10 Mb/s Single Twisted Pair Ethernet
Noise Measurements

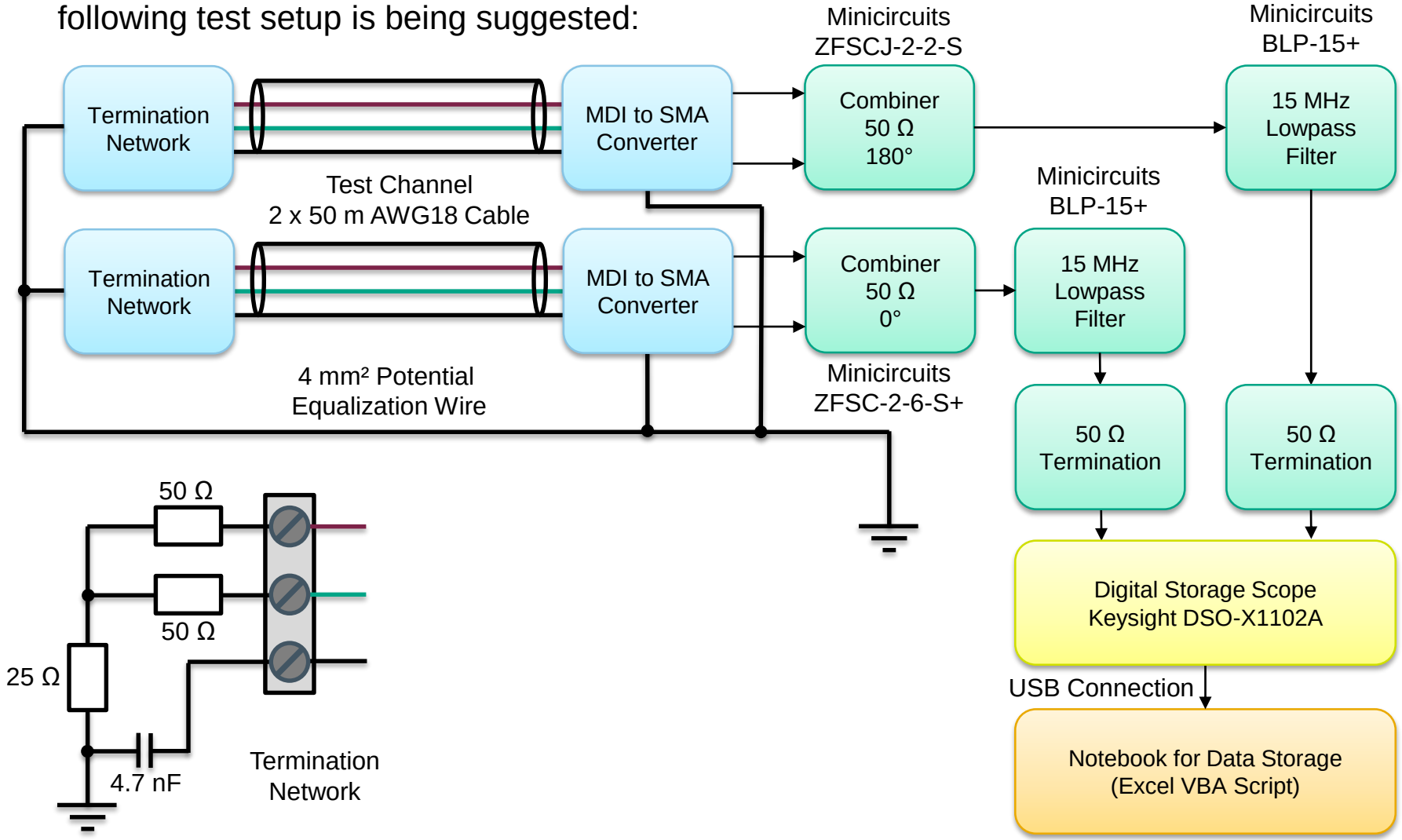
Steffen Graber
Pepperl+Fuchs

Content

- Impulsive Noise Measurement Setup
- Elevator Room Noise Measurement
- Air Conditioning Room Noise Measurement
- Compressor Room Noise Measurement
- Heating System Room Noise Measurement
- Noise File Data Format
- Conclusion

Impulsive Noise Measurement Setup

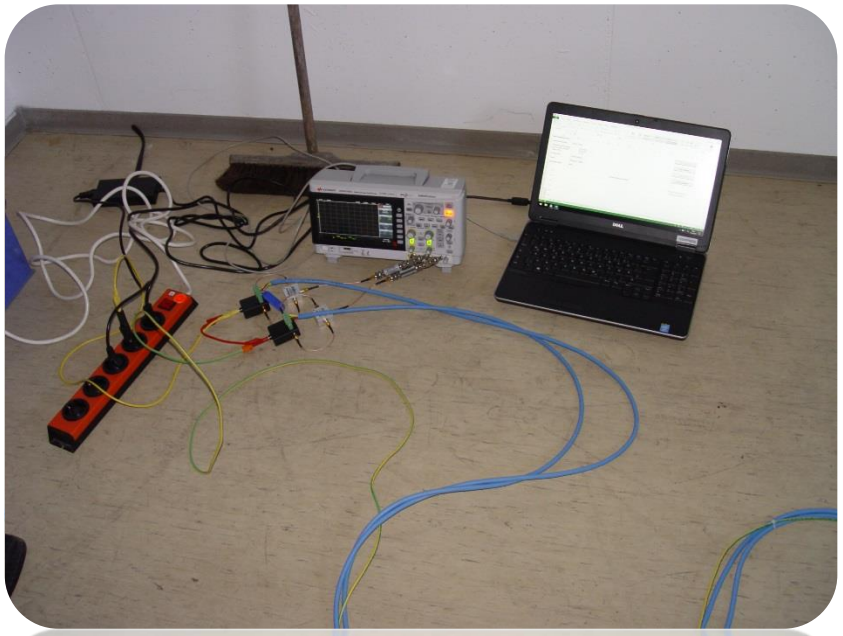
- To be able to measure ambient noise, which is being coupled to a shielded 2-wire cable, the following test setup is being suggested:



