92-220

SPI Working Group Contribution

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Subject: Suggested changes to Figure 8 (Differential driver test circuit) for SCSI-3 SPI document

It is our concern that that the proposed differential test circuit shown in Figure 8 of X3T9.2/91-010R7 does not reflect a fully loaded SCSI-3 application. There are four points of interest that this test circuit fails to address:

1) It does not model the equivalent loading created by 32 loads connected in parallel. RS-485.1983 specifies that the input impedance of a unit load to be greater than 12kΩ. Thirty two units loads (allowed by SCSI-3 and RS-485) would present a 375Ω load on each line. SCSI-1 and SCSI-2 could ignore this loading, since they limited the number of loads to 8 (12kΩ / 8 = 1.5kΩ worst case).

2) It does not model the fact that the 165Ω resistors are pulled to a 5V potential difference. Figure 8 implies that they are pulled to the same potential, which is incorrect for the DC test.

3) A minor mistake of assigning the inverting driver output to the SCSI defined "-SIGNAL" lead. This is not the case for all applications. Some SCSI µC provide positive logic outputs while others provide negative logic outputs. The inverting driver output could be connected to the -SIGNAL or the +SIGNAL depending upon the SCSI µC.

4) It models a DC ground shift of -7V to +12V, which if actually occurred would most likely cause an overload in the system or cable fault since SCSI defines a common ground (and assigns 6 conductors to GROUND).

I have included the related figures on this topic for ease of discussion. Figure 1 is the current Differential Test Circuit (SPI Figure 8) from R7 of the SPI draft.

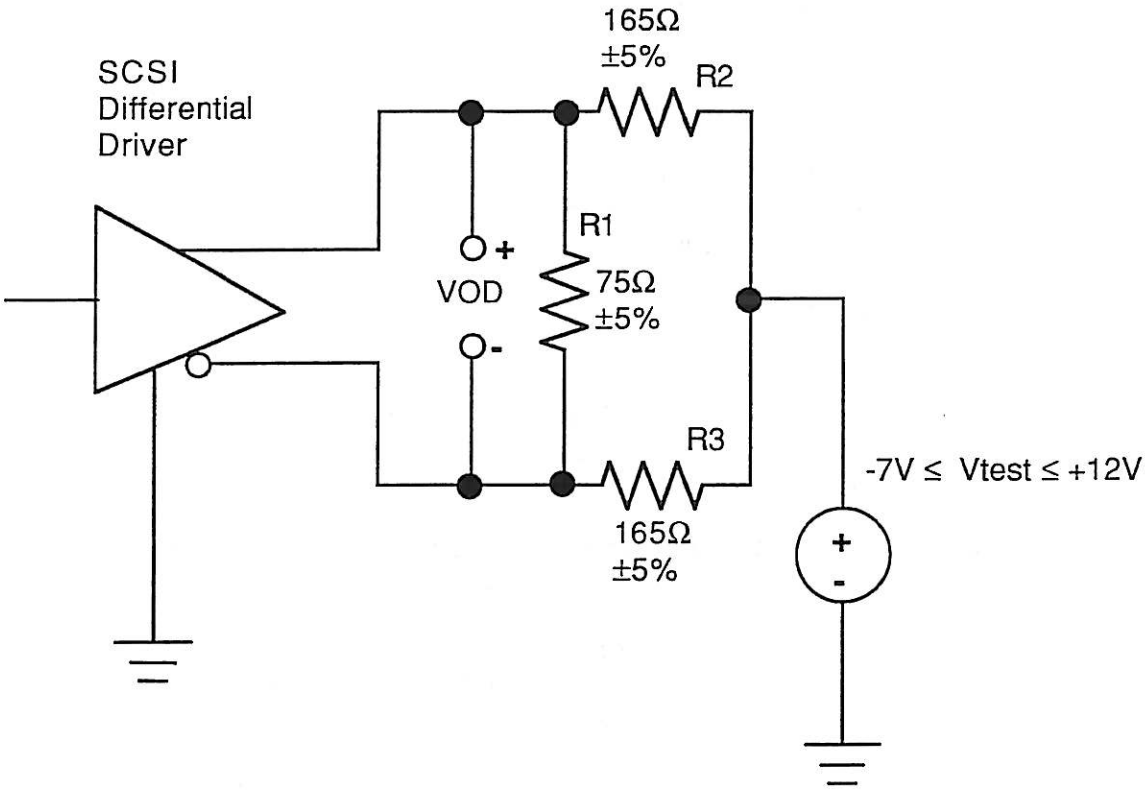

Figure 8 - Differential test circuit

FIGURE 1 - Figure 8 from SCSI-3 SPI

In summary this differential test circuit:

