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GTLP: Single vs. Multiple Output Switching Technical Discussion

Abstract

Single Output Switching (SOS) specifications are provided by the supplier as a tool to allow a cursory look at the performance of a device. Actual performance is highly dependent on the application in which it is used. The inclusion of Multiple Output Switching (MOS) specifications gives an additional data point to use when determining the change in relative performance of a device. Derating curves provide a number of additional data points to assist in determining the change in relative performance of a device.

This application note provides a description of SOS and MOS specifications that can be used to integrate new devices into a design. These tools must be used with caution when calculating parameters such as timing budgets in actual applications. The testing conditions used in setting standard specifications for a datasheet are most likely different than the actual loading and conditioning of the devices in an application.

Definitions

Single Output Switching

Single Output Switching (SOS) describes the *single bit* propagation delay performance of a device. The tested propagation delay performance is statistically processed into a *standardized* specification that is used in datasheets to provide a way to compare similar products from competing suppliers.

Multiple Output Switching

Multiple Output Switching (MOS) describes the *multiple bit* propagation delay performance of a device. The word “multiple” usually refers to *8, 16 or 32 bits*, depending on the total number of data bits that the device has. It can also refer to any other combination of multiple switching data bits, but is always two or more.

The MOS measurement conditions usually mimic the SOS conditions except for multiple bit switching. There is not a standardized methodology for specifying performance, making it somewhat difficult to compare similar products from competing suppliers.

Specifications

The datasheet specifications of propagation delay performance usually have only SOS specifications. Some IC suppliers provide *Extended AC Electrical Characteristics* that include MOS propagation delay performance and derating curves. This extended data gives a useful comparison to standard SOS specifications in a controlled test environment.

The test measuring conditions or testing environment for SOS and MOS rely on controlled parameters such as test loads, trace lengths and impedances, and frequency of operation. While the measurement conditions seem far removed from an actual application, they are currently the best standardized test conditions that are available to describe device propagation delay performance.

Understanding Specifications

Datasheet specifications (SOS, MOS or any other parameter) try to best describe the device performance in near-realistic applications. Currently the SOS and MOS propagation delay performance is measured using 30pF/25Ω or 50pF/500Ω lumped loads for the Gunning Transceiver Logic Plus (GTLP) family of products. The configuration of the TTL load can be modelled as shown in Figure 1. The output pull-up value of 6V is used for 3.3V V_{CC} operation.

When testing SOS propagation delay performance, each of the single bit paths are measured separately with the test load. Each single bit is remeasured over the range of operating V_{CC} and temperature. The statistical minimum, maximum, and mean of the sample of single bit paths are then used to calculate the databook specification.

When testing MOS propagation delay performance all bit paths are simultaneously switched in phase with the test sense probe being moved to measure each output. The load capacitance can be varied for additional extended AC electrical characteristics. Typically, derating curves of propagation delay versus load, use lumped load capacitances of 10 pF, 30 pF, 50 pF, 100 pF and at times 250 pF.

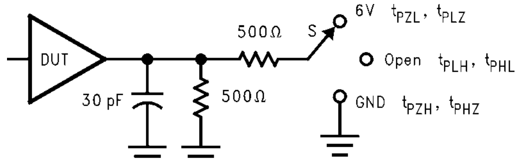

FIGURE 1. AC Test Circuit

How is MOS Used

When available, MOS specifications are used to determine *relative* deltas in propagation delay performance of the device. Because MOS testing uses the AC test circuit of Figure 1, the user must be careful in using the propagation delay values for timing budget analysis. The actual propagation delay performance will depend on the type and distribution of the load the device is driving.

The usefulness of MOS data applies more to applications that may be synchronous in nature when more than one output is switching simultaneously. Synchronous switching, especially *in-phase* synchronous switching, is generally considered the worst case application from the driving device point of view and is consequently the setup used for MOS testing.

Common Mistakes

There are some common mistakes when interpreting SOS propagation delay specifications. The most common mistake is assuming that the specification guarantees maximum propagation delay if all outputs were simultaneously switching. MOS derating curves explain the degradation beyond the specified SOS propagation delay.

