AN4994
Application note

10 gigabit Ethernet survives ITU-T K20 and Telcordia GR-1089-Core intra-building

Introduction

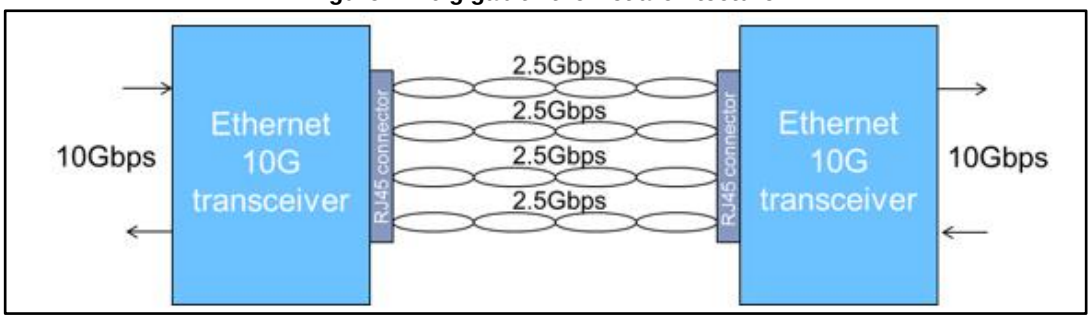
Ethernet links are very common to interconnect computers and servers in a campus environment. Cable length can reach 100 m and can be subjected to lightning surges. This document covers ST's protection products for both the 10 G Ethernet standard and ST's HSP product to protect Ethernet transceivers.

1 10 gigabit Ethernet

1.1 Architecture

10 gigabit Ethernet is defined by IEEE 802.3an standard. It is composed of 4 differential pairs, providing 2.5 Gbps each, in full duplex.

Figure 1: 10 gigabit Ethernet architecture



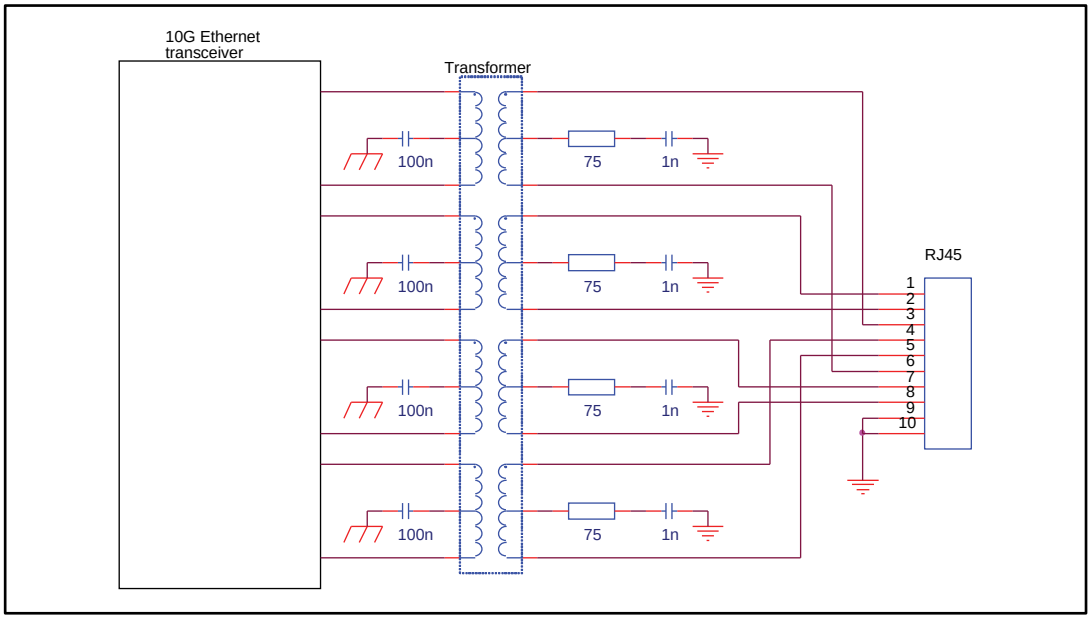
Modulation used is PAM 16 on each differential pair, so 4 bits per symbol.

