Switching Speed of Control Circuits with On-Chip Drivers

Introduction

Semiconductor control circuits like digital phase shifters, digital attenuators and SPDT switches are used extensively in radars, communication systems, electronic warfare, wireless applications, instruments and other systems for controlling signal flow.

Switches are basic components of most phase shifters and attenuators. The basic requirements of switches are simple configuration, low loss, low DC power consumption and high switching speed for high speed data communications.

Switching speed is an important characteristic of components which change their transmission state in response to control signals. Switching speed is defined as the time needed to change the state of a switch port from “ON’ to “OFF” or from “OFF” to “ON”. The parameters related to switching speed which are most often specified are:

Rise Time is measured between the 10% and 90% points of the square-law detected RF power when the unit is switched from full OFF to full ON.

Fall Time is the time between the 90% and 10% points of the square-law detected RF power when the unit is switched from full ON to full OFF.

On Time is measured from the 50% level of the input control signal to the 90% point of the square-law detected RF power when the unit is switched from full OFF to full ON.

Off Time is measured from the 50% level of the input control signal to the 10% point of the square-law detected RF power when the unit is switched from full ON to full OFF.

Figure below shows timing diagram of a switch and definition used to describe the switching time.

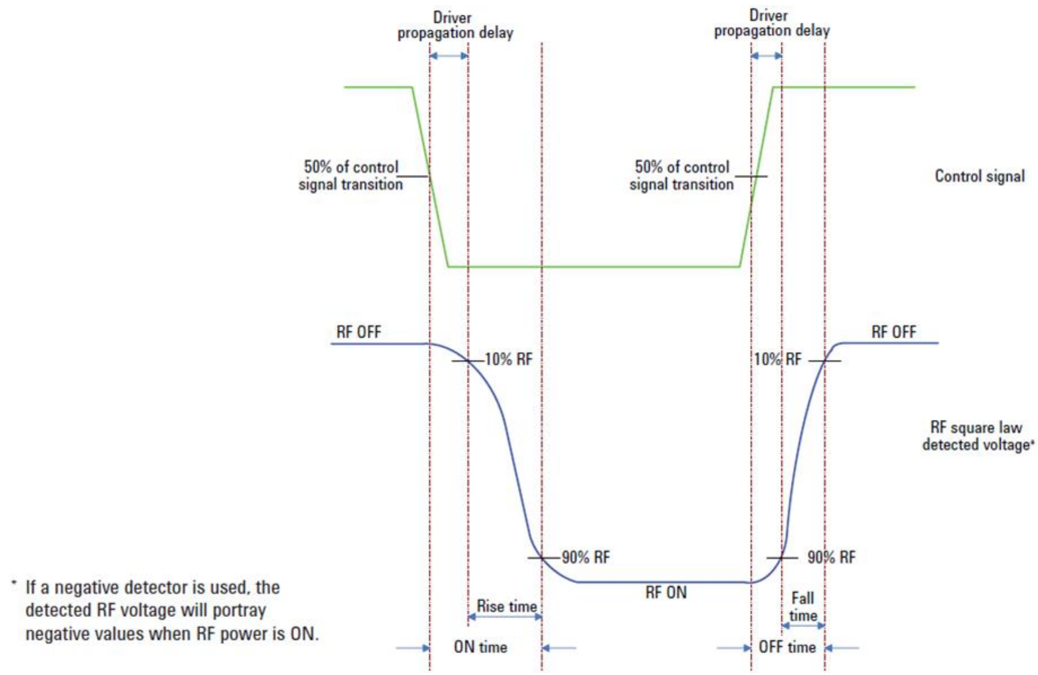

Fig.1. Timing diagram and definition of Switching time of a switch

Switching time measurement:

The switching Time measurement setup consists of Signal generator, an oscilloscope and function generator. To measure switching speed, switch is stimulated with a pulse from the signal generator with 10% duty cycle which is set to an output signal of 5GHz with a power level -5 dBm. 0/+5V Control voltage is given through function generator. Device output is connected to oscilloscope with a detector in between.