Impulsive Noise Measurement Setup

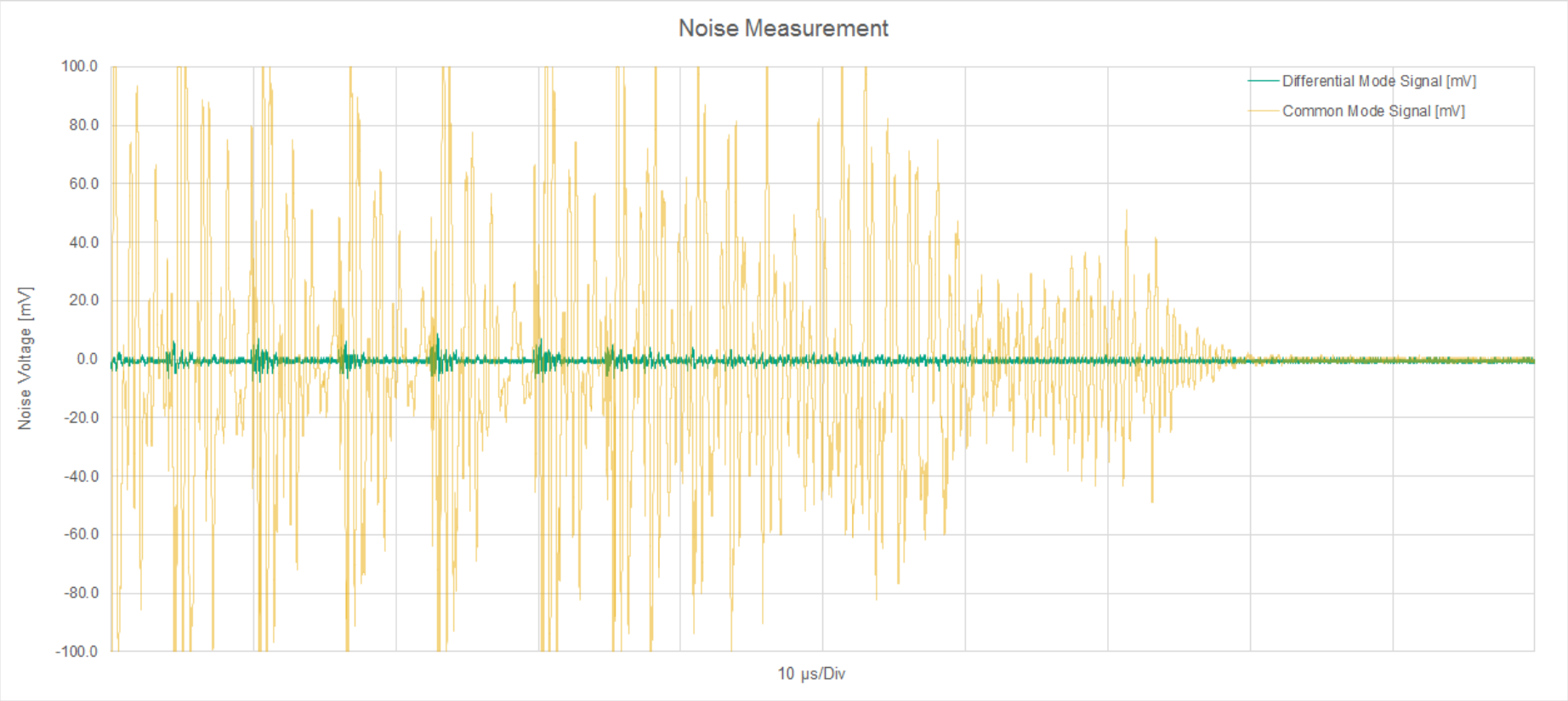
- Each combiner has a signal attenuation of approx. 3.5 dB.
- Therefore the noise values provided within the scope screenshots needs to be multiplied by a factor of about 1.5.
- The scope is using a sample rate of 1 GSPS/s.
- The horizontal scaling is 10 µs/div, therefore the time duration for a complete screen shot is 100 µs.
- Therefore each stored dataset consists of 100000 data points with a resolution of 8 bit.
- As trigger level 1 mV or 2 mV (depending on the base noise level) on the differential signal input has been set.

