LVD SCSI Assertion and Negation Currents

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Purpose

Define an operating region for driver assertion and negation currents (I_A and I_N) that will provide adequate DC voltage levels, incident wave voltage levels, and reflected wave voltage levels. I_A and I_N are defined such that both are positive quantities.

Constraints

- DC voltage levels:
  - » V_A >= 130 mV
  - » V_N <= -130 mV
- AC voltage levels (first transition):
  - » V_+ >= 150 mV
  - » V_- <= -150 mV
- Cable impedance:
  - » 85 ohms <= Z_L <= 135 ohms

Constraints (continued)

- Termination:
  - » 100 mV <= V_B <= 130 mV
  - » 100 ohms <= R_T <= 115 ohms
  - » 0.87 mA <= I_T <= 1.3 mA (derived)
- Leakage and number of nodes:
  - » -20 uA <= I_L <= 20 uA
  - » 2 <= N <= 16

DC Assertion Level

- V_A >= 130 mV
- $(I_A - 2 * I_T - N * I_L) * R_T / 2 >= 130$ mV
- $I_A >= 2 * (130 \text{ mV} + V_B) / R_T + N * I_L$
- Maximum V_B, N, and I_L; minimum R_T:

  I_A >= 5.52 mA

- V_N <= -130 mV
- $-(I_N + 2 * I_T + N * I_L) * R_T / 2 <= -130$ mV
- $I_N >= 2 * (130 \text{ mV} - V_B) / R_T - N * I_L$
- Minimum V_B, I_L, and R_T; maximum N:

  $I_N >= 0.92$ mA

Incident Wave Assertion

- $V_+ >= 150\ mV$
- $V_N + (I_A + I_N) * Z_L / 2 >= 150\ mV$
- $I_A + I_N >=$
  $(300\ mV + (I_N + 2 * I_T + N * I_L) * R_T) / Z_L$

Incident Wave Assertion (cont.)

- $I_A >=$

  $$\frac{300\ mV + I_N * (R_T - Z_L) + 2 * V_B + N * I_L * R_T}{Z_L}$$

- Maximum R_T, minimum Z_L:

  $I_A >= 7.02\ mA + .35 * I_N$

Reflected Wave Assertion

- V_{R+} >= 130 mV
- Let $Z_P = R_T * Z_L / (R_T + Z_L)$
- $V_N + (I_A + I_N) * Z_P$ >= 130 mV
- $I_A + I_N$ >=
  (130 mV + $(I_N + 2 * I_T + N * I_L) * R_T / 2$) / Z_P

- $I_A >=$

$$\frac{130\text{ mV} + I_N * (R_T/2 - Z_P) + V_B + N * I_L * R_T/2}{Z_P}$$

- Minimum R_T and Z_L:

  $I_A >= 6.01\text{ mA} + .09 * I_N$

- Maximum R_T, minimum Z_L:

  $I_A >= 5.69\text{ mA} + .18 * I_N$

Reflected Wave Assertion (cont.)

- Superposition of both reflected waves -- let $Z_R = 2 * Z_P - Z_L / 2$
- $I_A >=$

$$\frac{130\ \text{mV} + I_N * (R_T/2 - Z_R) + V_B + N * I_L * \mathbf{R}_T/2}{Z_R}$$

- Maximum Z_L, minimum R_T:

  $I_A >= 5.83\ \text{mA} + .055 * I_N$

Incident Wave Negation

- $V_- <= -150$ mV
- $V_A - (I_A + I_N) * Z_L / 2 <= -150$ mV
- $I_A + I_N >=$
  $((I_A - 2 * I_T - N * I_L) * R_T + 300 \text{ mV}) / Z_L$

Incident Wave Negation (cont.)

- I_N >=

  $$\frac{I_A * (R_T - Z_L) - 2 * V_B - N * I_L * R_T + 300\ mV}{Z_L}$$

- Minimum Z_L, maximum R_T:

  I_N >= 1.61 mA + .35 * I_A

Reflected Wave Negation

- $V_{R-} <= -130$ mV
- $V_A - (I_A + I_N) * Z_P <= -130$ mV
- $I_A + I_N >=$
  $((I_A - 2 * I_T - N * I_L) * R_T / 2 + 130 \text{ mV}) / Z_P$

Reflected Wave Negation (cont.)

- $I_N >=$

  $$\frac{I_A * (R_T/2 - Z_P) - V_B - N * I_L * R_T / 2 + 130 \text{ mV}}{Z_P}$$

- Minimum Z_L, maximum R_T:

  $I_N >= 0.99 \text{ mA} + .18 * I_A$

Reflected Wave Negation (cont.)

