AN1725
APPLICATION NOTE

ADVANCED PERFORMANCE USING STG3699

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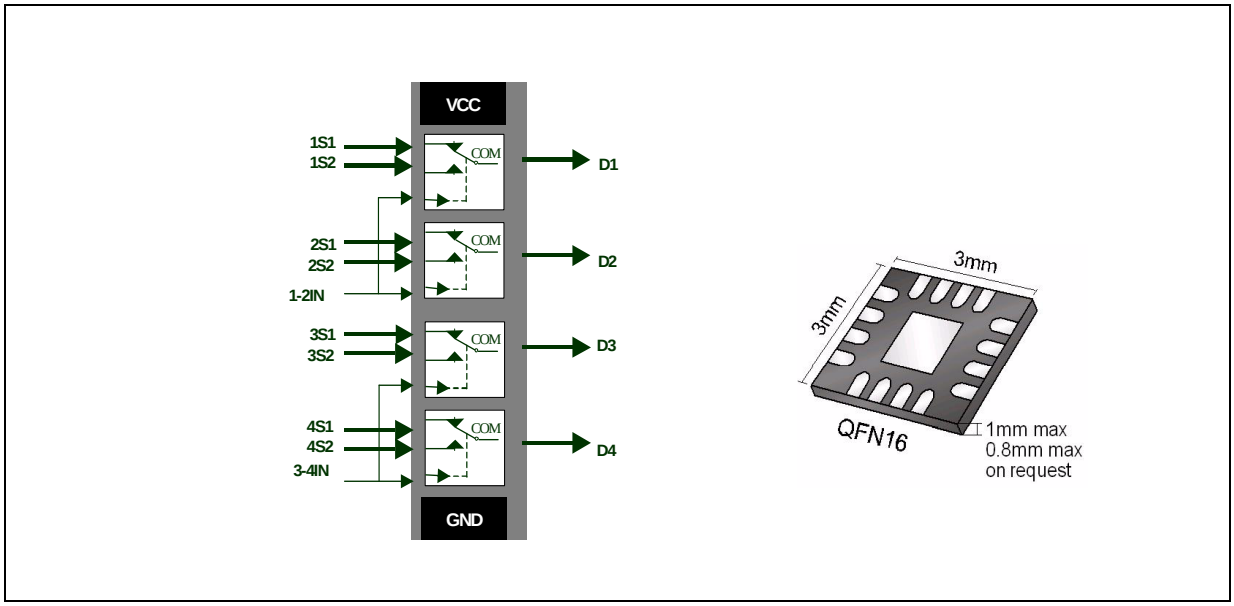
1. ABSTRACT

IC analog switches traditionally have found limited use in applications involving high - frequency analog or digital signals.
Degradation of switch performance and intolerable signal cross-talk between channels have undoubtedly forced many microelectronics manufacturers to study new technologies to solve the problem.

2. DEVICE DESCRIPTION

The STG3699 is a high speed CMOS with low on resistance and low voltage quad analog S.P.D.T. (Single Pole Dual Throw) switch or quad 2:1 Multiplexer / Demultiplexer switch fabricated in C2MOS technology.
These Analog Switches are designed to operate from 1.65V to 3.6V and offer asymmetrical normally closed (NC) and normally open (NO) R_{ON} for applications that require asymmetrical loads (such as speaker headsets and internal speakers).
The STG3699 has Break-Before-Make switching and fast switching features (t_{ON} = t_{OFF} = 30ns Typical at V_{cc} = 2.7V).