Modulation rate is 800 Msymbols/second, which results in a 400 MHz Nyquist frequency.

1.2 Electrical implementation

Electrical implementation between the Ethernet transceiver and the connector is shown on the following figure.

Figure 2: 10 gigabit Ethernet implementation



To ensure high voltage isolation, transformer between transceiver and connector is implemented.

1.3 EOS on 10 gigabit Ethernet

As all Ethernet lines, 10 gigabit Ethernet is submitted to EOS (electrical over stress). These EOS are defined by ITU-T K20 or Telcordia GR-1089-Core:

- ITU-T K20:
  - +1500 V (10/700 µs) +37.5 A (5/310 µs) metallic (x5)
  - -1500 V (10/700 µs) -37.5 A (5/310 µs) metallic (x5)
  - +1500 V (10/700 µs) +37.5 A (5/310 µs) longitudinal (x5)
  - -1500 V (10/700 µs) -37.5 A (5/310 µs) longitudinal (x5)
- Telcordia GR-1089-Core intra-building:
  - +1500 V (2/10 µs) +100 A (2/10 µs) metallic (x1)
  - -1500 V (2/10 µs) -100 A (2/10 µs) metallic (x1)
  - +1500 V (2/10 µs) +100 A (2/10 µs) longitudinal (x1)
  - -1500 V (2/10 µs) -100 A (2/10 µs) longitudinal (x1)

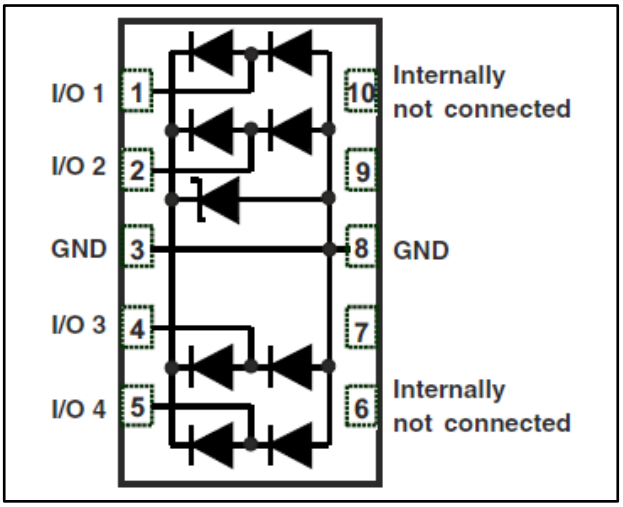
2 HSP product to protect 10 gigabit Ethernet

HSP (high speed protection) series has been designed to protect against ESD high speed differential links, such as HDMI, USB3.x.

However, these products can be also used to protect 10 gigabit Ethernet against ITU-T K20 or Telcordia GR-1089-Core intra-building, by placing HSP part between transformer and Ethernet transceiver.

The below figure shows an example of HSP product, providing 4 lines protection: HSP061-4M10.