- Superposition of both reflected waves
- I_N >=

$$\frac{I_A * (R_T/2 - Z_R) - V_B - N * I_L * R_T / 2 + 130\text{ mV}}{Z_R}$$

- Minimum R_T, maximum Z_L:

$I_N >= 0.97\text{ mA} + .055 * I_A$

Ideal Asymmetric Drivers

- $V_A = - V_N$
- $(I_A - 2 * I_T) * R_T / 2 = (I_N + 2 * I_T) * R_T / 2$
- $I_A = I_N + 4 * I_T$
- I_T (mid-range) = 1.05 mA
- $I_A = I_N + 4.2$ mA

Symmetric and Asymmetric Drive

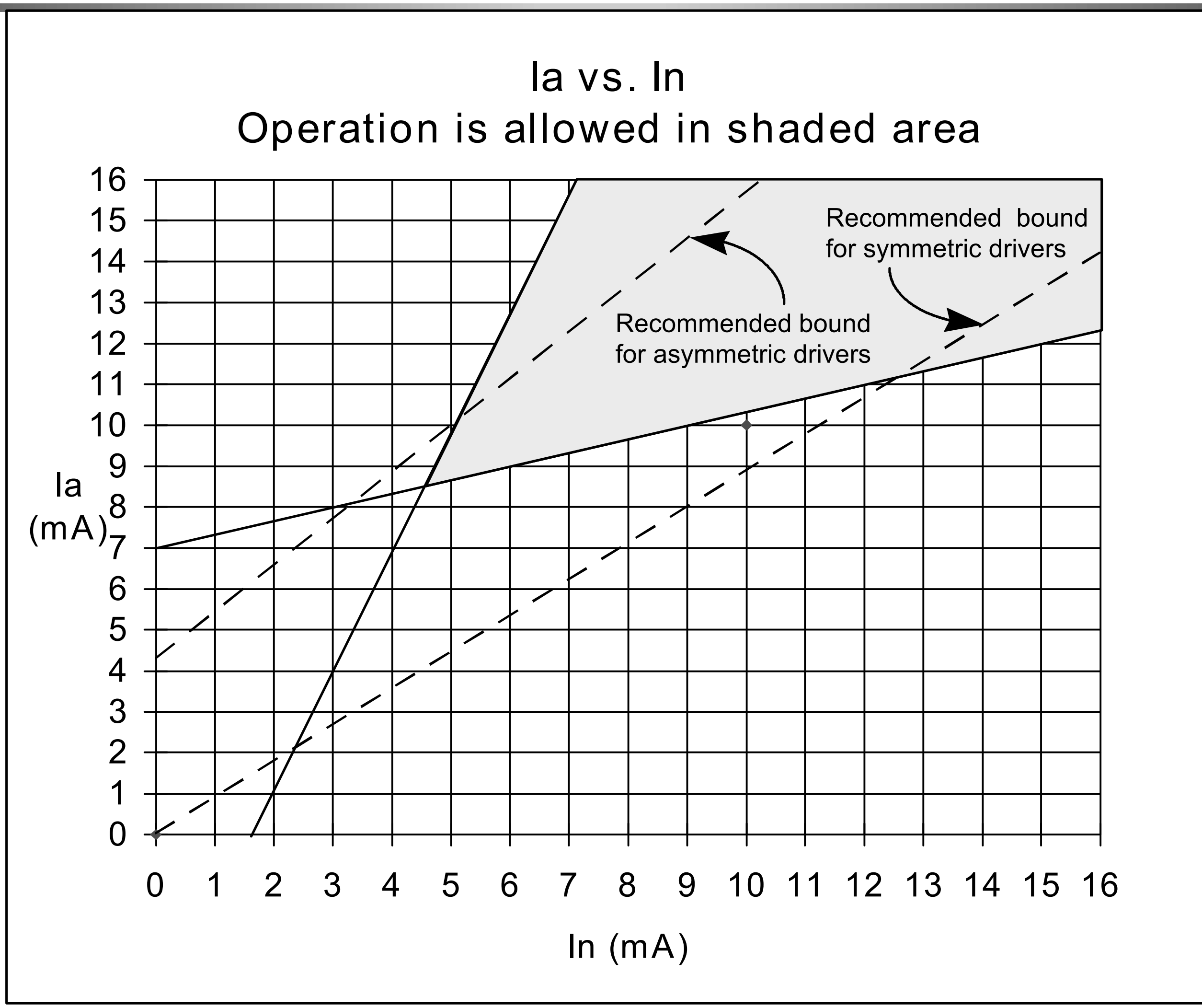
- Symmetric drivers with 10% mismatch:

  $I_A >= 0.9 * I_N$

- Asymmetric drivers with 10% mismatch:

  $I_A <= 1.1 * I_N + 4.6 mA$

Allowed Region of Operation



Comments

- Analysis is for current-mode drivers and neglects driver and load impedances; i.e., $R_S >> Z_L$ and $R_L >> Z_L$.
- A simple current source model for leakage is used. A better model would be a diode bridge with a current source.

Comments

- Worst case conditions arise from lowest loaded cable impedance combined with highest termination resistance.
- Incident wave amplitude is the dominant constraint for both assertion and negation drivers.

Comments

- Tightening range of R_T would provide relief by relaxing driver design constraints.
- If minimum negation current for DC conditions is positive, does this mean that the terminator bias is insufficient?