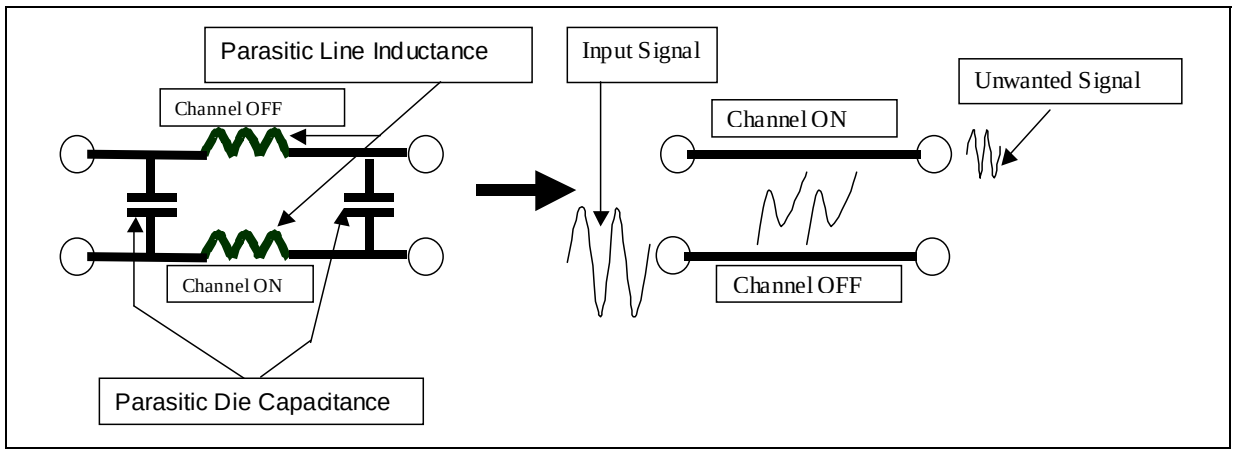
Figure 1: Quad Analog Switch



3. CROSS-TALK

The main sources of cross-talk are caused by parasitic line inductance generated by transmission line of PCB and parasitic die capacitance generated by internal structure of the die.
The single channel cross-talk can be defined as the ratio between the unwanted signal present in a channel switched ON, and the signal applied to another single Off channel input.
Figure2 shows the single channel cross-talk phenomenon.

Figure 2: Cross-Talk Phenomenon

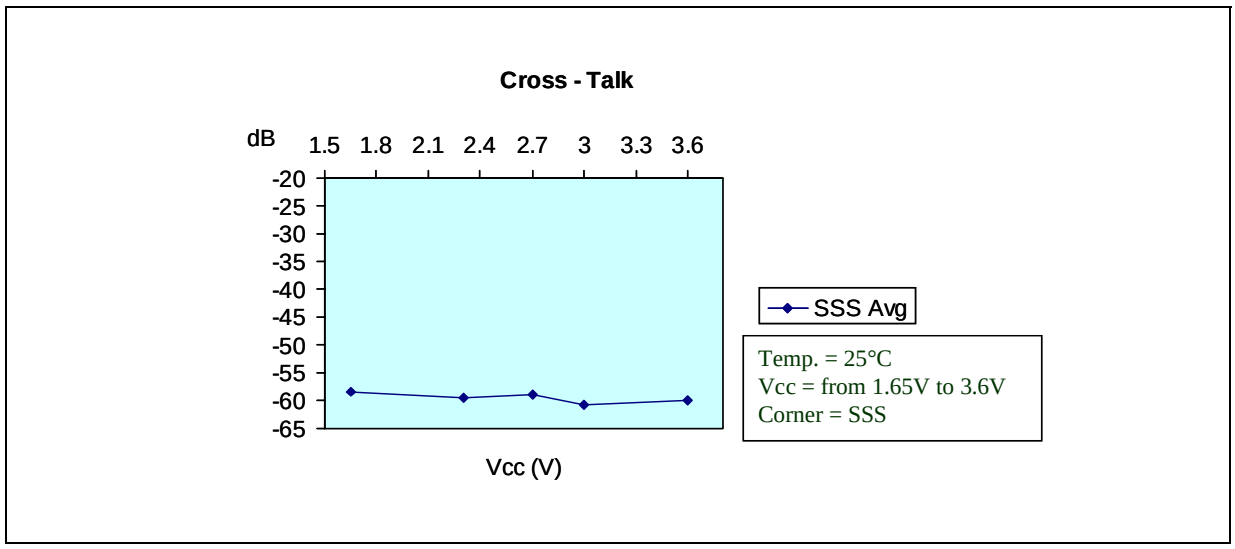


The value of cross talk are expressed in decibel by the following formula:

$$XTALK\ (dB) = 20\log V_{out} / V_{in}$$

V_{out} is the value of the unwanted signal present in the channel switched ON, while V_{in} is the value of the signal applied to the other single channel OFF input.
The internal architecture of the STG3699 device allows very low values of unwanted signal thus avoiding interference between different signals applied on switch.

Figure 3: Cross-Talk

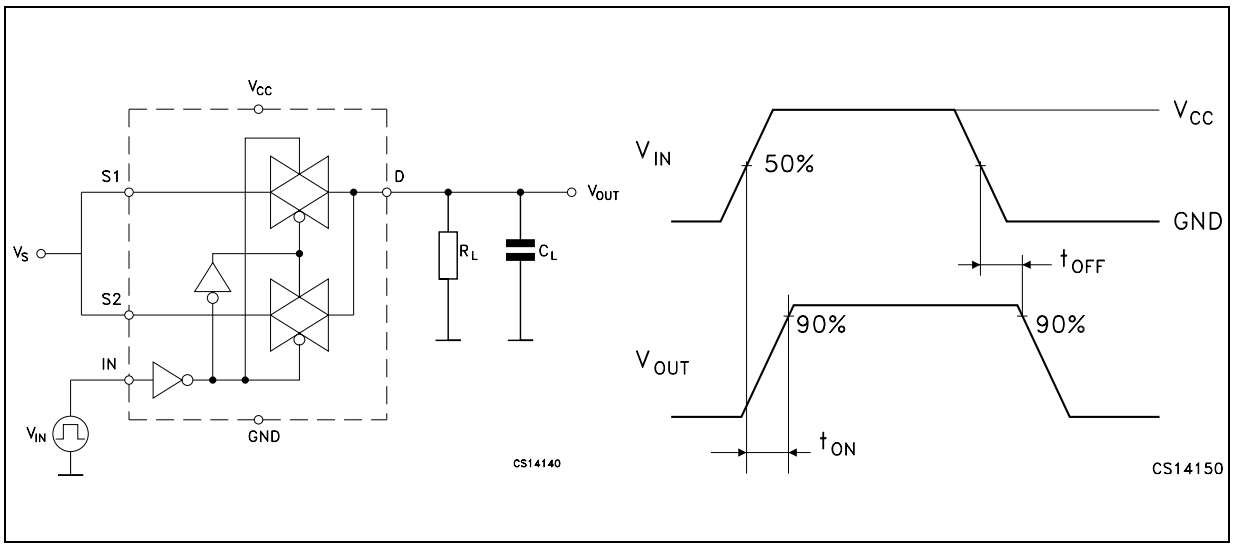


The previous chart shows the values (expressed in dB) of cross-talk depending on Power Supply.

4. CHARGE INJECTION

Charge injections consist of the charge transferred from the digital driver to the analog channel at the time of switching the device to the "off" state (measured in pC). This unwanted charge is normally induced through parasitic capacitance to source or gate to drain capacitance.
The table below shows the method to measure the charge injection.