Figure 3: HSP061-4M10 pin out

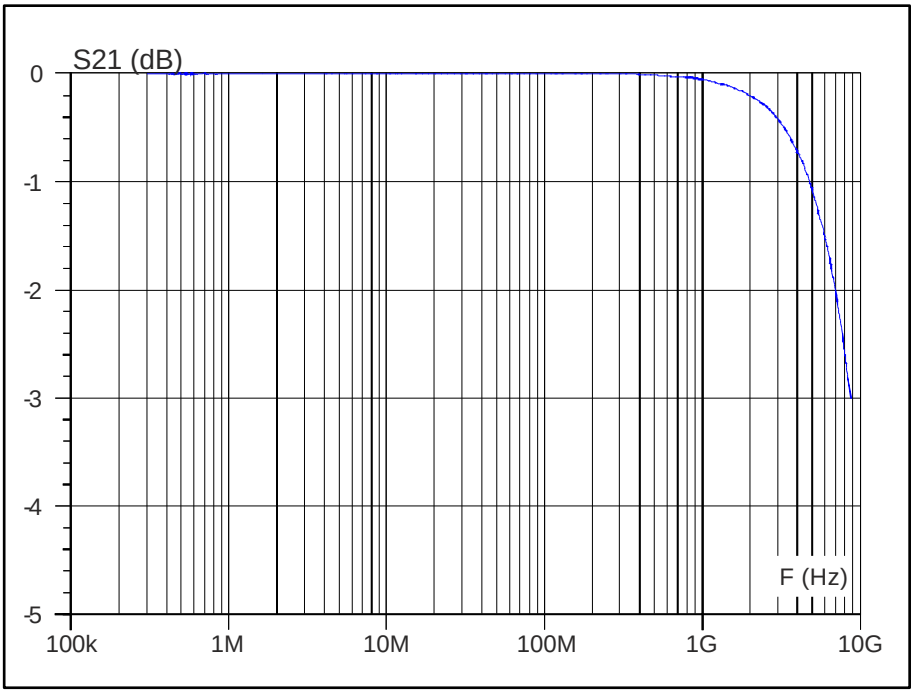


2.1 HSP061-4M10 bandwidth

HSP family offers a very large bandwidth (several GHz), to be compatible and transparent with high speed differential links.

The following figure shows frequency response of HSP061-4M10.

Figure 4: Frequency response of HSP061-4M10



The Nyquist frequency (400 MHz) falls comfortably within the 9 GHz range of our HSP family of products.

2.2 EOS measurements

To evaluate the behavior of HSP061-4M10, placed between transformer and transceiver, EOS measurements have been performed in metallic and longitudinal configuration, according to Figure 5 and Figure 6.

Figure 5: Schematic test for metallic surge configuration

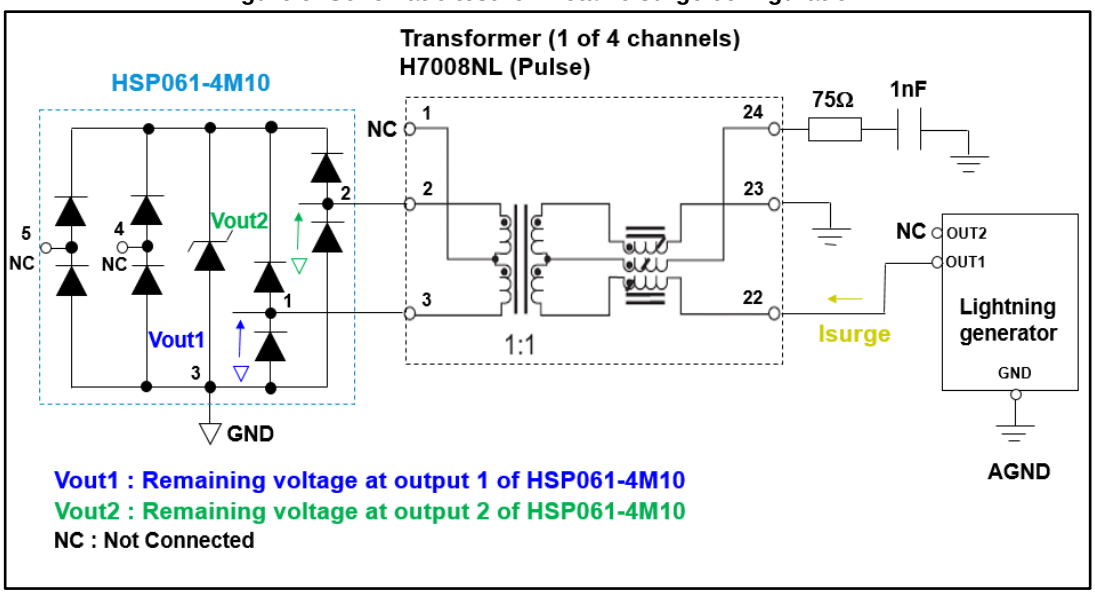
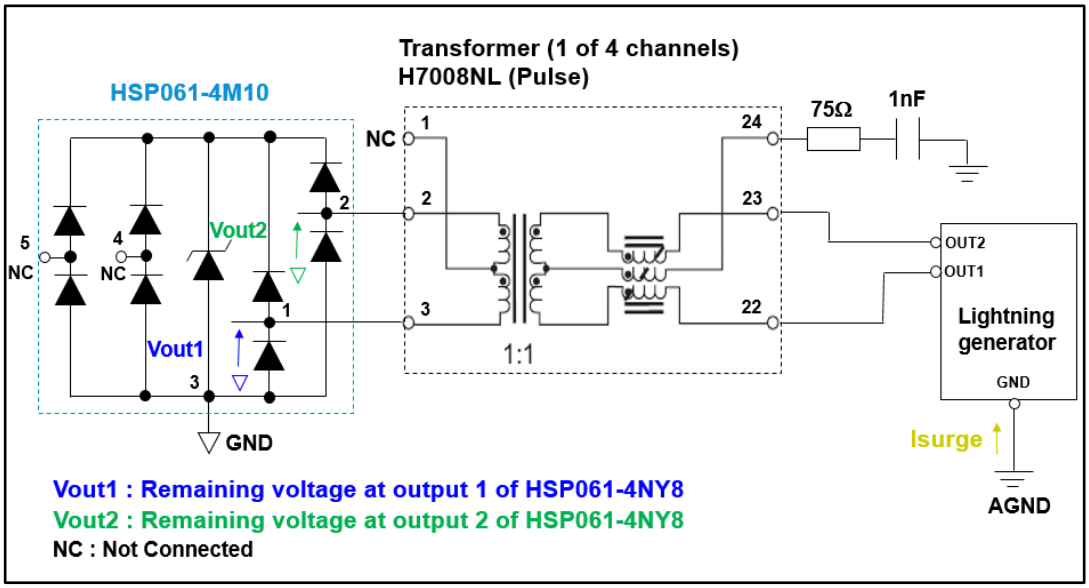