Elevator Room Noise Measurement



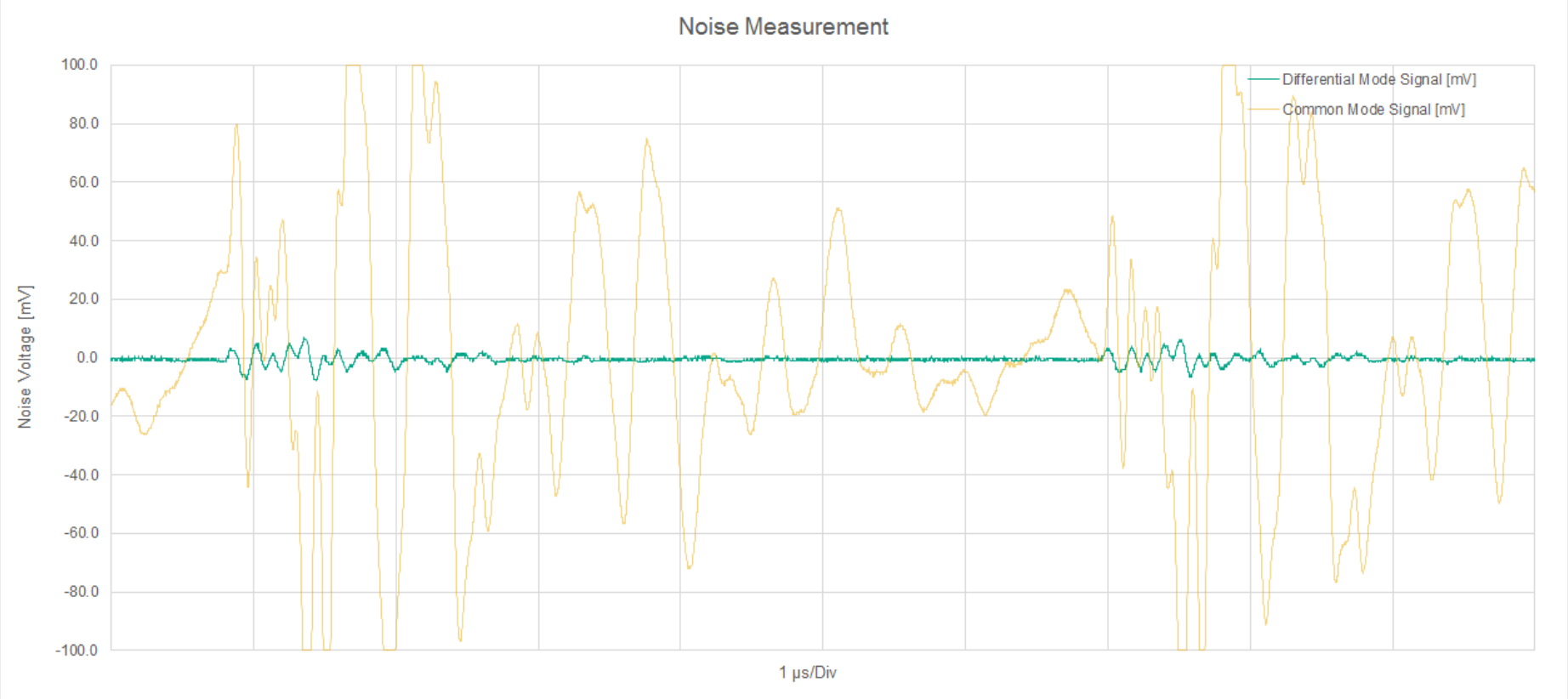
- 3-Phase Elevator Motor with 18 kVA (400 V).
- Measurement time approx. 6 h (also during lunch-break time).
- Only one event recorded during this time.

Elevator Room Noise Measurement



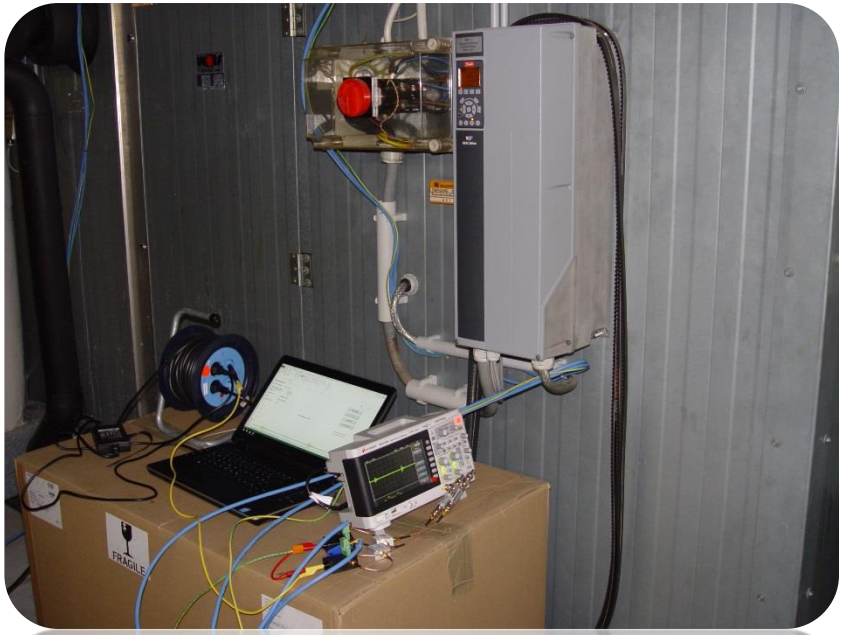
- Maximum peak-to-peak differential mode noise is 16.80 mV (25.20 mV with gain correction).
- The noise event is not coming from elevator motor itself.
- The noise event most likely is coming from the building power distribution system.

Elevator Room Noise Measurement



- Zoomed version of the last slide.