Figure 4: Charge Injection Measurement Bench



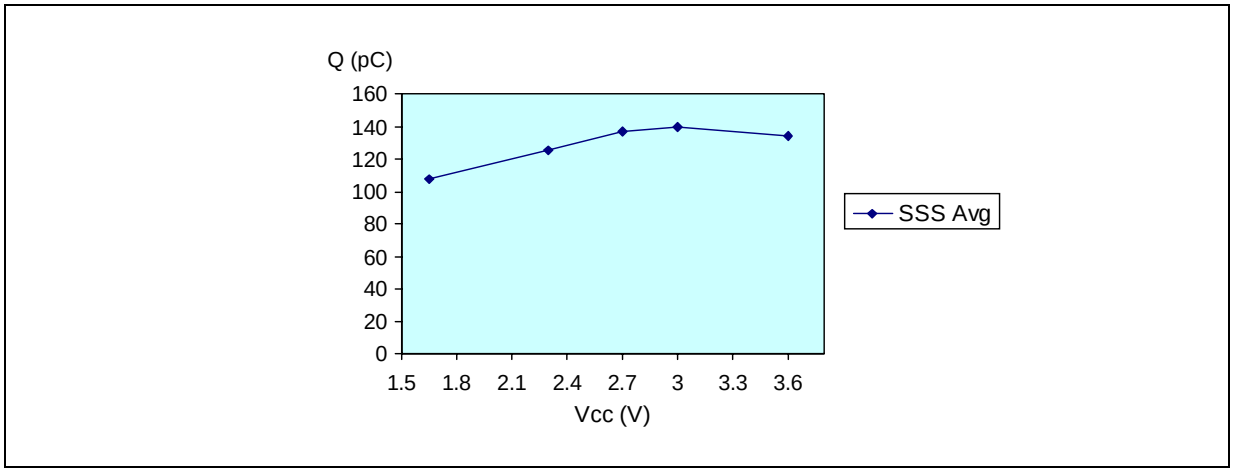
The architecture of the internal circuitry of STG3699 reduces this parasitic capacitance to a low value, typically 200pC with Vcc range from 2.3V to 3.6V
The next formula shows how to calculate the value of charge injection:

$$Q = \Delta V_{OUT} \times C_L$$

Note: where C_L is the value of Load Capacitance

The chart below shows the variation of charge injection depending on Power Supply condition, using a C_L = 0.1nF and a $\Delta V_{out} \cong$ **2mV**

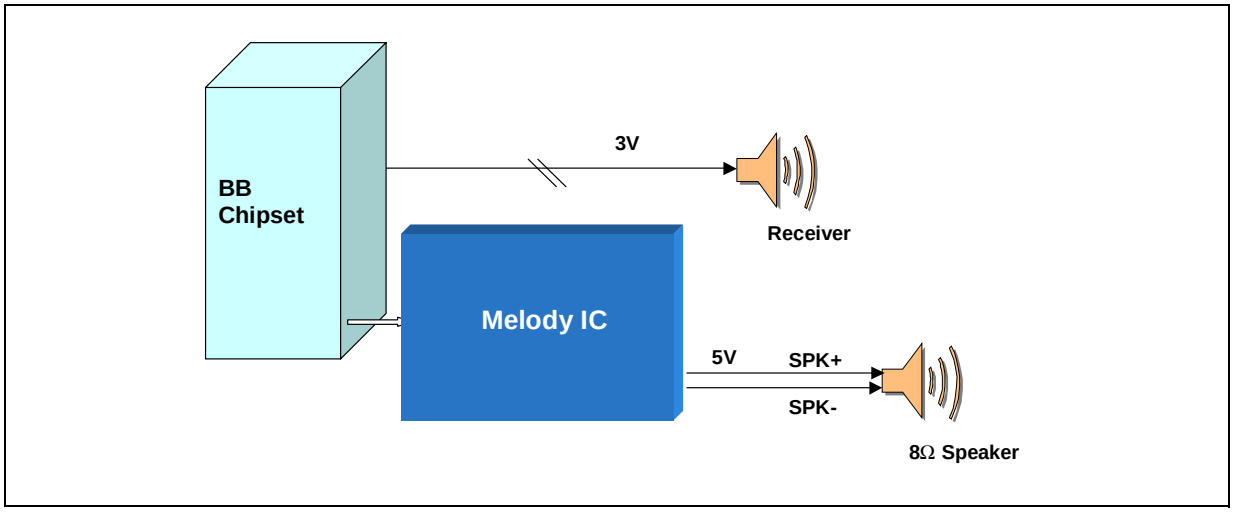
Figure 5: Charge Injection Characteristics



