10 Mb/s Single Twisted Pair Ethernet
Evaluation Board Noise Measurements

Marcel Medina
Steffen Graber
Pepperl+Fuchs

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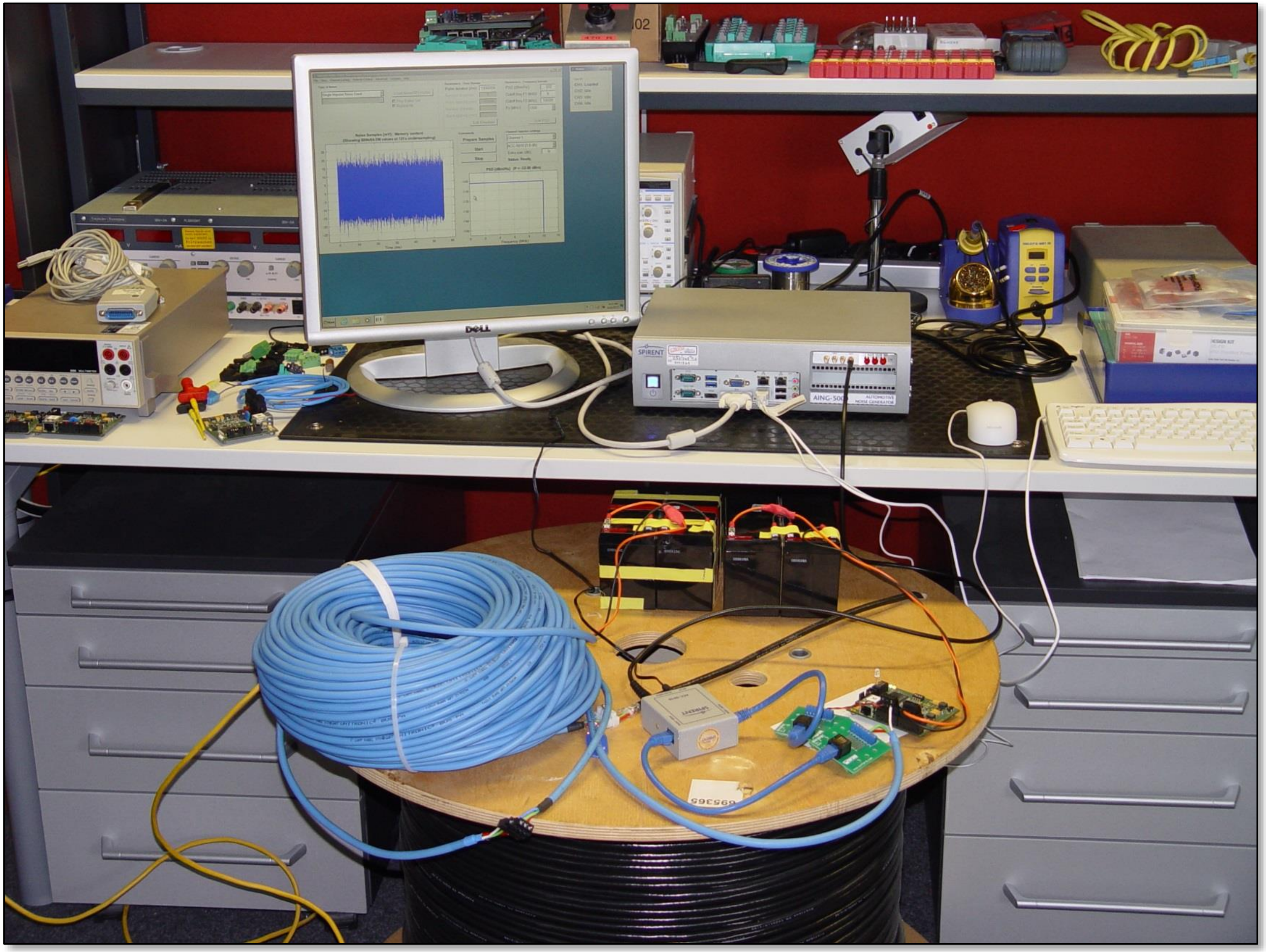
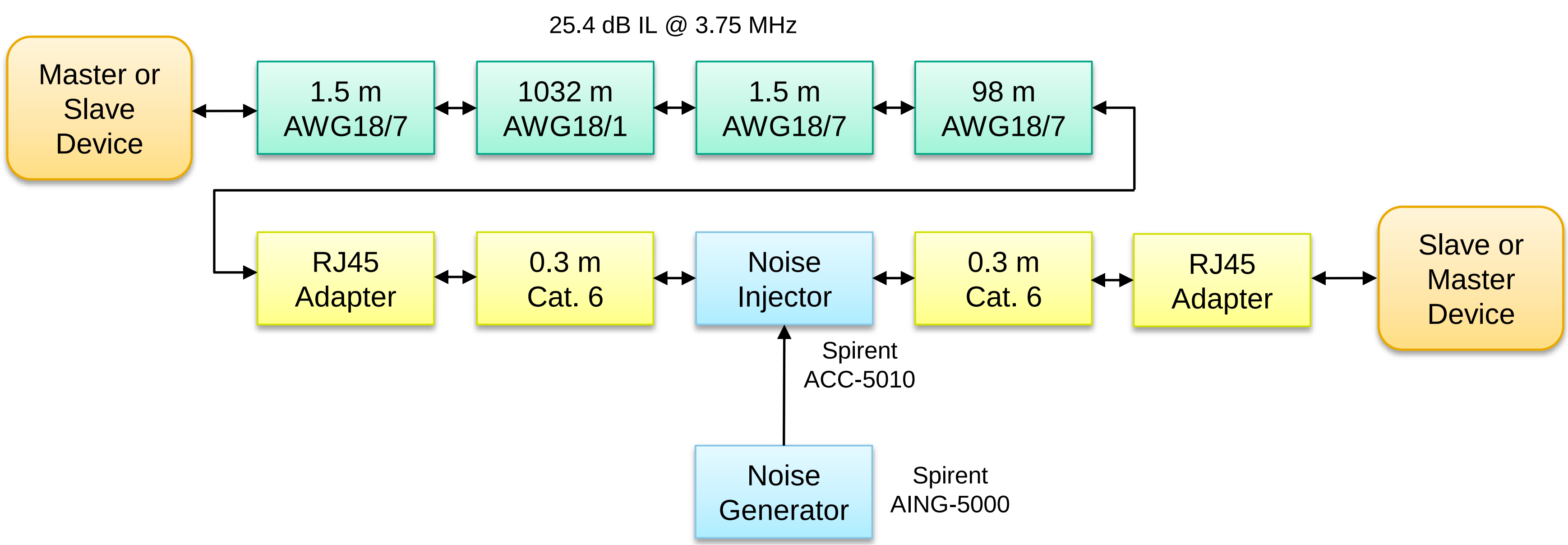
AWGN/Impulsive Noise Measurement Setup