Air Conditioning Room Noise Measurement

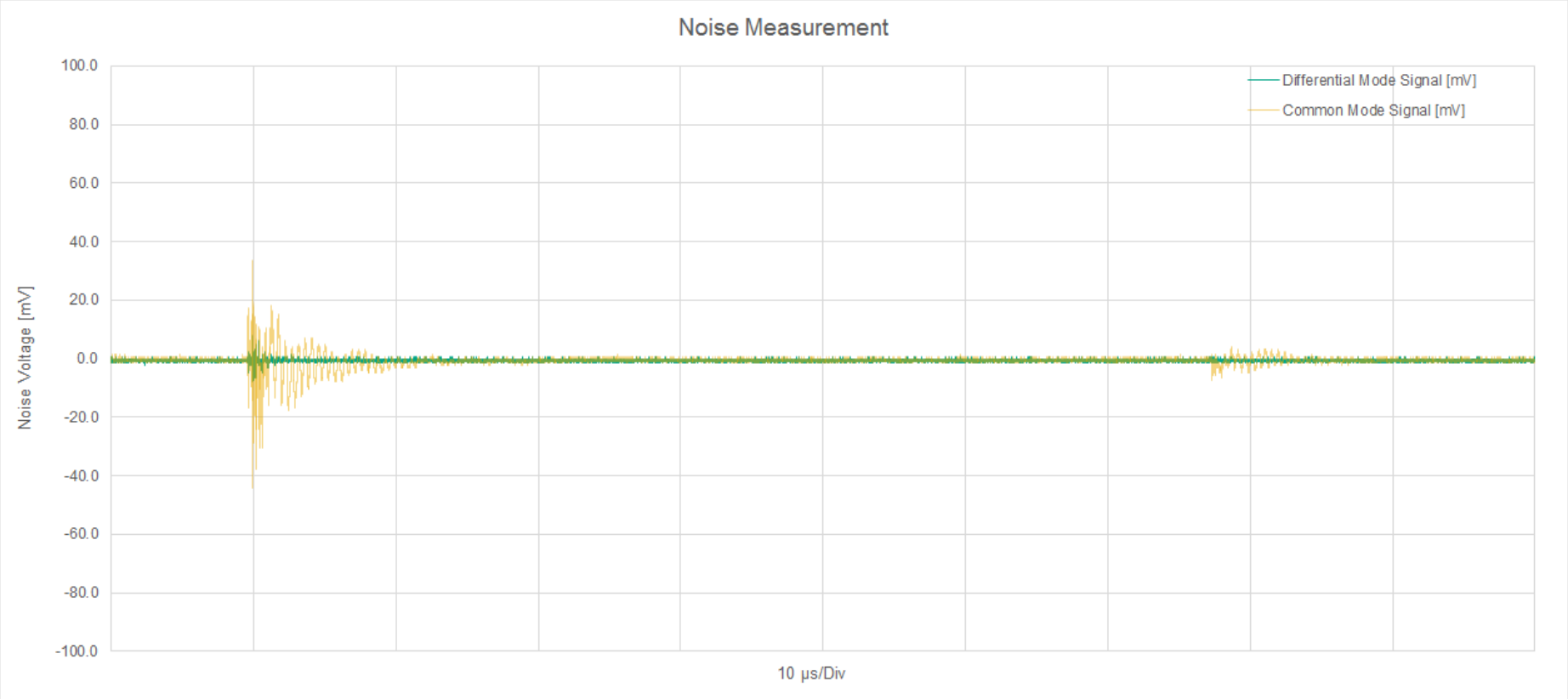


- 2 inverter controlled motors (each motor approx. 30 kVA, 400 V, 3-Phase).
- Shielded cables between inverter and motor.
- Communication cable positioned near to supply and motor cables.
- Communication cable in same cable tray than power cables.

Air Conditioning Room Noise Measurement

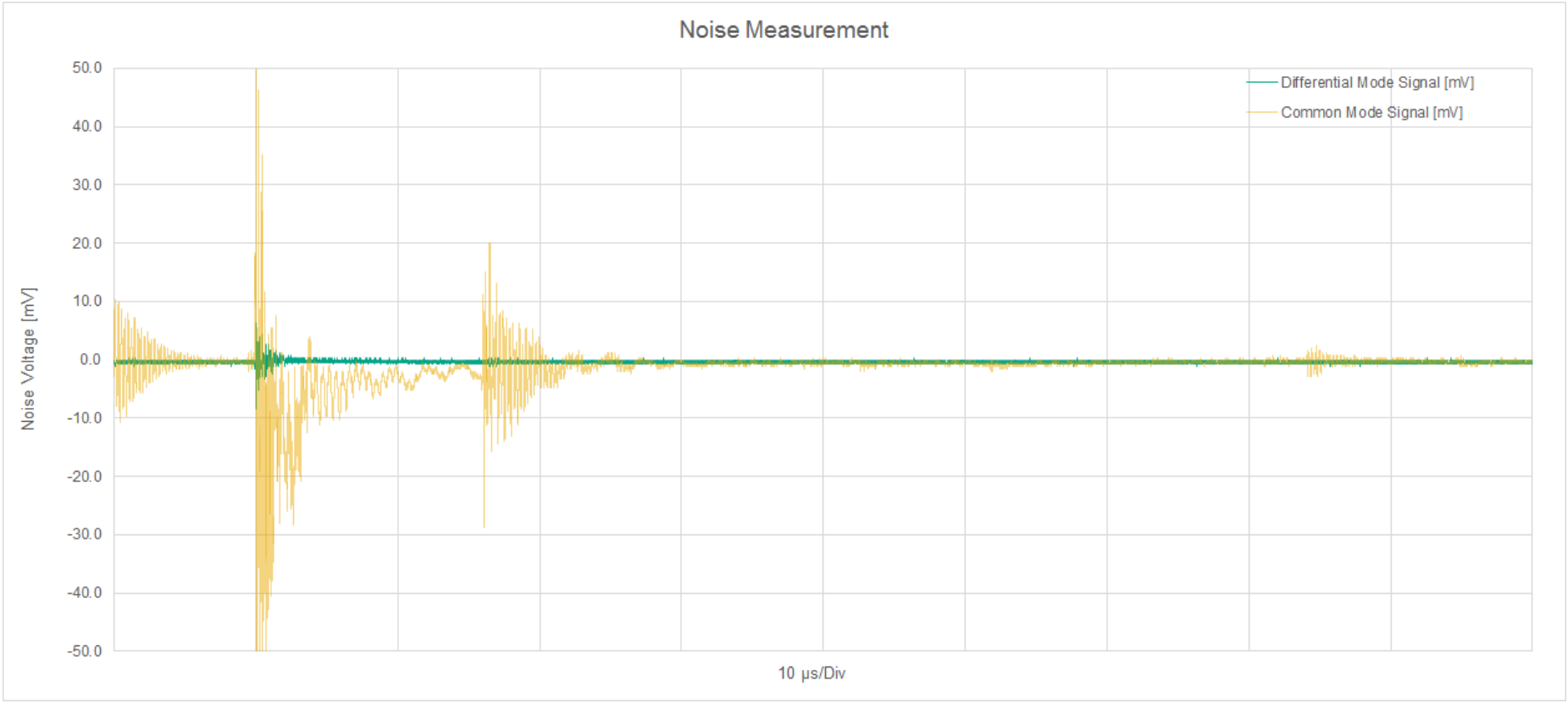
- Beginning at the motor inverters, the total 50 m of cable have been laid out within the room.
- Two humidifiers, an air dryer and several other heating pumps are also within the air conditioning room.
- During a measurement time of approx. 18 h there have been several noise events, where most of the events were really small.
- The next slides show four exemplary „higher“ noise events.