5. TYPICAL APPLICATION FOR AUDIO APPLICATIONS

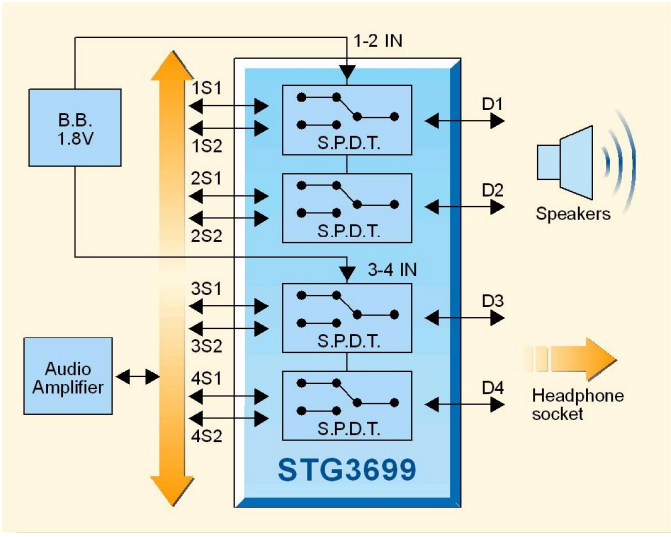
Before the STG3699, realizing an application without interference from different loads was very hard, because the coupling of several loads introduces noise problems, this caused the designer to study PC boards that reduced noise at the cost of fewer features.

Figure 6: Previous Mobile Phone Application



Using the Analog Switch STG3699, it is possible to drive some receiver without interference. Thanks to low cross-talk the typical value measured for these devices was -54dB at a Power Supply range from 1.65V to 3.6V.

Figure7: Typical Application Using the STG3699



The designer can realize a layout for a very complex PC board, using, for example, a sound amplifier for the speaker and receiver to improve High Fidelity sound, and coupling a different load (EARJACK) without interference among signals.

6. FEATURES

The features of STG3699 are summarized in the table below:

Table 1: STG3699 Features

Low Ron = 0.5 ohm Typ (3V Supply); 3 ohm Max (+1.8V Supply) 0.15 ohm Max Ron Flatness (+2.7V Supply)
High-Current Handing Capacity (150mA Continuous)
Low Cross-talk –54dB Typ.
Available in TSSOP and QFN packages
Fast switching (300 ps typical TPD with Vcc = 3V)
High Electric Static Discharge protection >3KV
1.65V to 3.6V Single Supply Voltage

7. COMPATIBILITY OF STG3699 WITH COMPETITORS' DEVICES

The pin configuration of Quad SPDT STG3699 is compatible with competitors' MAX4699 while the electrical characteristics are compatible with competitors' Dual SPDT Max4684 Analog Switch.
The table below shows some common electrical parameters.

Table 2: Electrical Parameters

STG3699	COMPETITOR
Cross–Talk = -54dB, Vcc from 1.65V to 3.6V	Cross–Talk = -54dB, Vcc from 2.7V to 3.6V
QFN and TSSOP packages	UCSP package
RON = 0.5Ω with Vcc = 2.7V	RON = 0.5Ω with Vcc = 2.7V
RON flatness = 0.15Ω Vcc = 2.7V	RON flatness = 0.15Ω Vcc = 2.7V
Vcc from 1.65V to 3.6V	Vcc from 1.8V to 5.5V
Vin < Vcc	Vin < Vcc

ST's portfolio also offers a 3V Dual SPDT Analog Switch named STG3684 with the same performance.

8. CONCLUSIONS

The Quad Analog Switch STG3699 allows several uses in different applications where the R_{ON}, Cross-Talk, Charge injection and the other features present in these devices are very important, as shown in these pages. Thanks to the QFN package, these devices are suitable for applications where the small PC board layout is basic, such as wire lines and telecom segments.
In fact, it is possible to realize a PCB using a single ST device instead of two Competitors' devices.