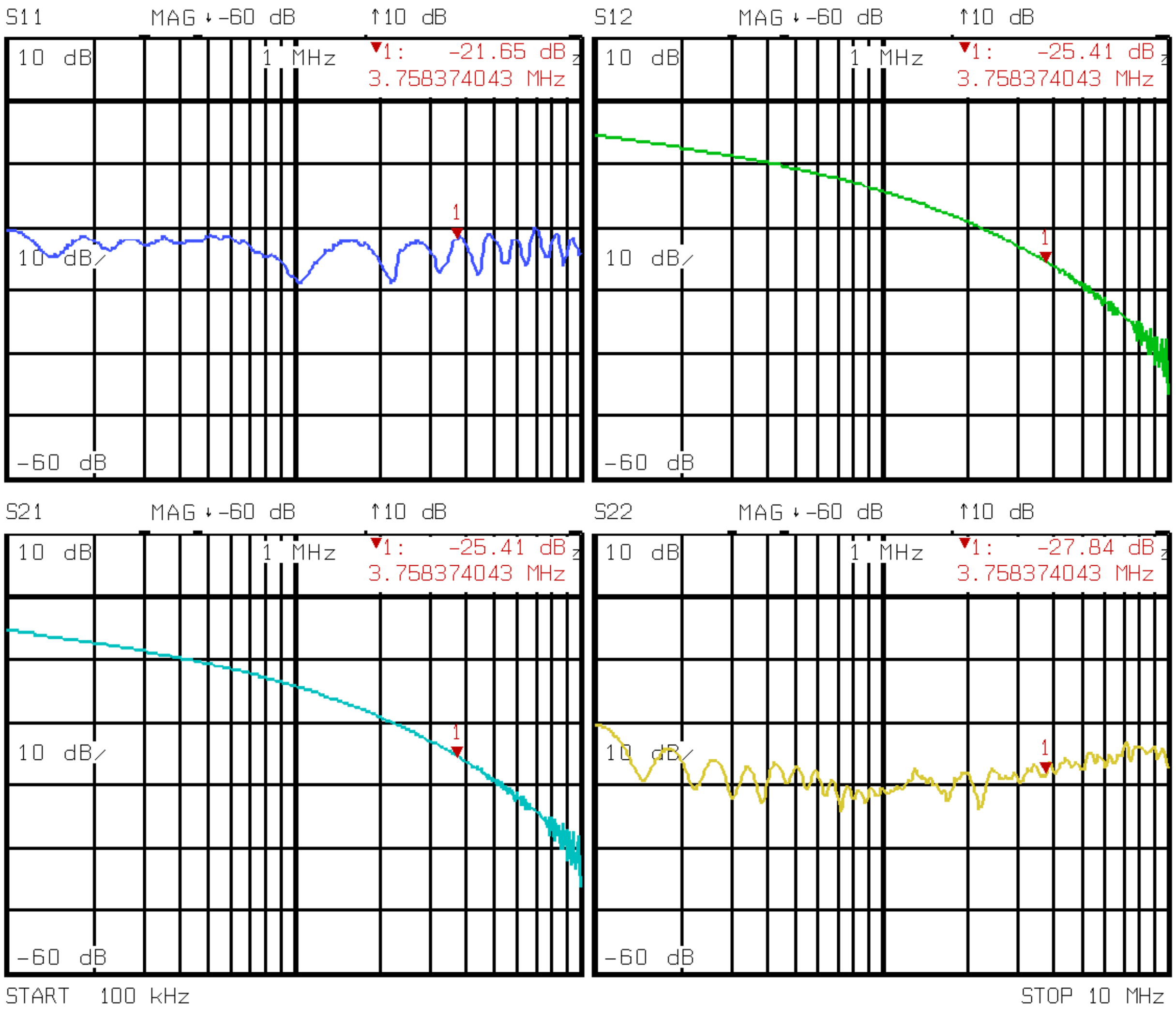
AWGN/Impulsive Noise Measurement Setup

- The following block diagram shows the basic setup for the AWGN and impulsive noise measurement.
- The link segment is built using a cable drum with 1032 m AWG18/1 cable in combination with a cable ring with 98 m AWG18/7 cable and two short 1.5 m cables for interconnection purposes.
- The resulting insertion loss is 25.4 dB @ 3.75 MHz.
- This is almost equal to the defined insertion loss for a 1000 m link segment of 25.6 dB @ 3.75 MHz.
- On one end of the link segment a Spirent Communications AING-5000 noise generator is connected via a Spirent Communications ACC-5010 noise injector.
- Tests are done with AWGN noise and impulsive noise (based on the samples taken from the air conditioning room as shown in http://www.ieee802.org/3/cg/public/May2017/Graber_3cg_06_0517.pdf).