Air Conditioning Room Noise Measurement



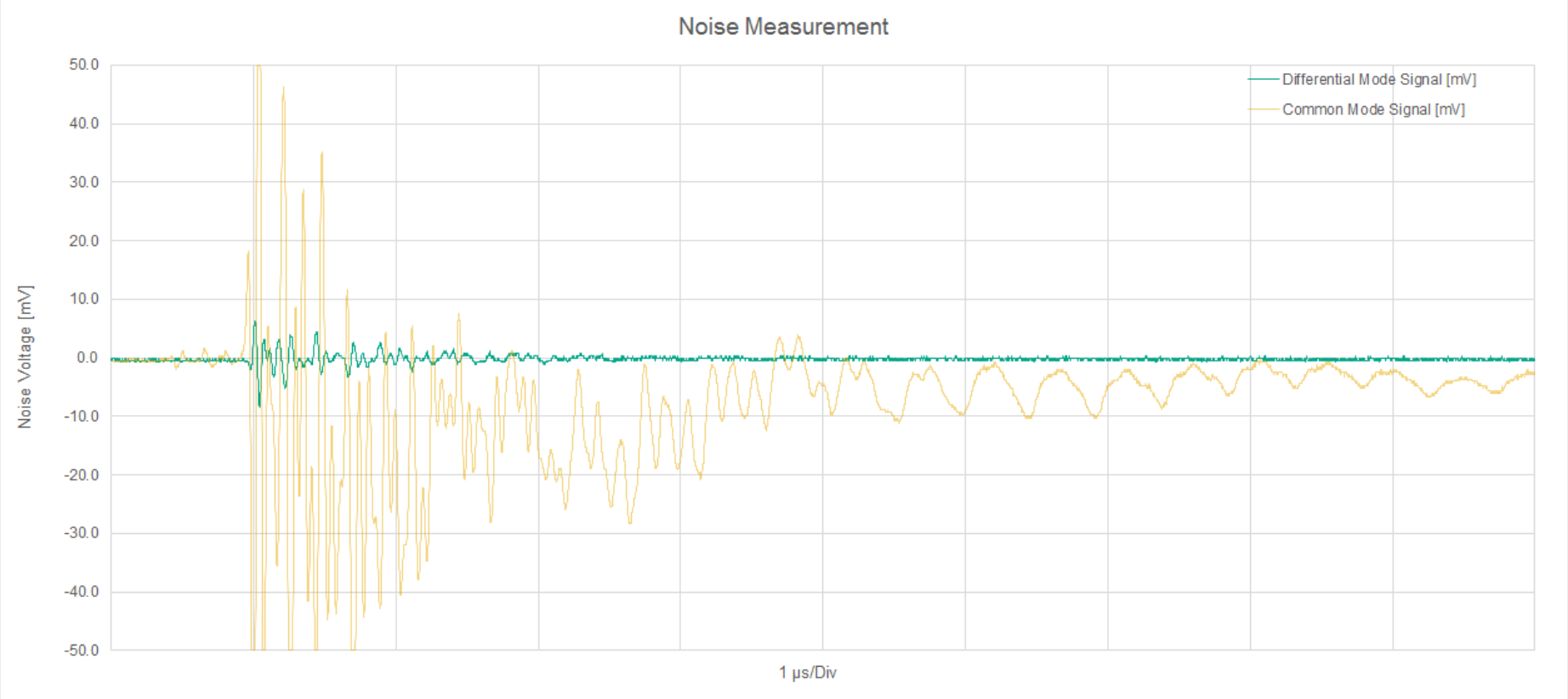
- The measured differential mode peak-to-peak noise is 16.00 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 24.00 mV.

