Combination MOSFET and JFET Operable for Modulating Current Voltage Response or Mitigating Electromagnetic or Radiation Interference Effects by Altering Current Flow through the MOSFETS SCR

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The U.S. Navy seeks a partner for licensing and collaboration on a system and method for controlling current or mitigating electromagnetic or radiation interference effects using a combination of metal-oxide semiconductor field effect transistor (MOSFET) and junction field effect transistor (JFET) disposed perpendicularly and with a certain orientation.

Metal-oxide-semiconductor field-effect transistors (MOSFETs) are used because of their fast switching, low power capabilities. Numerous modifications and improvements to the design, layout, and fabrication of MOSFETs have been made to enhance electrical and radiation performance; however, radiation issues have been discovered and continue to present challenges to the use of MOSFETs. Significant research has been devoted to resolve specific radiation issues like total ionizing dose (TID.)
Current applications involving radio-frequency (RF) applications such as RF mixers, RF amplifiers, RF gain control, and RF detectors may employ two individual MOSFETs to perform an intended function. If an electrical circuit uses two transistors to accomplish an intended function, there are added costs and weight and requires more space when compared to a single transistor option. A dual gate transistor can be used in many other RF type applications. Presently, dual-gate MOSFETs can be built by packaging two MOSFETs into a hybrid-type

package where the two MOSFETs are placed in series but this implementation does not address radiation effects and increases overall cost, weight and size. Another implementation is to place two MOSFETs in series using a monolithic type layout. Again, this implementation does not address radiation effects.

NSWC Crane has developed and patented an invention that addresses the various disadvantages associated with current MOSFETs and provide the desired improvements, especially in the area of radiation effects. The invention includes a combination of MOSFET and JFT operable for modulating current and voltage response or mitigating electromagnetic or radiation interference effects by altering current flow through the MOSFET's semi-conductive channel region (SCR). For example, it can include a layout of a structure integrating and combining aspects of a MOSFET and a JFET which allows a drain-to-source current to be controlled by a MOFET gate as well as be controlled by a buried JFET gate.
One examples of the invention includes a Buried-Gate Metal-Oxide-Semiconductor Field Effect Transistor (BGMOSFET) which can include a layout or design of an innovative structure integrating and combining aspects of a MOSFET and a JFET. This combination allows a drain-to-source current to be controlled by a MOSFET gate as well as be controlled by a buried JFET gate. The exemplary BGMOSFET can be fabricated as a monolithic device, merging functions of a MOSFET with a MOSFET gate and functions of a JFET with a buried JFET gate, into one device. The BGMOSFET can enhance operational performance in a TID radiation environment. Existing MOSFETs can be prone to TID-induced threshold voltage (Vth) shifts from ionizing radiation environments that can lead to functional failure. An exemplary embodiment's independent buried JFET Gate can provide a radiation-hardened-by-design (RHBD) approach if MOSFET gate functionally fails from TID effects by using buried JFET gate to control current flow beyond operational failure point of MOSFET gate (e.g., an exemplary improved buried JFET gate allows the exemplary structure to control current in the semi-conductive channel region even after the MOSFET gate becomes non-functional from TID-induced threshold voltage shifts).
Additionally, an exemplary BGMOSFET can be useful in RF type applications such as mixers, gain control, amplifiers, and detectors because the exemplary device employs a second independent gate to control current flow in the semi-conductive channel region.

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