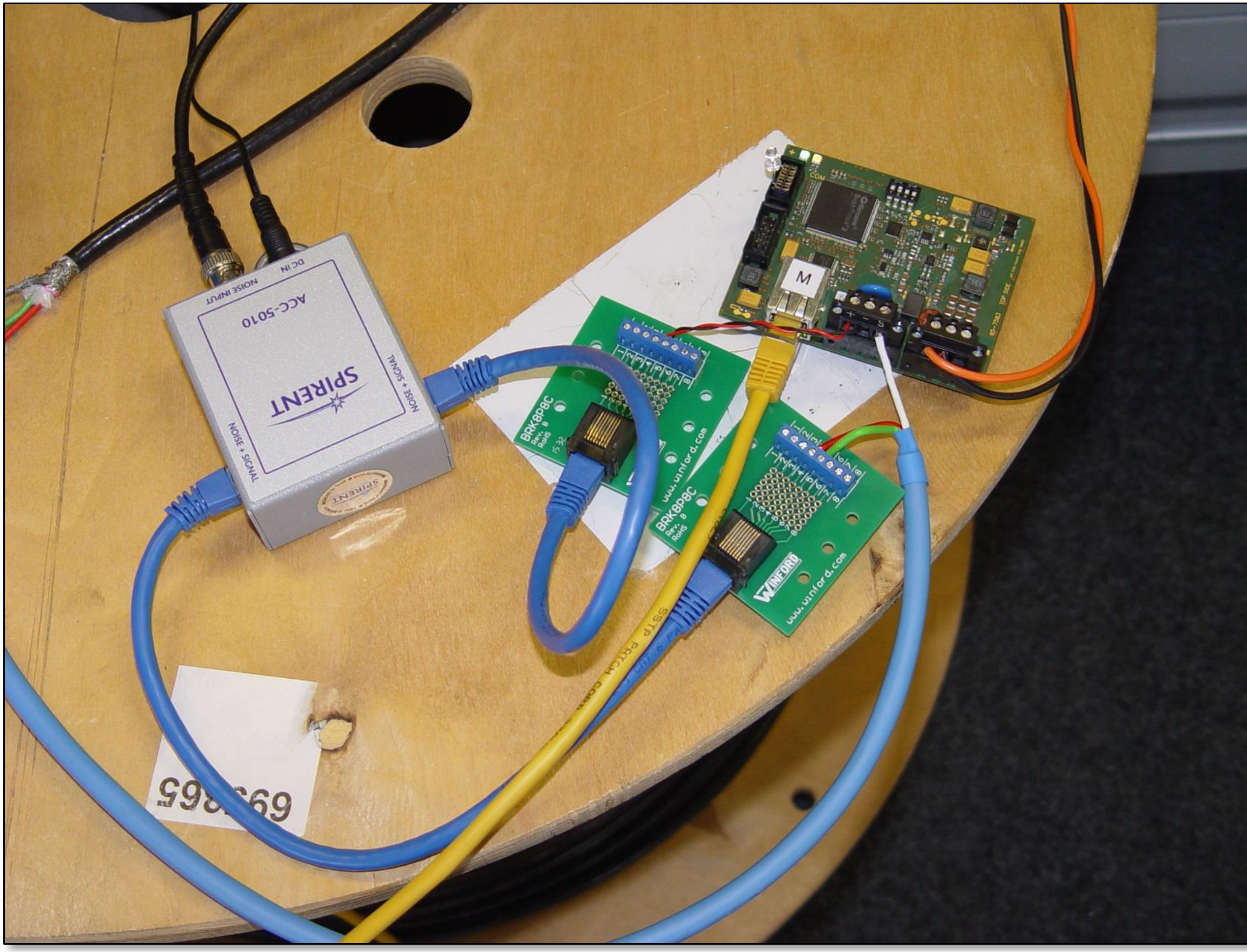


AWGN/Impulsive Noise Measurement Setup

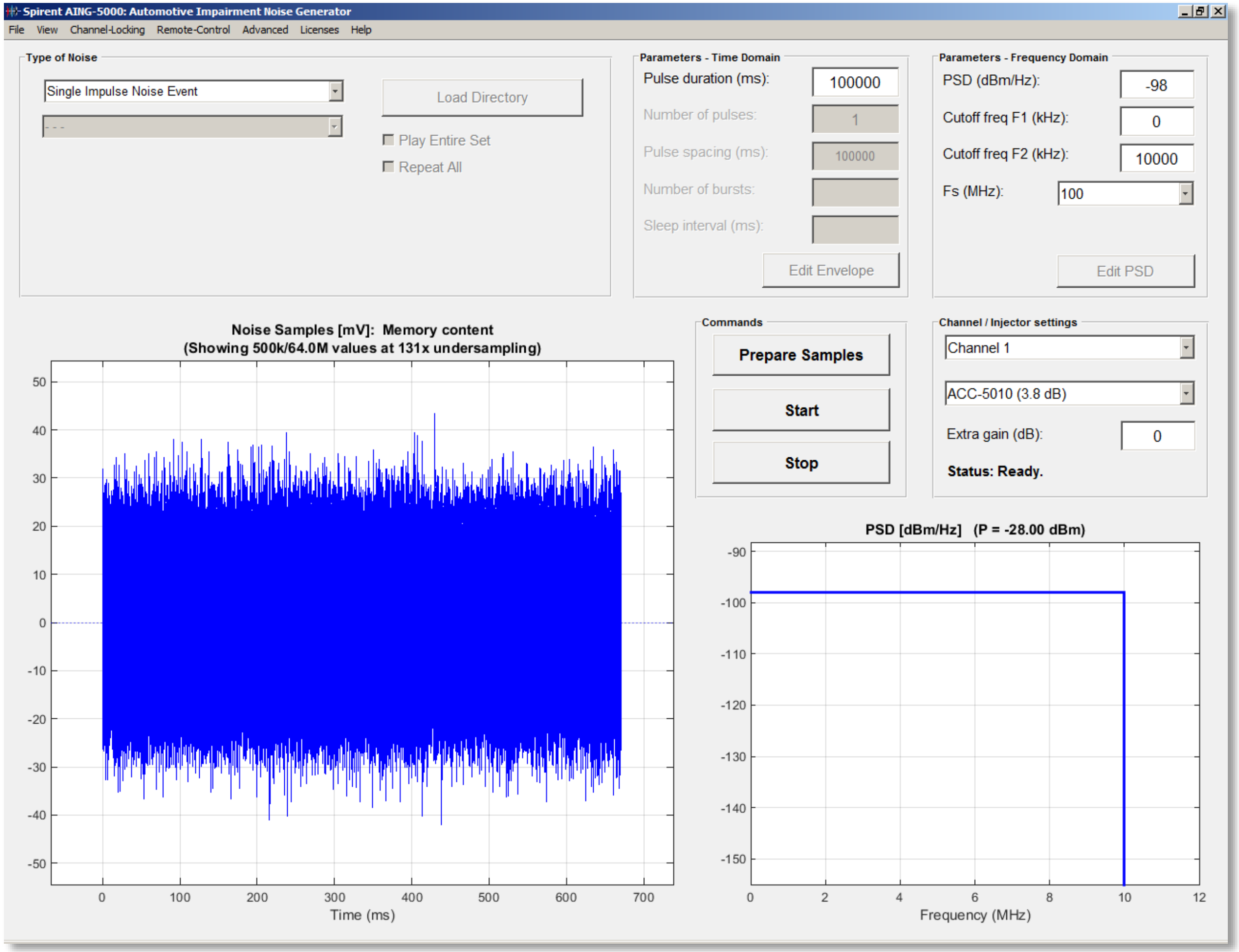
- Link segment (green colored blocks on previous slide) S-parameters measurement (100 kHz to 10 MHz):