Air Conditioning Room Noise Measurement



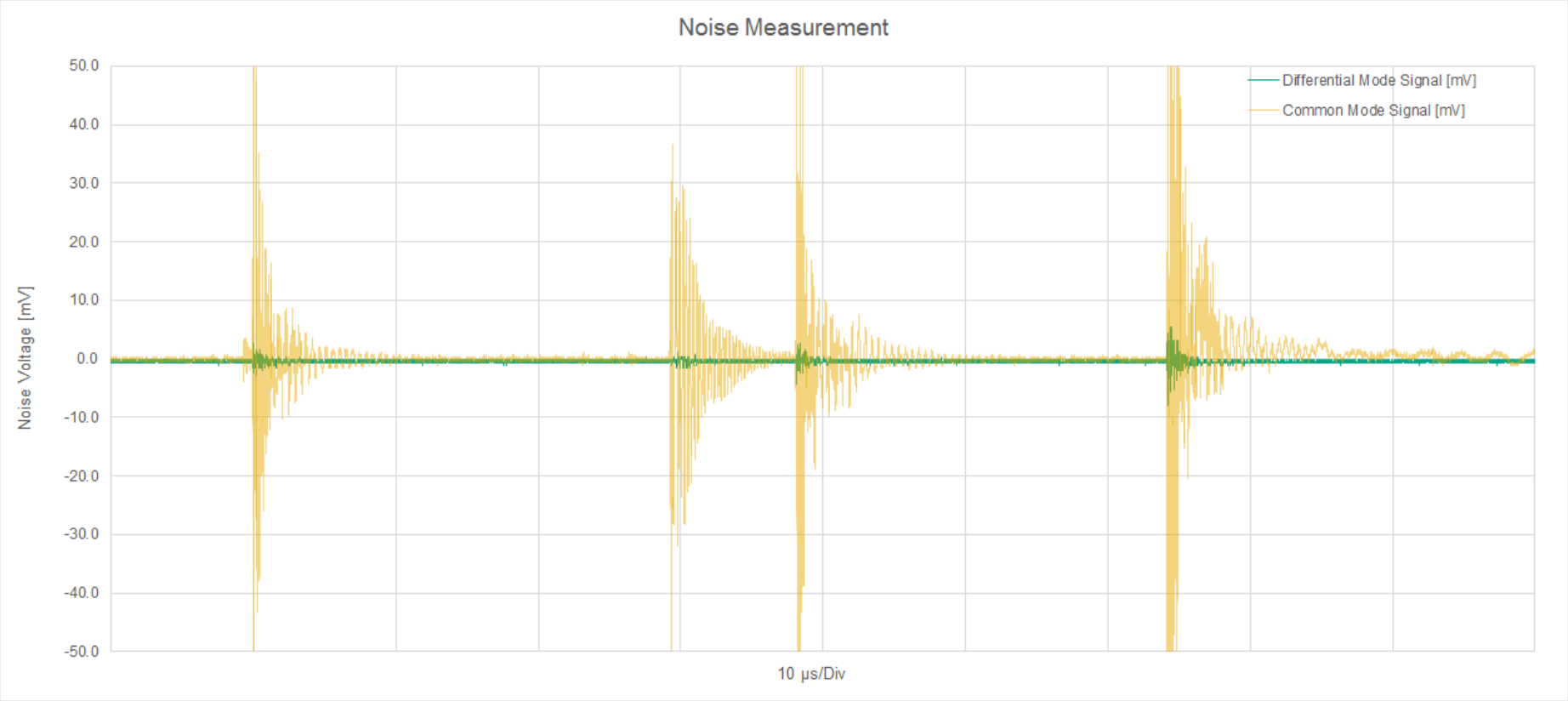
- The measured differential mode peak-to-peak noise is 14.80 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 22.20 mV.

Air Conditioning Room Noise Measurement



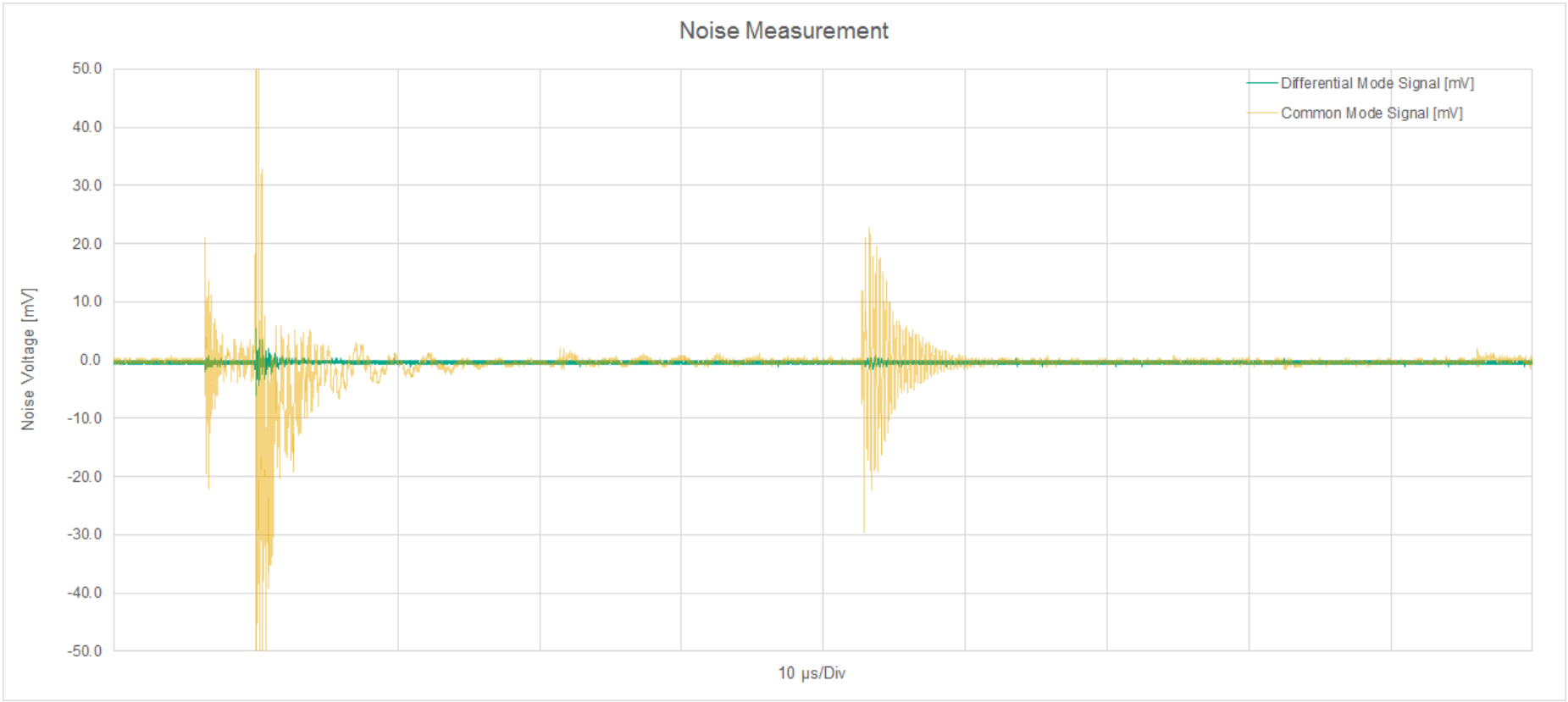
- Zoomed version of the last slide.