Figure 6: Schematic test for longitudinal configuration



2.3 ITU-T K20 lightning test

Following figures show measurement results when applying +1500 V (10/700 µs) and 37.5 A (5/310 µs) waveforms in metallic and longitudinal configuration.

Figure 7: +1500 V (10/700 µs) +37.5 A (5/310 µs) metallic configuration, after 5 shoots

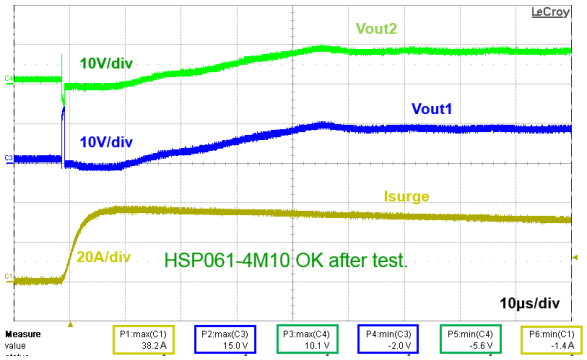


Figure 8: -1500 V (10/700 µs) -37.5 A (5/310 µs) metallic configuration, after 5 shoots

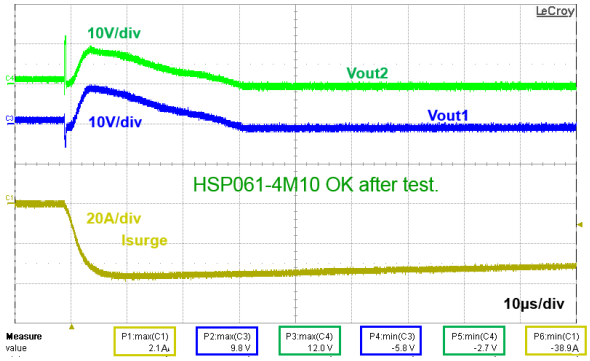


Figure 9: +1500 V (10/700 µs) +37.5 A (5/310 µs) longitudinal configuration, after 5 shoots