AWGN/Impulsive Noise Measurement Setup

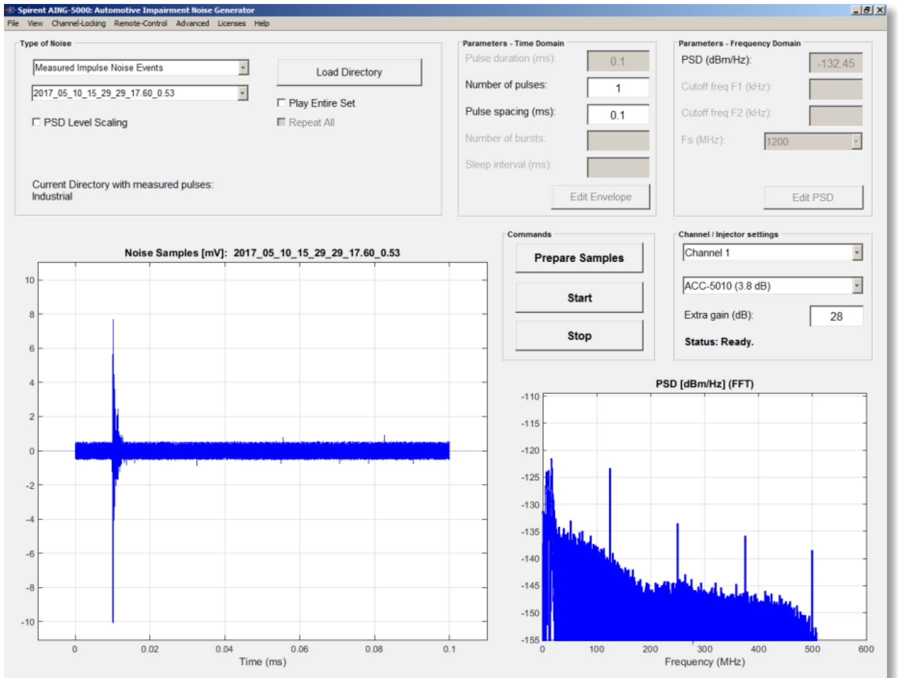


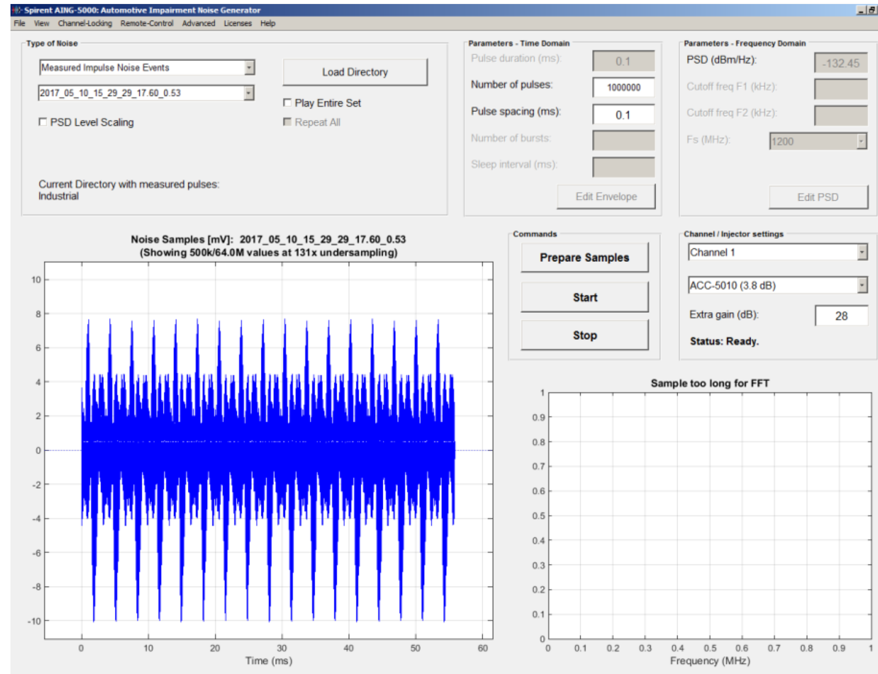
AWGN Noise Measurement



- AWGN noise with -98 dBm/Hz and a bandwidth of 10 MHz does not cause any bit errors within a run time of 100 s.
- Adding 8 dB safety margin leads to an AWGN noise limit of -106 dBm/Hz having a bandwidth of 10 MHz.