The other common mistake is to assume the SOS propagation delay maximum specification guarantees performance across all loading conditions. There are often datasheet derating curves for the change in propagation delay over capacitive load. The test load in all cases is lumped versus distributed.

Data Specifications Format

Table 1 and Table 2 are examples of datasheet specifications. Table 1 gives the maximum and minimum specifications of SOS propagation delay over the industrial/ commercial temperature range, V_{CC} range, and standard loading. Table 2 gives MOS specifications of propagation delay with the same testing conditions as SOS but with all outputs switching.

TABLE 1. AC Electrical Characteristics

Symbol	**Parameter**	**$T_A = -40°C$ to $+85°C$, $C_L = 30$ pF, $R_L = 25\Omega$; $V_{CC} = 3.3V \pm 0.15V$, $V_{CCQ} = 5.0V \pm 0.25V$**		**Units**
(A to B)		**Min**	**Max**	
t_{PLH}	Propagation Delay	1.0	6.5	ns
t_{PHL}	Propagation Delay	1.0	8.2	ns

TABLE 2. Extended AC Electrical Characteristics

Symbol	**Parameter**	**$T_A = -40°C$ to $+85°C$, $C_L = 30$ pF, $R_L = 25\Omega$; $V_{CC} = 3.3V \pm 0.15V$, $V_{CCQ} = 5.0V \pm 0.25V$**		**Units**
(A to B)	**18 Outputs Switching**	**Min**	**Max**	
t_{PLH}	Propagation Delay	1.0	8.8	ns
t_{PHL}	Propagation Delay	1.0	9.7	ns

Derating Curves

Derating curves provide device performance data beyond standard datasheet specifications. These curves are often provided when a new family of products are introduced and can be used for all the functions in the family. The MOS derating curves describe the change in propagation delay of a device as the number of switching outputs for that device increases. Examples of t_{PLH} and t_{PHL} derating curves include a table of the statistical mean @ 3.3V/5.0V, 30 pF along with the corresponding plot of the data.

TABLE 3. Mean Propagation Delays (t_{PLH})

Outputs Switching	Mean Propagation Delay (A to B)
LH	**GTLP16612**
1	4.1
5	4.71
9	5.37
13	5.93
18	6.44

TABLE 4. Mean Propagation Delays (t_{PHL})

Outputs	Mean Propagation Delay
HL	**GTLP16612**
1	5.02
5	5.47
9	5.89
13	6.23
18	6.54

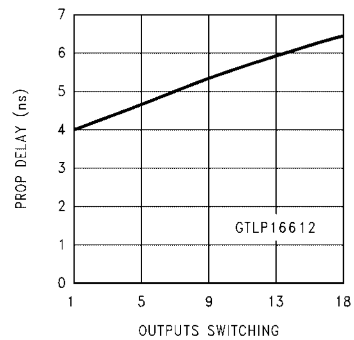

FIGURE 2. Derating Curve (t_{PLH})

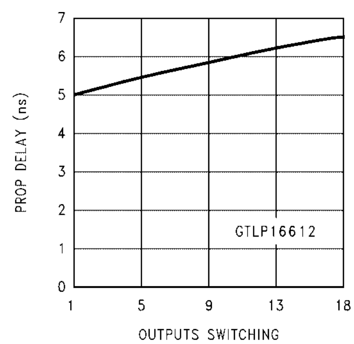

FIGURE 3. Derating Curve (t_{PHL})

Conclusion

Single Output Switching (SOS) specifications are provided by the supplier as a tool for the user to allow a cursory look into the performance of a device. Actual performance is highly dependent on the application in which it is used. The inclusion of Multiple Output Switching (MOS) specifications give the user an additional data point to use when determining the change in relative performance of a device. Derating curves provide a number of additional data points to assist the user in determining the change in relative performance of a device.

With a clearer understanding of SOS and MOS specifications it is possible to be better prepared to integrate new devices into a design. These tools must be used with caution when calculating parameters, such as timing budgets, in actual applications. The testing conditions used in setting standard specifications for a datasheet are most likely different than the actual loading and conditioning of the devices in an application.

The use of standard specifications, such as SOS, make the selection of which family to use an easier task. Before testing in the actual application, using MOS and derating curves offers more detailed information available to make the selection process easier.