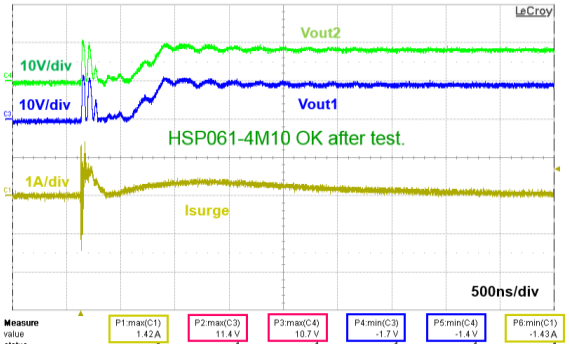
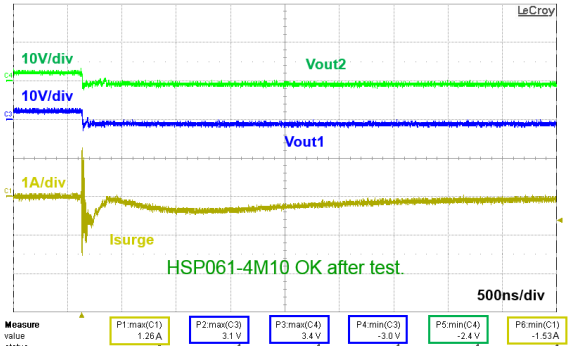


Figure 10: -1500 V (10/700 µs) -37.5 A (5/310 µs) longitudinal configuration, after 5 shoots



ST's HSP061-4M10 provides full transceiver protection per ITU-T K20 lightning surge tests.

2.4 Telcordia GR-1089-Core intra-building lightning test

Same measurements have been performed with Telcordia GR-1089-Core intra-building surges (i.e. 1500 V (2/10 µs), 100 A (2/10 µs)).

Figure 11: +1500 V (2/10 µs) +100 A (2/10 µs) metallic configuration, after 1 shoot

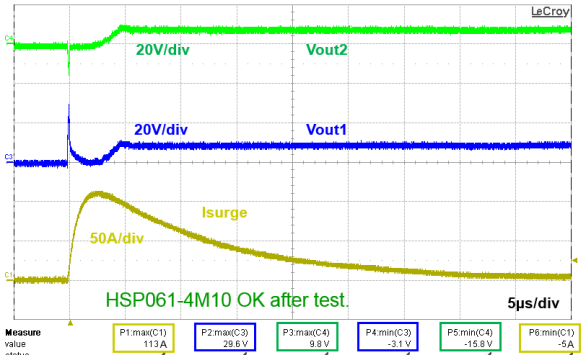


Figure 12: -1500 V (2/10 µs) -100 A (2/10 µs) metallic configuration, after 1 shoot

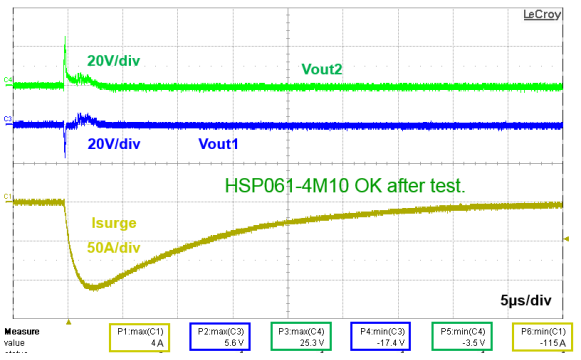


Figure 13: +1500 V (2/10 µs) +100 A (2/10 µs) longitudinal configuration, after 1 shoot