Air Conditioning Room Noise Measurement



- The measured differential mode peak-to-peak noise is 13.60 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 20.40 mV.

Air Conditioning Room Noise Measurement

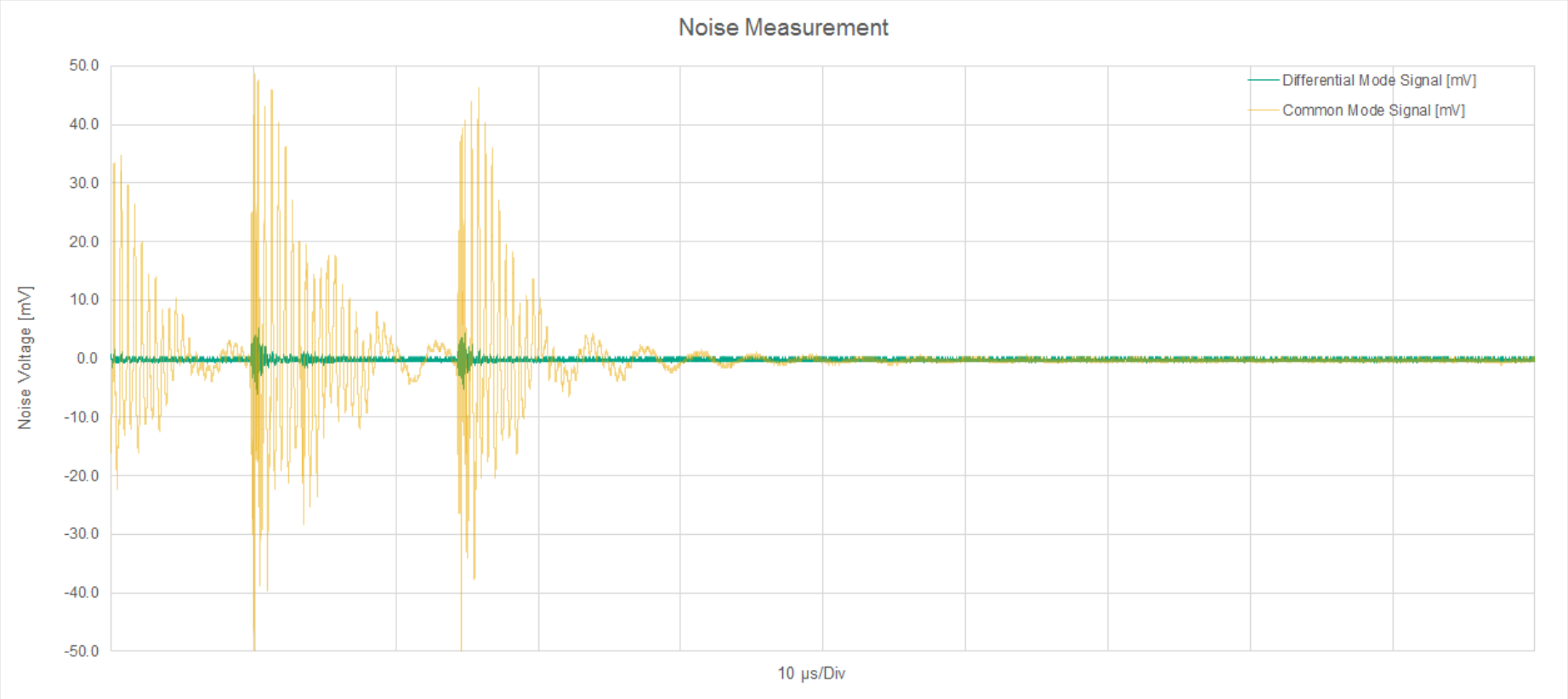


- The measured differential mode peak-to-peak noise is 11.60 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 17.40 mV.

Compressor Room Noise Measurement

- Within this room three compressors and an air dryer are running.
- Depending on the pressurized air demand, the compressors are automatically controlled.
- During a measurement time of approx. 6 h a few events have been captured.
- The highest noise event is shown on the next slide.