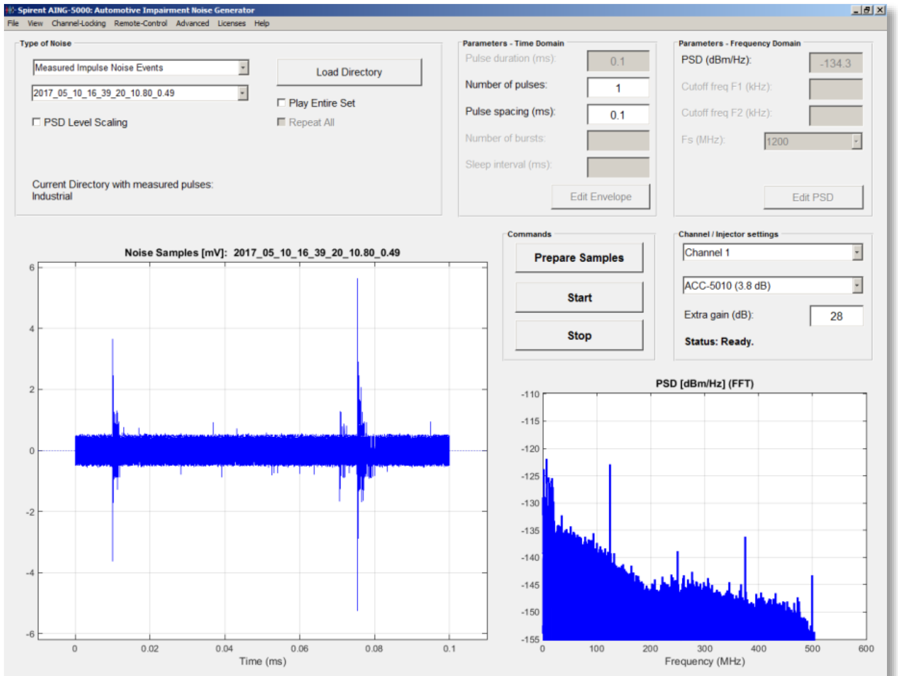
Impulsive Noise Measurement

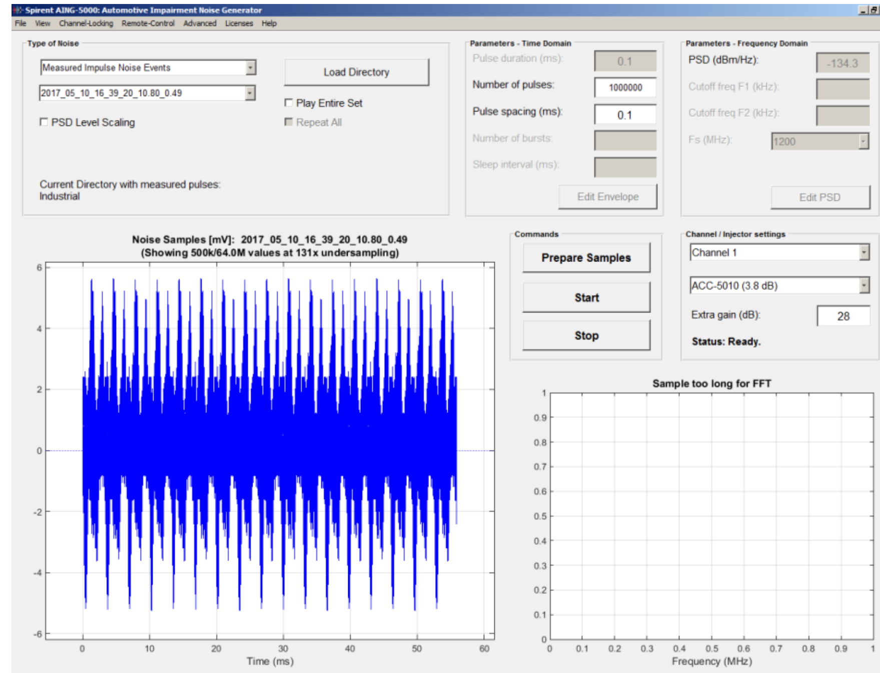




- The samples taken during the measurements within the air conditioning room have been converted to the file format of the Spirent Noise Generator and can be played back as single pulse or in a repeated manner (as used during noise testing).
- Each pulse train is played back with the originally measured signal amplitude multiplied with an extra gain (set in dB).
- The impulsive noise shown above is the one with the highest measured noise amplitude (17.60 mV_{pp}).
- The extra gain can be set to 28 dB, before the first bit errors are observed.
- Therefore for this noise event a maximum amplitude of approx. 440 mV_{pp} can be applied without bit errors occurring within a time span of 100 s (10^6 repetitions of the 100 µs impulse noise measurement).