- does not model the input impedance of 32 loads (375Ω),
- does not model the Term Power potential of +5V,
- incorrectly assigns the non-inverting to the -SIGNAL lead, and
- assumes that a -7V to +12V DC ground shift can occur in a SCSI application.

Before proposing a modified test circuit, it is best to review what the RS-485 standard specifies and what the proposed SCSI-3 bus standard currently defines. Figure 2 is from the RS-485 Interface Standard.

The generic RS-485 bus is terminated at both extreme ends of the cable with a resistance of 120Ω. Two 120Ω resistors in parallel (neglecting the cable resistance) is effectively 60Ω. The 375Ω resistors shown in Figure 2 represent the 32 unit loads (mainly from receiver input current). The test signal (Vtest) is ranged from -7V to +12V to represent a 7V DC ground shift between the active driver and ALL 32 receiver loads. It is also important to note that not all RS-485 applications tie the grounds together. Recall that RS-485 allows for cable lengths up to 4000 feet. In a typical RS-

485 application cables are commonly run between buildings tieing various pieces of equipment together thus, the possibility arises that nodes can be referenced to different ground planes. This is where a DC ground potential difference more commonly occurs.

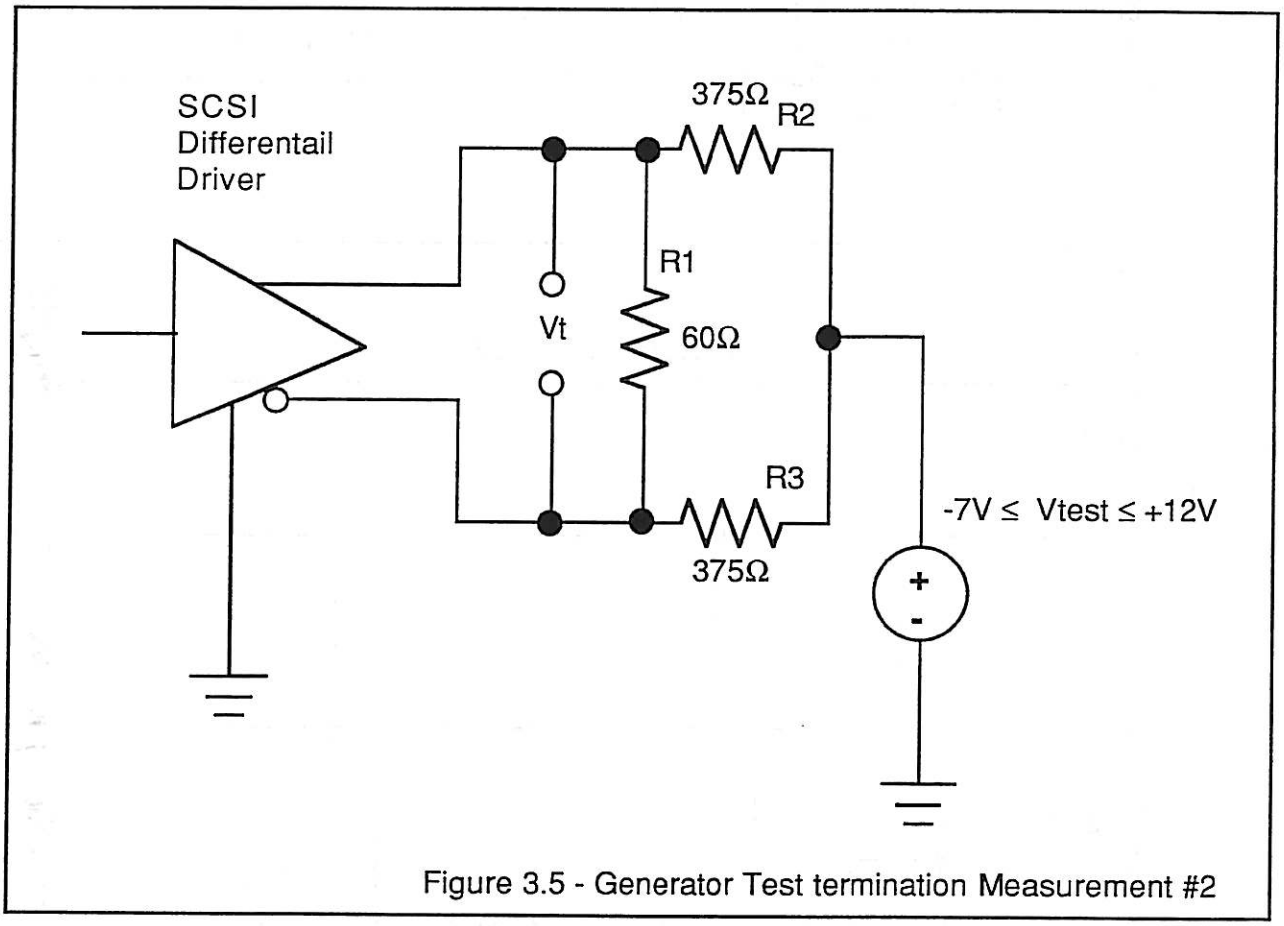

Figure 3.5 - Generator Test termination Measurement #2

Figure 2 - Figure 3.5 from RS-485.1983

To meet the terminated differential voltage requirement of >1.5V, the driver must support 60mA (source and sink) drive capability. This is the reason RS-485 drivers are referred to as having ±60 mA drive.

The differential SCSI bus presents an additional load due to the fact it employs failsafe biasing resistors at both ends of the cable. These pull resistors provide a ~1V bias when all drivers are OFF. SCSI also defines that 6 conductors are assigned to GROUND, and four are TERMPWR. Additionally SCSI-3 allows for up to 32 nodes to be connected to a SCSI bus (compared to eight in SCSI-1). An active driver on this fully loaded bus would see both the termination load and the input current loading. All nodes are referenced to the (very low impedance) common ground. If a DC ground shift occurred between nodes a large ground loop current would result, and most likely cause a cable fault. Figure 3 illustrates the proposed differential SCSI-3 bus, as defined in R7 of the SPI document.

