Back to Reality

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Frank Gasparik

SPI-2 Working Group
4/18/97
Issues

First Pulse Magnitude

*Whose Fault is it?*

Asymmetric/Symmetric Current Drive

*Which is Better?*

Tolerances of Current Sources

*Can they Work?*

Active Bias Terminators

*Why we Need Them?*
Do you Remember These?

Picture by Bill Ham, SPI-2 Meeting, June 6, 1996

First Pulse Distortion
Symmetric Driver, 150Ω  Symmetric Terminator
Fully Loaded Cable
Advanced Warning
Bill Ham’s Measurement

SLOW SLEW RATE AT LOAD 1

First Pulse

BIL HAM DIGITAL EQUIPMENT SPI-2 WORKING GROUP JUNE 6, 1996
Whose Fault is it?

¿ Current Source Drive ?

¿ Active Terminator ?

¿ Asymmetric Driver ?

¿ Symmetric Driver ?
Whose Fault is it?

( None of the Above )

It is the **TRANSMISSION LINE**
How to Prove it?

$I_1 = I_3 = 9\text{mA}$

$I_2 = I_4 = 4.5\text{mA}$

$\text{Sw}_x - \text{CMOS Switch}$

$R_{ox} - \text{Current Source} R_{out}$

$I_x - \text{Current Source}$

$T - \text{Balanced Terminator}$

28AWG 12m Loaded Cable

Distributed RLC Model
Bill Ham’s Test Ckt

Hspice Simulation of First Pulse
Which is Better?

Asymmetric Current Driver

or

Symmetric Current Driver?

Measured data - verified by simulation results proves that symmetric drive offers no advantage over present asymmetric drive.
Active Terminator Benefits

- Built-in Bias for Fail-Safe Operation
- Common-Mode Drive / Sink Current
- Controlled Impedance
- Low Capacitance
- Simpler Receiver Circuitry
- Even without Bias, Active Terminator Needed
Why Terminator Bias?

Provides Fail-Safe Operation

Symmetric Signal is Achievable

Balanced Receiver - Low Skew

No Complex Dual Receiver
Receiver Sensitivity

Typical $V_{\text{in DIFF}} = 400\text{mV}$ (No Load)

Worst Case $V_{\text{in DIFF}} = 60\text{mV}$ (Loaded Cable)

Worst Case Process, Temp & Supply Voltage

Low Skew Critical
Current Source Drivers

Issues

Current Mirror Match

$I_{DP}$ versus $I_{DN}$ Match

Identical Challenge for Symmetric or Asymmetric Drivers
Test Setup

Loads: C1 = 10pF
C2 = 21pF
C3 = 21pF
# Cable Specification

<table>
<thead>
<tr>
<th>Voltage Rating: 150V</th>
<th>Conductor: 30AWG Solid Silver Plated Copper, 0.010&quot; Diameter</th>
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<tr>
<td>Propagation Delay: 1.31 ns (Single End)</td>
<td>Insulation: FEP Clear Blue Stripped</td>
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<tr>
<td>Impedance: 103 ± 10 ohms (Differential)</td>
<td>Notes:</td>
</tr>
<tr>
<td>Capacitance: 0.012 μF/ft (Single End)</td>
<td></td>
</tr>
<tr>
<td>Transmission Line: 2.1 μF/ft (Differential)</td>
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**Tolerances**

- ± 0.024 ± 0.003
- ± 0.025 ± 0.003
- ± 0.024 ± 0.006
- ± 1.00 ± 0.008

**Revised Difference: Initial Release**

<table>
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<tr>
<th>REV</th>
<th>DESCRIPTION</th>
<th>REVISION</th>
<th>DATE</th>
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<td>7/1/2003</td>
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**Related Documents**

- CABLE CODE: OCC01
- PART NO: F9001-36-005-45
- DATE: 3/1/2004

**Cable Specification**

**Title:** TEMP FLEX CABLE, INC.

**DFM:** KF

**Date:** 3/1/2004

**Notes:**
Fast-80 Transfer

@ Driver REQ - No Load

\[ I_{\text{ASSERT}} / I_{\text{NEGATE}} = 9\text{mA} / 4.5\text{mA} \]
Fast-80 Transfer
@ Driver REQ - 15 Loads
Fast-80 Transfer
@ Driver ACK - 15 Loads
Fast-80 Transfer
REQ @ Load 0
Fast-80 Transfer
REQ @ Load 12
Fast-80 Transfer

$I_{AS}/I_{NEG} = 8mA/4mA$
Fast-80 Transfer

\[ I_{AS}/I_{NEG} = 10\text{mA}/5\text{mA} \]

REQ @ Load 1
**LVD Power**

Asymmetric Drive: $V_{\text{diff}} = 400\text{mV}$, $Z_o = 120\Omega$

\[ V_{\text{BIAS}} = 120\text{mV} \]

\[ I_{\text{assert}} = 8.667\text{mA} \]

\[ P_D = (3.3 - 0.4)V \times 8.667\text{mA} = 25.13\text{mW} \]

\[ I_{\text{negate}} = 4.667\text{mA} \]

\[ P_D = (3.3 - 0.4)V \times 4.667\text{mA} = 13.53\text{mW} \]

Total Average Power = 19.33mW
LVD Power

Symmetric Drive: $V_{\text{diff}} = 400\text{mV}$, $Z_o = 120\Omega$

\[ I_{\text{assert}} = 6.67\text{mA} \]
\[ \Rightarrow P_D = (3.3-0.4)V \times 6.67\text{mA} = 19.33\text{mW} \]

\[ I_{\text{negate}} = 6.67\text{mA} \]
\[ \Rightarrow P_D = (3.3-0.4)V \times 6.67\text{mA} = 19.33\text{mW} \]

Total Average Power = 19.33mW
Symmetric Driver?

No Advantage in Performance
No Fail-Safe Operation
Identical Power Dissipation
Increased Receiver Complexity
Beyond Fast-80

Cable Length
Number of Loads
Receiver Sensitivity
Cable Media
Protocol Issues
If Symmetric Driver has Merit Beyond Fast-80, the Transition Need Not to be Disruptive