- The reason for this seemingly high value is that the frequency spectrum of the measured impulse noise is high enough to be partially outside the communication frequency spectrum.

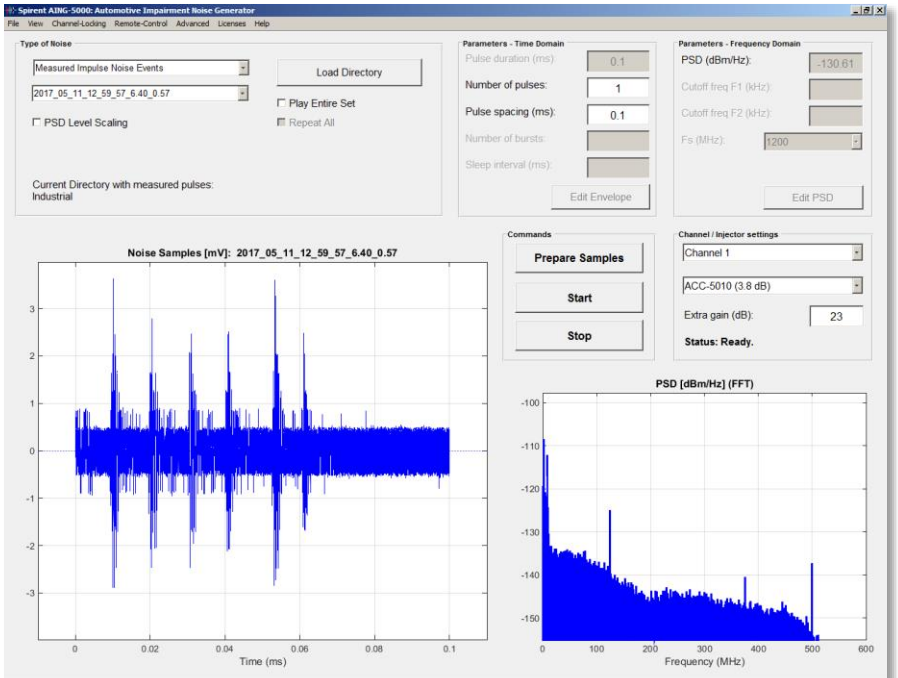
Impulsive Noise Measurement

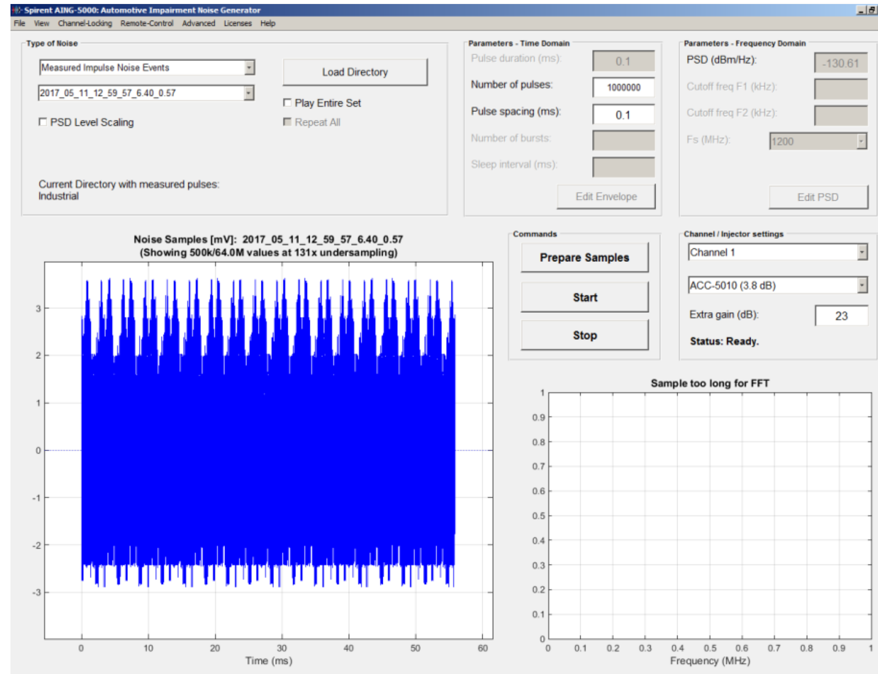




- Taking another sample with an amplitude of 10.80 mVpp allows for an extra gain of 28 dB.
- This leads to a maximum allowed noise amplitude of approx. 270 mV_{pp}.
- The noise is again played back for 100 s (10^6 repetitions of the 100 µs impulse noise measurement) without detecting a bit error.
- For each of the noise measurements the noise has been injected at the MASTER PHY side as well as at the SLAVE PHY side.

