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LVDS: Calculating Driver/Receiver Power

Introduction

To insure system functionality and reliability many board and system level designs must employ power budgets. The cumulative power dissipated by each device in the application contributes to the total power dissipated by the system. Calculated total device power dissipation can help determine a power source best suited for the specific application. It can also provide an understanding of the system's (or board's) operating conditions that might have an impact on system reliability or cause damage to on board ICs.

This application note outlines an example of a power dissipation calculation for typical LVDS differential line drivers. It provides designers a method for calculating power dissipation of individual LVDS components to assist in meeting system power budgets.

Components of Total Power Dissipation

Total power dissipation can typically be divided into two parts: a static and a dynamic component. The static component, or supply power, is derived from current flowing into the power pins. The dynamic component is the output power derived from current into or out of the output pins.

The static power consumption of a device is the total DC current that flows from V_{CC} to GND with the inputs connected to V_{CC} or GND with the outputs left open. To calculate the supply power, multiply the device supply current (I_{CC}) by the supply voltage (V_{CC}). The maximum specifications are found in the DC electrical characteristics of the datasheets.

(1) $PD_{DC(max)} = I_{CC(max)} * V_{CC(max)}$

Where,

PD_{DC}	= Static DC Power
I_{CC}	= Supply Current
V_{CC}	= Supply Voltage

The current sinking and sourcing capability of the driver's output structure, along with the load being driven, dictates the amount of power being consumed.

To calculate the dynamic power dissipated by the device outputs, use the differential output voltage (V_{OD}) and the output current (I_O) being sourced and sunk. The formula to calculate the output power dissipated by a single differential channel is:

(2) $PD_{OUTPUT(S)} = [I_O(V_{CC}–V_{OD})]$

Where,

$PD_{OUTPUT(S)}$	= Power dissipated by the output(s)
I_O	= Differential current per output
V_{CC}	= Supply Voltage
V_{OD}	= Differential Output

When dealing with LVDS products with multiple channels, the formula to calculate the power dissipated by the output is:

(3) $PD_{OUTPUT(S)} = (\# \text{ of channels}) [I_O(V_{CC}–V_{OD})]$

The approximate total power dissipated by the differential driver is the sum of the supply power and the power dissipated by the differential outputs:

(4) $PD_{TOTAL} = PD_{DC} + PD_{OUTPUT(S)}$

For an LVDS receiver, the supply power is calculated similarly to the approach used for the driver. The output power of the receiver would be derived using the following equation and inserting the values from the datasheet electricals:

(5) $PD_{OUTPUT} = V_{OL} * I_{OL} + [(V_{CC} – V_{OH}) * I_{OH}]$

The device switching frequency component of the total power varies from application to application. The following example demonstrates how to calculate total power dissipation, with assigned values for illustrative purposes only. If the exact application configuration is known, appropriate adjustments can be made to the calculations.

Power Dissipation Calculation Example

To illustrate the calculation for total power dissipation, this example uses typical values for a Quad High-Speed Differential Line Driver (FI1031) with the following conditions:

V_{CC}	= 3.6V (max)
T_A	= 25°C
V_{OD}	= 350 mV (typical)
I_{OD}	= 3.5 mA (typical)
I_{CC}	= 4 mA (max)

(6) Static DC Power

$$PD_{DC(max)} = I_{CC(max)} * V_{CC(max)}$$
$$= (4\text{ mA})(3.6\text{V})$$
$$= 14.4\text{ mW}$$

Power Dissipation Calculation Example (Continued)

(7) Dynamic Output Power

$PD_{OUTPUTS}$ = (No. of channels) $[I_O(V_{CC} - V_{OD})]$
= (4) [3.5 mA (3.6V – 350 mV)]
= 45.5 mW

(8) Total Power

PD_{TOTAL} = $PD_{DC} + PD_{OUTPUT(S)}$
= 14.4 mW + 45.5 mW
= 59.9 mW

A more comprehensive total power dissipation calculation would include power dissipation from the device's switching frequency. Therefore, the equation would be as follows:

(9) Total Power

$PD_{TOTAL} = PD_{DC} + PD_{OUTPUT(S)} + C_{OUT}\,(V_{CC})^2(f)$

C_{OUT} = device output capacitive load
f = switching frequency

For most differential line drivers the magnitude of the CV^2f term on total device power dissipation is negligibly small. The significant advantage of LVDS technology is the low power requirement because of the constant current source driver rather than a voltage mode driver. With minimal switching spikes in the driver, I_{CC} does not increase exponentially, resulting in very low (almost flat) power consumption across frequency. Refer to Figure 1 for a relative comparison.

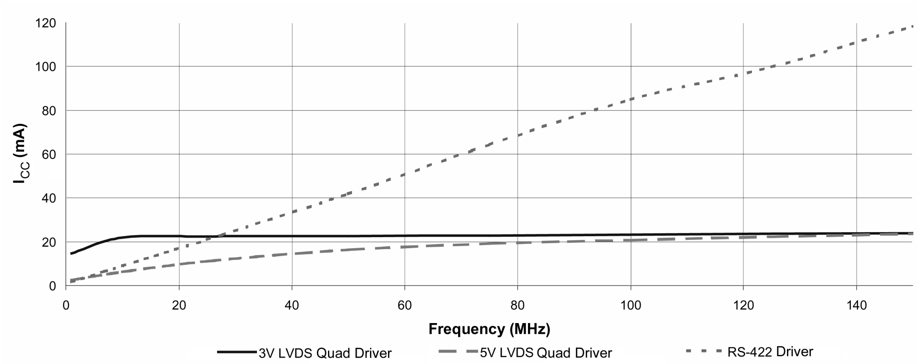

FIGURE 1. I_{CC} vs. Frequency

Summary

An advantage of LVDS is its low power at high data rates. With a current draw of 3.5 mA per output, an LVDS output at 3.3V dissipates about 11 mW, a constant with the frequency of operation. A method for calculating the total power dissipated by an LVDS TIA/EIA-644 compliant driver and receiver was presented. This approach can be applied to similar LVDS devices designed to meet the TIA/EIA-644 requirements and specifications.