Figure below shows test setup for measuring switching time of a switch

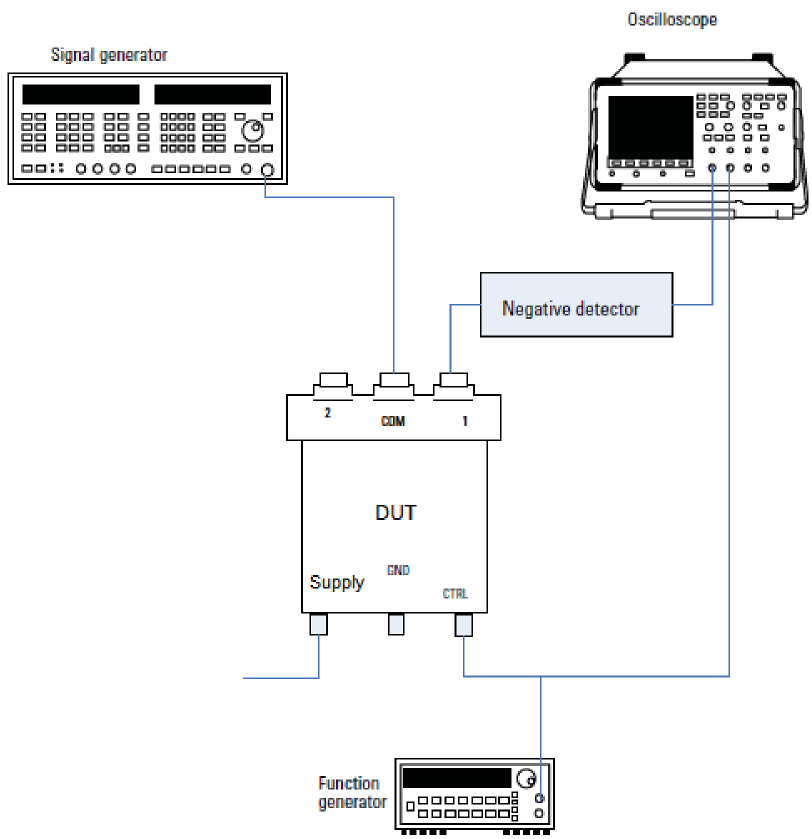

Fig.2. Test set up for switching time measurement

The turn-on delay can now be determined conveniently via cursor measurements on the trace displayed on the oscilloscope screen. Turn-on delay is the time it takes from the moment the gate-to-source voltage reaches 10% of its final value until the drain-to-source voltage declines to 90% of its initial value. Similarly, turn-off delay is the time taken from the moment the gate-to-source voltage declines to 90% of its previous level until the drain-to-source voltage has risen to 10% of the supply voltage.

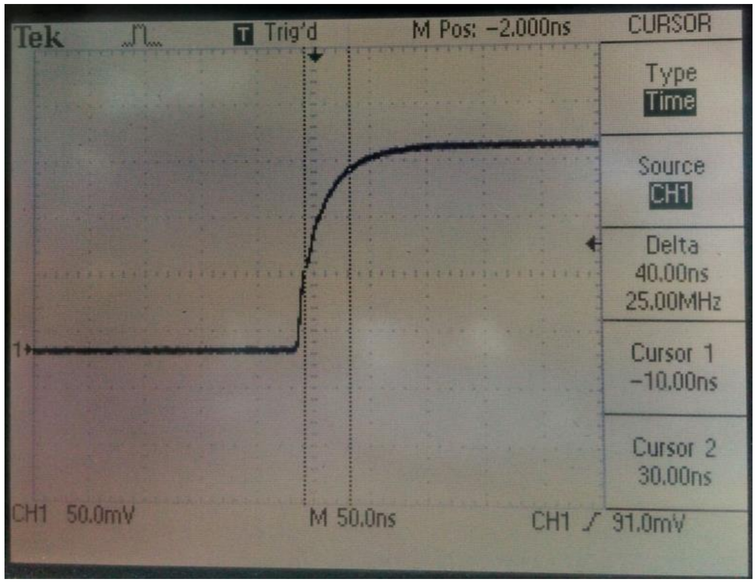

Fig.3. Oscilloscope output shows switching time of Detector 40nS

The detector-alone switching time is measured 40nS as shown in fig.3.

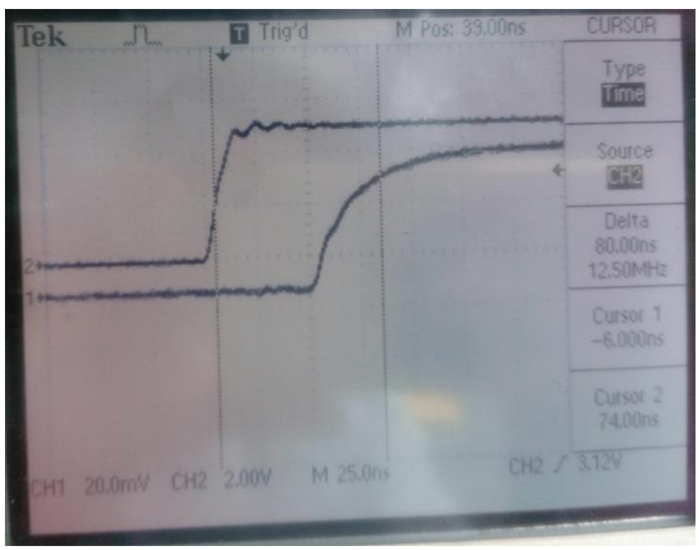

Fig.4. Oscilloscope output shows switching time of Switch along with Detector

The total switching time of DUT along with detector is measured 80nS as shown in fig.4.

In order to arrive at the DUT switching speed, we need to subtract the time taken by the detector. Hence the accurate switching speed of the DUT is 40ns.