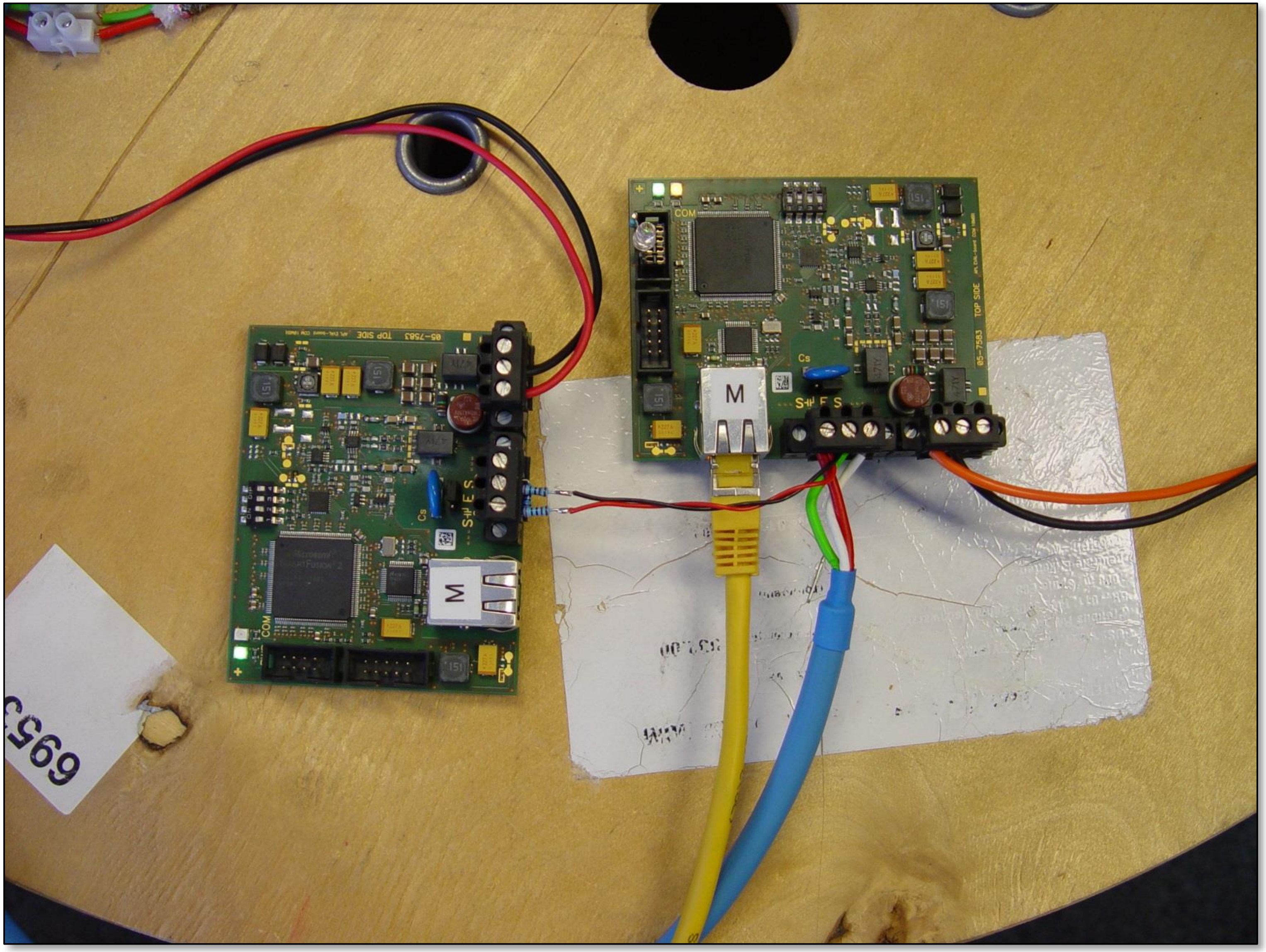
Impulsive Noise Measurement





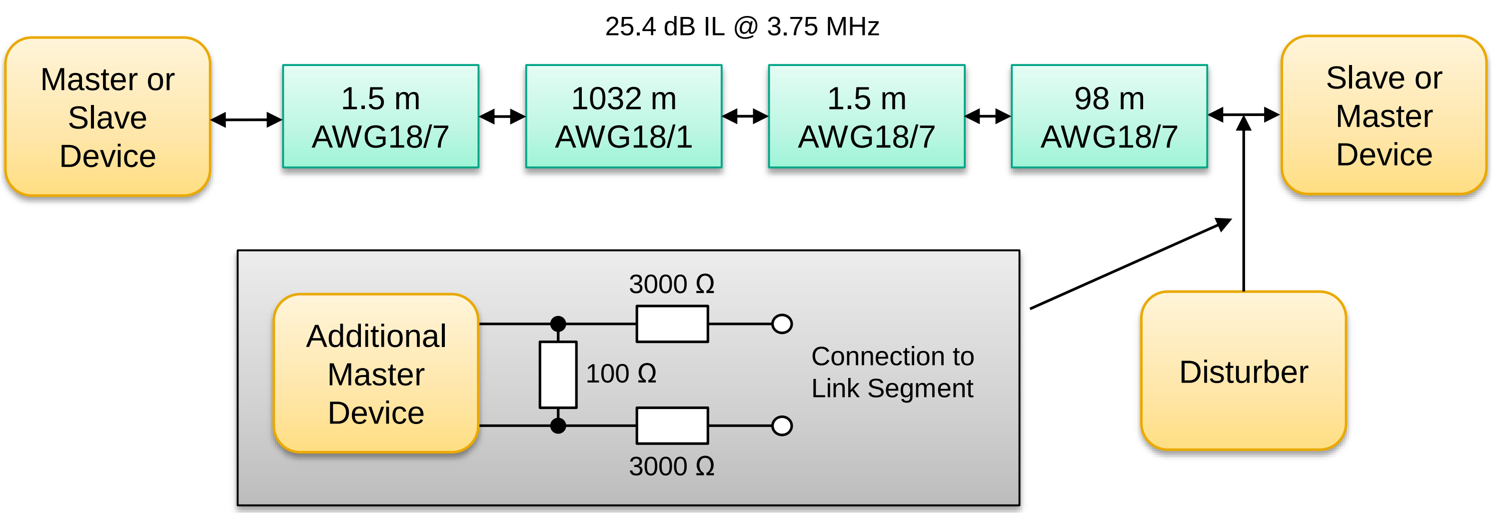
- The above shown noise event occurred when switching on the neon light bulbs within the room.
- Even though the noise amplitude is quite low, this noise event has a higher amount of the noise within the signal frequency range.
- Therefore the maximum allowed extra gain, before the first bit errors occur, is 23 dB.
- The resulting noise amplitude is approx. 90 mV_{pp}.
- From the tested samples, this is the noise event which causes the first bit errors at the lowest impulse noise amplitude.

Alien Noise Measurement Setup



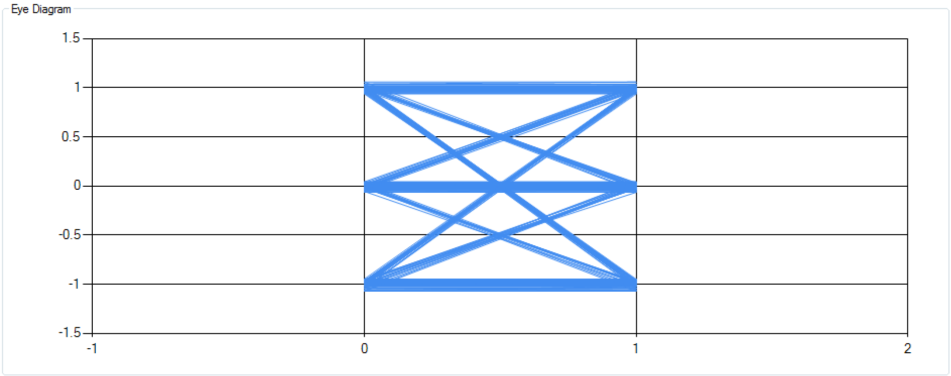
Alien Noise Measurement Setup

- The following block diagram shows the basic setup for the alien noise measurement.
- The link segment is the same as being used for the AWGN and impulsive noise measurements before.
- On one end of the link segment an additional PHY device sending idle data is being connected (for this purpose just another evaluation board configured as MASTER has been used).
- The additional PHY is being connected using a simple resistor network to reduce the transmit amplitude to a low enough value (20 mVpp typ.) and to simulate the alien crosstalk noise.

