platform and deceiving signals coming from the airborne RF decoy.

62. A method according to any of claims 35 to 61, wherein interferences between the airborne RF decoy and the on-board equipment of the airborne platform are minimized.

63. A method according to claim 62, wherein said interferences are minimized
15 by blanking systems of said airborne RF decoy so it does not interfere with on-board equipment of the airborne platform when operation of said on-board equipment has higher priority; or by blanking on-board systems of the airborne platform that interfere with said airborne RF decoy when operation of said airborne RF decoy has higher priority.

20 64. A method according to any of claims 35 to 63, wherein said plurality of radar signals are stored in Digital Radio Frequency Memory.

65. A method according to any of claims 35 to 64, wherein the airborne RF decoy can automatically enter into an "end of life" mode with self-destruction capability and complete memory erasure of sensitive components.

66. A method according to any of claims 35 to 65, wherein said airborne RF decoy is ejected automatically after an alert from the missile warning system on board of the airborne platform.

67. A method according to any of claims 35 to 65, wherein said airborne RF
5 decoy is ejected after a manual command of the airborne platform's aircrew.

68. A method according to any of claims 35 to 67, wherein said independent power supply is a standard alkaline battery or a thermal battery that is activated during ejection of said airborne RF decoy from the airborne platform.