SGMII Ethernet Problems

# Summary

When SGMII link between CPU and PHY is at 100M, many transmitted frames have the last byte of the frame (i.e. part of the FCS) dropped or corrupted. There are no problems receiving data through SGMII at 100M from known-good transmitters.

# Setup

CPU1 and CPU2 are identical parts (and baremetal software); PHY1 and PHY2 are also identical parts.

CPU1 has SGMII to its T1 PHY. CPU2 has RGMII to its T1 PHY.

PHY1 and PHY2 are connected via a twisted pair through the harness.

# Description of 1000M (gigabit)

When the SGMII, RGMII, and T1 links are all at gigabit, no packets are dropped, and the link achieves over 900 Mbps of error-free throughput in both directions simultaneously. This is correct and what we expect to happen.

# Description of 100M (fast Ethernet)

When the SGMII, RGMII, and T1 links are all at 100M, many packets are dropped consistently all the time. The SGMII MAC reports no errors, while the RGMII MAC reports align/code errors as well as fragment errors. We’ve tested using small packets (< 100 bytes) and large packets (1500 bytes). We’ve tested using between 1 and 100 packets per 1ms. Results are always similar in all cases.

Each time the 100M T1 link is established, there’s a chance it will be fully operational instead of defective as described above. We can generally repeat the auto-negotiation to establish a link around ten times and one of them will land on a successful link.

When the test is repeated using RGMII for both CPU1 and CPU2, then 100M has no problems and achieves 99 Mbps in both directions on all link attempts.

Inspecting the dropped frames at the RGMII side reveals all bytes are present and correct except the FCS at the end, which is typically missing its final byte. Using software to compute the CRC32 of our frames, we see that 3 of the 4 bytes in the FCS are correct, and the reported size of the frame is one byte less than expected.

# Tentative Conclusion

Since SGMII can receive packets without problems from an RGMII link partner, and RGMII can receive packets without problems from an RGMII link partner, we conclude that the SGMII link between CPU1 and PHY1 is sometimes dropping or corrupting the final byte of an outgoing Ethernet frame (in the FCS).

# Main Question

Why does the 1000M link work properly over SGMII and RGMII, but the 100M link has problems transmitting correctly over SGMII? What can we do to debug and fix the 100M SGMII link problems?

# Definitions

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| An alignment error is defined to be:   * A frame containing an odd number of nibbles * Failing the Frame Check Sequence test if the final nibble is ignored |
| A code error is defined to be:   * A frame which has been discarded because the port’s MRXER pin driven with a one for at least one bit-time’s duration at any point during the frame’s reception |
| A frame fragment is defined to be:   * Any data frame (address matching does not matter) * Less than 64 bytes long * Having a CRC error, an alignment error, or a code error * Not the result of a collision caused by half-duplex, collision-based flow control |

Note that the CPU only has one counter for both alignment errors and code errors, so I cannot tell them apart.