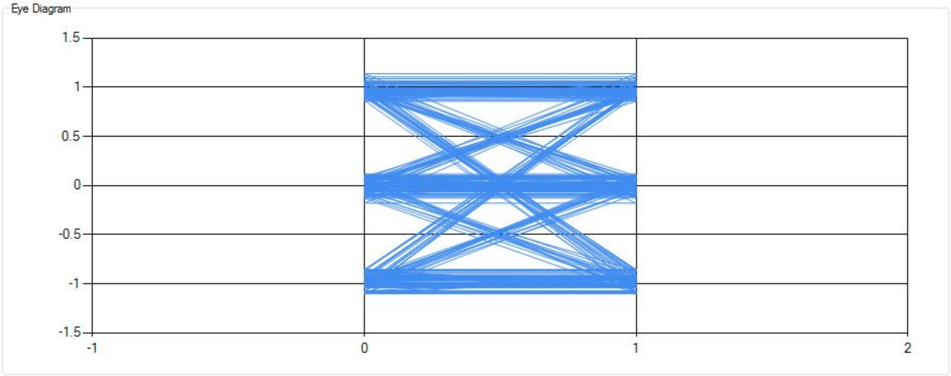


Alien Noise Measurement

- The eye diagram on the top is showing a communication over the specified 1000 m link segment without an additional disturber.



- The eye diagram on the bottom is showing a communication over the specified 1000 m link segment with a second MASTER PHY being connected as alien noise disturber using the resistive coupling network shown on the previous page.



- Taking the insertion loss of a 1000 m link segment into account, the received voltage level at the far end side of the link segment distinguishing two different PAM-3 symbol values is approx. 60 mV at Nyquist frequency.
- Therefore there is not much headroom above the 20 mV_{pp} alien noise.
- The first errors start to occur at approx. 30 mV_{pp}, as the alien noise statistically exactly fits to what the receiver of the PHY is expecting.
- As for the long reach link segment, only shielded cables are specified, which provide a high shield attenuation. The question is whether such an alien noise crosstalk test makes sense, or if there are better tests for the receiver.

Thank You