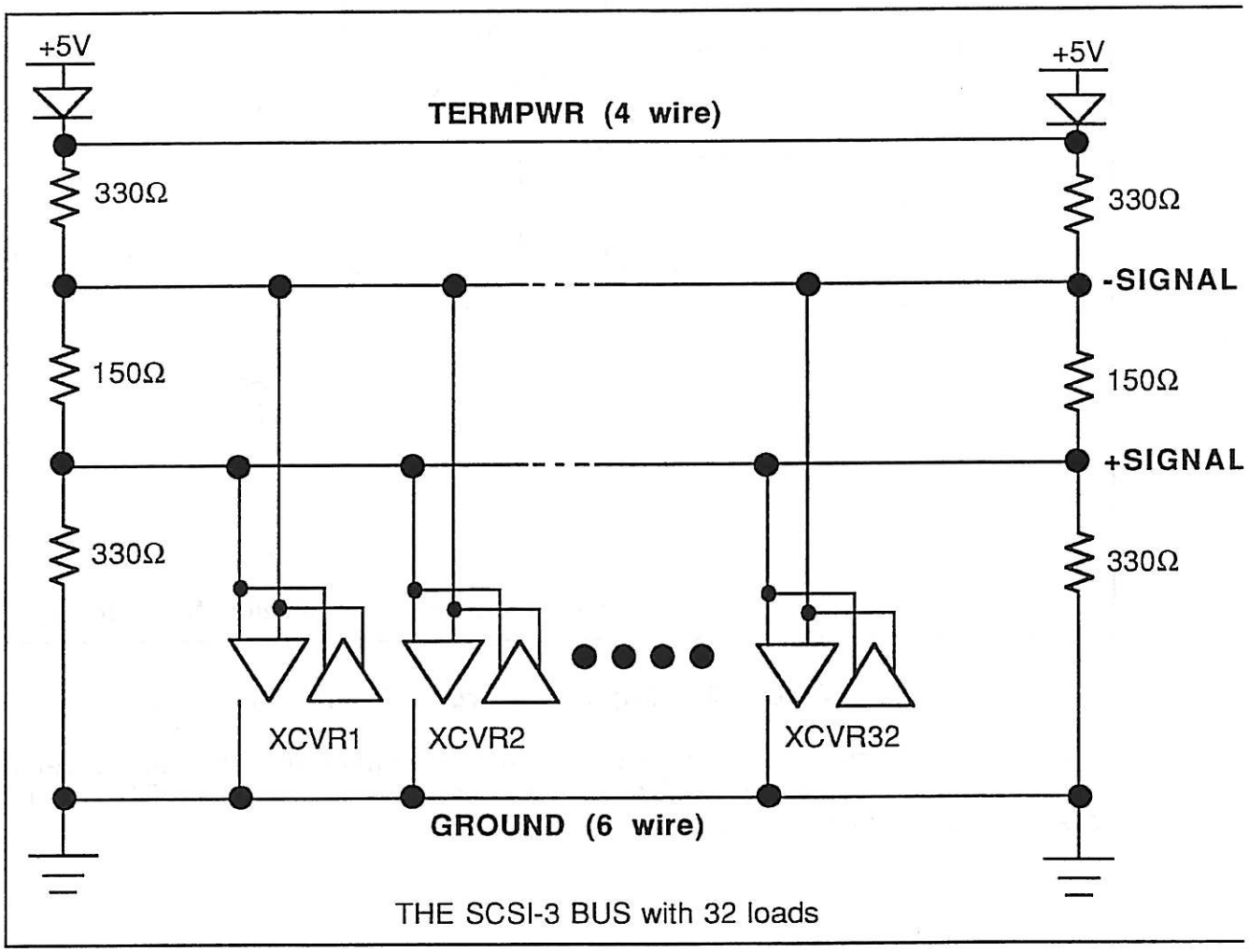

Figure 3 - The proposed SCSI-3 Differential Bus (32 loads and termination)

A typical RS-485 driver would have to provide over 110mA drive capability to meet the requirement of the Differential Test Circuit (from R7 of SPI) and to also meet RS-485 requirements. For example, if Vtest was -7V in magnitude, a typical RS-485 driver would have to support > 100mA drive capability. At the other extreme of +12V Vtest, the driver would have to support >120mA drive capability. This is an unrealistic demand on the RS-485 driver, not to mention the on-chip power dissipation of the transceiver.

Based on figure 3, we recommend that the circuit shown in figure 4 be included in the SPI standard as the differential test circuit, in addition to compliance to RS-485 specifications. This figure models:

- The SCSI defined termination load (R1, R2, R3)
- The Vterm potential of 5V (VT)
- The worst case loading of 32 unit loads (R4, R5)