Compressor Room Noise Measurement

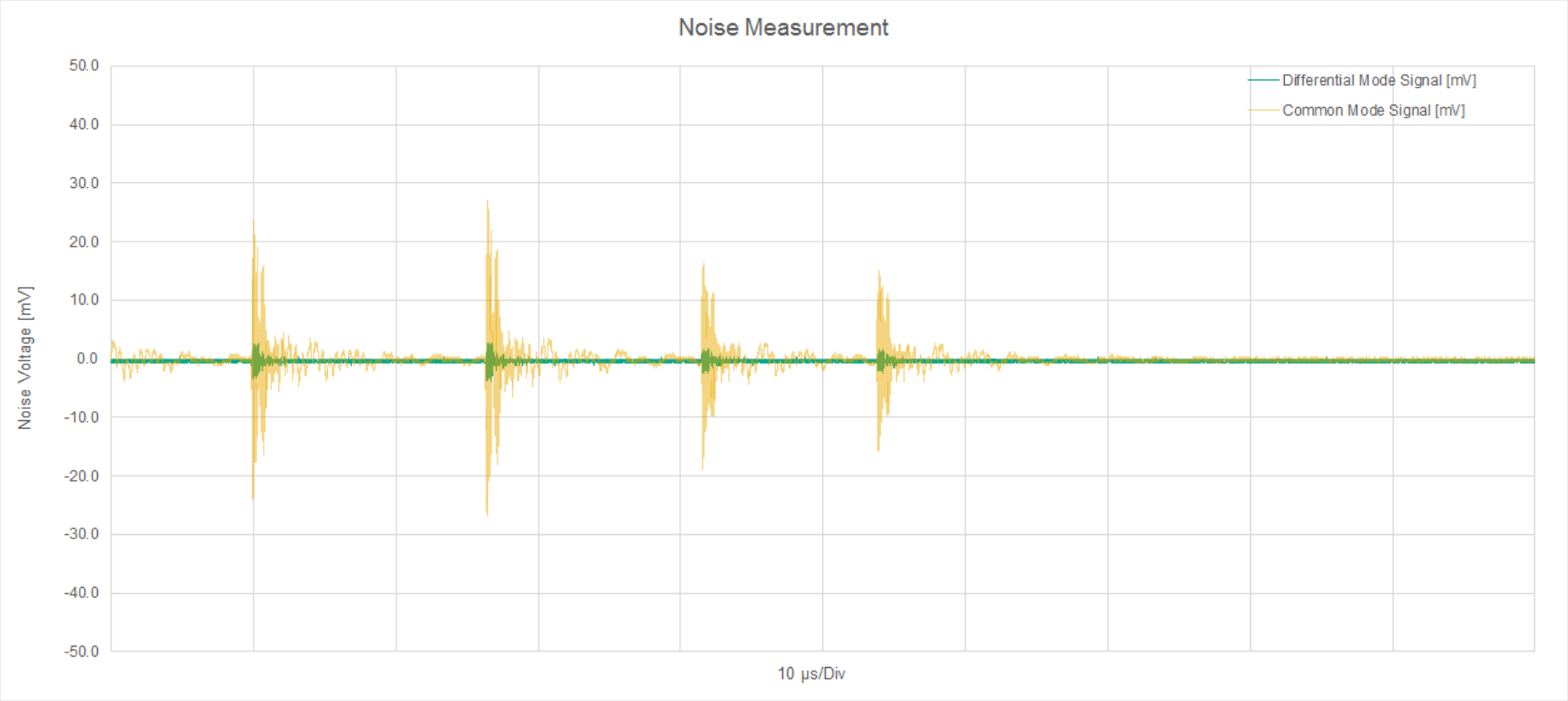


- The measured differential mode peak-to-peak noise is 11.20 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 16.80 mV.

Heating System Room Noise Measurement

- Within the heating system room three burners and several heating pumps are running.
- The cable has been laid out near to the burners (plastic housing) and the heating pumps.
- Measurement time has been approx. 6 h.
- During this time two small noise events have been captured.
- The higher noise event is shown on the next slide.

Heating System Room Noise Measurement



- The measured differential mode peak-to-peak noise is 6.80 mV.
- Applying a gain correction of 1.5, the maximum peak-to-peak noise is 10.20 mV.

Noise File Data Format

- Attached to this presentation there is a ZIP archive with several noise data files.
- At the beginning the file names provide the date and time when the data have been captured.
- The value after the time is the differential mode peak-to-peak noise level in millivolts.
- The last value within the file name is the RMS value of the differential mode noise in millivolts.
- Therefore relevant noise events can easily be identified by the file name.
- The used data format is very simple:

```
Differential Mode Scaling [mV/Div] / Common Mode Scaling [mV/Div] / Trigger Level [mV] / Sample Time [ns]
10	10	1	1
Differential Mode Signal [mV] / Common Mode Signal [mV]
-0.4	0.0
-0.4	0.0
….
```

- The first data line shows the vertical resolution of both channels, the set trigger level and the sample time (1 ns per sample).
- The other 100000 data lines contain the measured data in millivolts (separated by tab stops).
- Included within the ZIP archive there is also the Excel file (Excel 2013 with macros enabled), which has been used for communication with the scope (actual Keysight VISA COM library needs to be installed).
- This file can also be used to simply view the data (and there is also a zoom button, which allows to zoom into the first 10 µs (from the 100 µs) to see better how the noise looks in detail).

Conclusion

- Several examples of noise sources within our facility have been measured.
- Due to the use of a shielded twisted pair cable the measured differential mode in-band noise is quite low.

- The maximum differential mode noise level measured in all four measurement locations has been 25.20 mV_{pp}, applying a gain correction factor of 1.5.
- It is expected, that this noise level will not cause communication issues in conjunction with the proposed 4B3T coded PHY.

- The maximum common mode noise level is significantly higher than the differential mode noise level.
- It is in the range of 300 mV_{pp} or even higher, applying a gain correction factor of 1.5.
- Nevertheless because a symmetric differential receiver is being used, common mode noise within this amplitude range is not expected to be an issue.

Thank You