

# Solid-State Microwave Switches: Circuitry, Manufacturing Technologies and Development Trends. Review (Part 1)<sup>1</sup>

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**Abstract**—This paper presents an overview of the process and design capabilities of state-of-the-art in the field of microwave solid state switches. The paper describes types of solid state switches, switch specifications, a review of technological advances in this area. The overview results indicate that AlGaIn/GaN MMICs including solid state switches are realizable.

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## INTRODUCTION

Solid-state microwave switches are widely used in communication, navigation and radar system for switching frequency bands, changing power of transmitted signal, switching between transmission and reception modes, etc. Papers published in the last 5-years' time-frame [1–4] as well as corresponding chapters of scientific and educational literature [5–9], confirm keen interest in design and application of microwave switches.

This paper generalizes the known views on solid-state microwave switches from production using semiconductor technology to circuitry. Comparative analysis of different technological and circuit decisions is conducted pointing out the most promising ways of designing solid-state microwave switches. The overview does not consider electromechanical switches and switches based on micro electromechanical systems since the forth do not meet modern requirements and the latter demand expensive manufacturing technologies.

The overview consists of five sections. Section one names main definitions and parameters of microwave switches as well as mentions approaches to their measurement. Section two deals with classification of solid-state microwave switches based on switching element types. Section three reveals the main peculiarities of semiconductor technology of solid-state microwave switch production. Section four generalizes circuitry decisions and gives examples of common switch circuits including those that have been developed during the last decade. Section five considers circuitry decisions using solid-state microwave switches. In the end we draw conclusions and justify prospect of gallium nitride technology for manufacturing solid-state microwave switches.

## 1. BASICS OF MICROWAVE SWITCHING THEORY

### *1.1. Definition and Purpose*

A microwave switch represents a device capable of closing/opening segments of microwave path, which connects signal sources and loads, based on external control signal. At the switching instant a rapid change of switching element's impedance takes place, which in theory should instantly change from zero to infinity or vice versa. There are three main block-diagrams of a switching device (Fig. 1.1) [10] that connects/disconnects microwave path segments: load is disconnected, generator operates in idle mode (Fig. 1.1a); load is shunted, generator operated in short-circuit mode (Fig. 1.1b); load is disconnected,

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