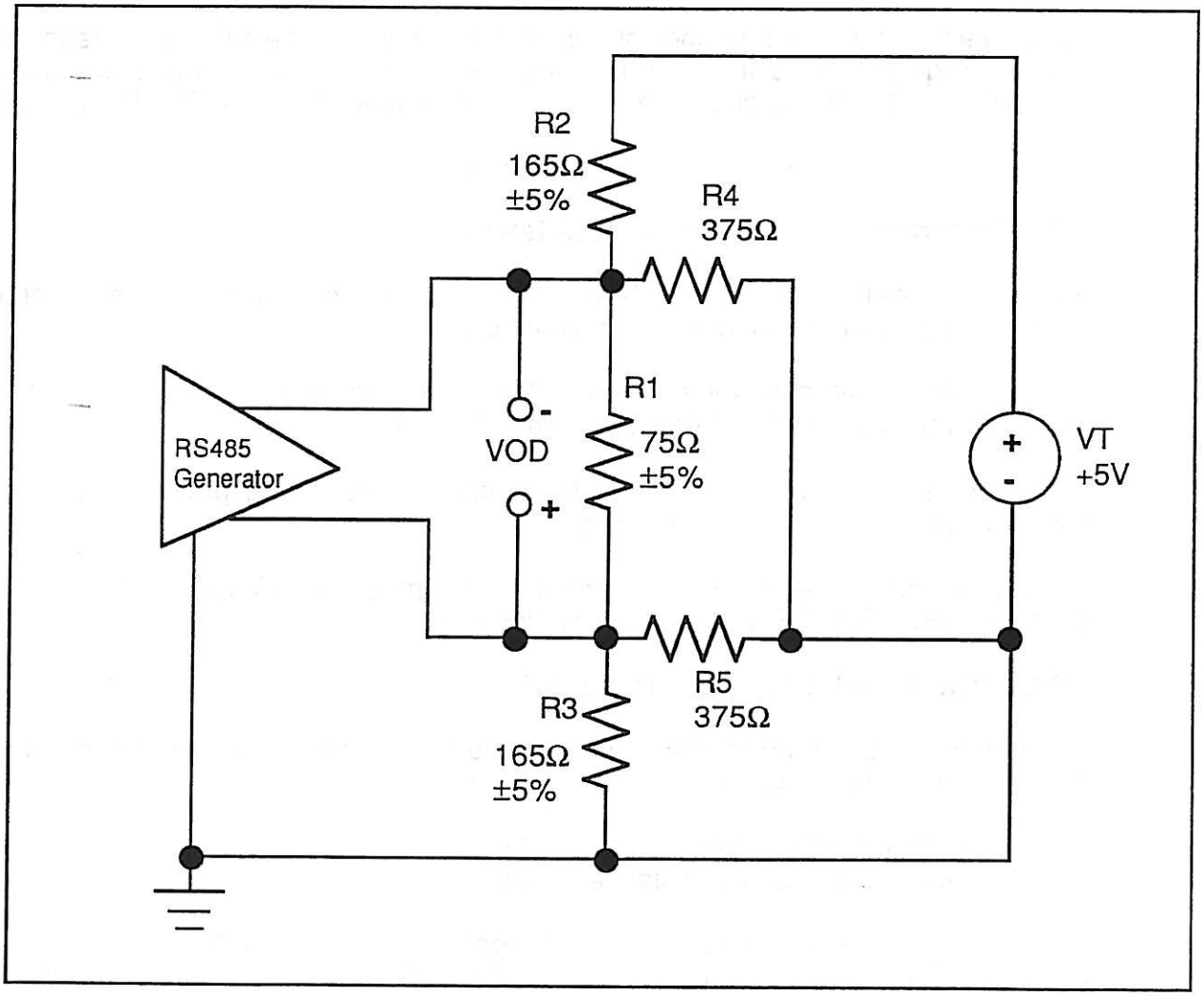

Figure 4 - Loading seen by an RS-485 drivers in a SCSI-3 application

These proposed changes do not imply that a RS-485 driver is no longer required. The RS-485 standard guarantees other important parameters for the drivers and receivers.

RS-485 defines:

- the differential driver and receiver function
- fault protection for the driver
  - current limiting over the -7V to +12V bus range (AC & DC)
  - recommends thermal shutdown
  - contention safe
- minimum drive capability over common mode range
- driver high impedance state over common mode range
- driver signal quality
- receiver thresholds
- the unit load concept
- maximum receiver input current

These parameters and any special parameters unique to the SCSI application are all that are required to be included in the SCSI-3 SPI standard. Parameters already required for RS-485 compliance need not be duplicated by the SCSI SPI standard.

We recommend the following changes to sections:

7.2.2 Differential Output Characteristics

Each signal sourced by a SCSI device shall have the following output characteristics when measured at the SCSI device's connector:

a) V_{OD} (Differential output voltage) = 1.0V minimum for either steady state logic input. The test circuit for this parameter is shown in figure 8.

All drivers shall maintain the high output impedance during power-up and power-down cycles until the driver is enabled.

The output characteristics shall additionally conform to EIA RS-485 1983.
(INSERT NEW FIGURE 8, figure 4 of this document)

7.2.3 Differential Input Characteristics

SCSI devices shall meet the following electrical characteristics on each signal (including both receivers and passive drivers):

a) Minimum input hysteresis = 35 mV
b) Maximum input capacitance = 25 pF

The input characteristics shall additionally conform to EIA RS-485 1983.
(NOTE delete ±2mA input current, as RS-485 already defines +1/-0.8mA for -7V≤Vin≤+12V input current limit for power on and off)