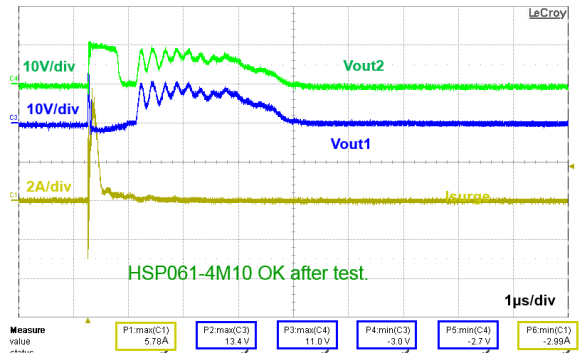
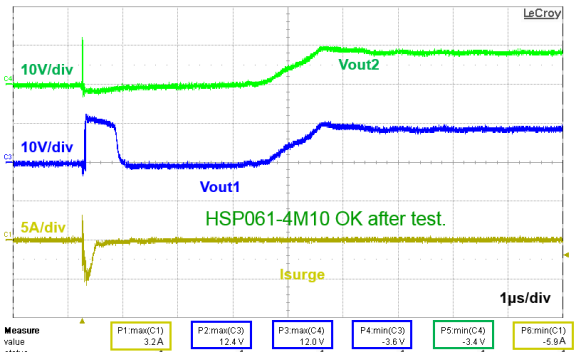


Figure 14: -1500 V (2/10 µs) -100 A (2/10 µs) longitudinal configuration, after 1 shoot



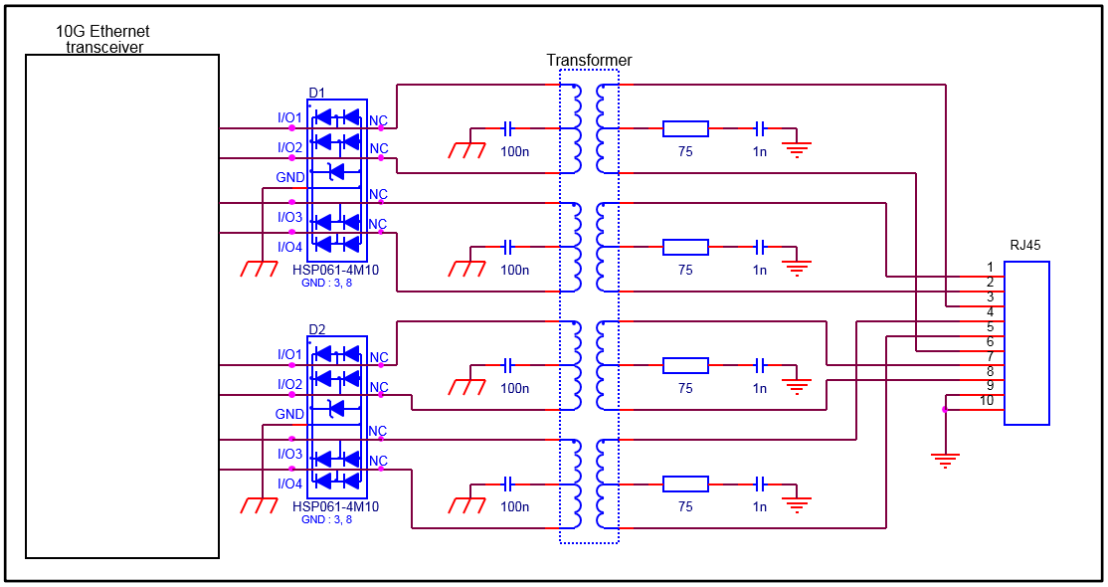
ST's HSP061-4M10 provides full transceiver protection against Telcordia GR-1089-Core intra-building lightning surge tests.

3 Protection implementation

10 gigabit Ethernet uses four differential pairs (8 lines) to achieve a data rate of 10 Gbps.

As one HSP061-4M10 provides protection for four lines, two HSP061-4M10s are needed to protect all lines of 10 gigabit Ethernet link.

Figure 15: HSP061-4M10 implementation on 10 gigabit Ethernet



4 Conclusion

10 gigabit Ethernet port conformity with ITU-T K20 or Telcordia GR-1089-Core standards can be ensured by inserting two components of HSP061-4M10 between transformers and Ethernet transceiver.

The HSP061-4M10 protection device ensures voltage outputs between -17.4 V to 28.6 V with either the ITU-T K20 or the Telcordia GR-1089-Core surge test applied.

5 Revision history

Table 1: Document revision history

Date	Revision	Changes
06-Feb-2017	1	Initial release.

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