Form C Opto-Solid State Relay on Bonded Wafer with 1600V [solation

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In this paper we will present a circuit in which two optically coupled but independent relays, separated by 1600V are triggered from a common optical input. This represents one of the highest isolation voltages ever achieved on a bonded wafer monolithic IC.

Solid state relays (SSR) are the electronic equivalents of a mechanical relay with some notable advantages. The SSR consists of an LED input, which is galvanically isolated from an output switch circuit. The output switch uses a photo diode stack to detect the LED optical signal and then drives a pair of common source power MOSFET's which short or open the output depending on the state of the input. This arrangement offers a number of important advantages over mechanical relays. These include high input-output isolation as a result of the optical coupling, high reliability because of the elimination of contacts, immunity to magnetic field coupling and very small packaging. As a result, SSR's are widely used in a number of applications ranging from modems to candy machines.

There are basically three types of relays, a Form A which is normally closed, Form B which is normally open and form C which is a Form A and Form B both triggered by a common input. The Form C is widely used in telecommunications circuitry. This paper will describe the design and construction of the Form C output switch, which when packaged with an LED forms a complete Form C relay. These products are presently entering commercial production at Infineon Technologies.

Trench isolated circuits on bonded wafer is a technology ideally suited to the fabrication of particular opto-electronics devices, because of the complete isolation that is provided between elements. This isolation allows the simple construction of photodiode stacks, a key component for optical coupling, which are difficult if not impossible to fabricate with conventional technology. Of even greater interest, it allows two independent circuits to be fabricated on the same chip working totally independently of one another.

The process of fabricating this output switch begins with a device wafer, which is selected for a tight resistivity spread to optimize the IC process. This wafer is bonded to a thick buried oxide and thinned to the appropriate thickness of SOI to support the output power transistors. The wafer is then trenched using a new high speed silicon etch process which end points on the buried oxide. The trenches are then filled with a conformal TEOS and polysilicon. The trench is planarized using CMP. After trench the wafer is process through a BiCMOS process to create a Form A circuit and a Form B circuit with an isolation barrier between them. Each circuit consists of a nominal 20V circuit driving a nominal 3S0V output transistor and is easily isolated by the conventional trenching technology. The isolation barrier between the two circuits consists of a novel design consisting of multiple trenches in type of concentric ring pattern. This isolation is achieved by a combination of the trench technology coupled with an overlaying passivation technology.

Currently a form C relay which uses a single optical triggering source has demonstrated a 1600V pole to pole isolation. The incorporation of multiple switching circuits on a single substrate allows circuit functions that would not be possible in any other configurations.

In conclusion, we have presented an optically coupled monolithic Form C relay in which an on-chip isolation of 1600V has been achieved. This was accomplished using wafer bonding and trench isolation coupled with innovative circuit design.

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