

Reliable vessel performance is conditioned by stable Power Management operation. Sea trials have to include accurate electrical network PQ / EMI evaluation.

On a vessels with harmonics filters, constant PQ monitoring should be installed (IACS [UR E24 regulation](#)) if vessels are contracted for construction after 1.7.2017., on older vessels yearly PQ sourvays should be done.

Idea of independent PMS monitoring has been evolving paralel to resolving demanding [issues in the field](#).

2010 Queen Mary II switchboard fire was red flag in industry , [UK investigation report](#) (page 46) reveals a need for continous waveform monitoring/recording

This accident demonstrates how electrical instability can cause unpredictable and potentially disastrous consequences in marine high voltage electrical networks. It is therefore necessary to consider how such transient events can be monitored and recorded to understand the exact nature and cause of electrical instabilities and the best way to mitigate them.

Methods of choice are multipoint microgrid synchrophasors ([PMU analyser](#) IEC 61000-4-30 A/S) measurements of voltage/current synchrophasors and derived quantities with rate of 60 estimations per second , 16 bit A/D conversion, 3.2kHz continous waveform recording,THD and harmonics meassurements (DC- 2kHz/3.2kHz) aggregated on 1 min intervals.

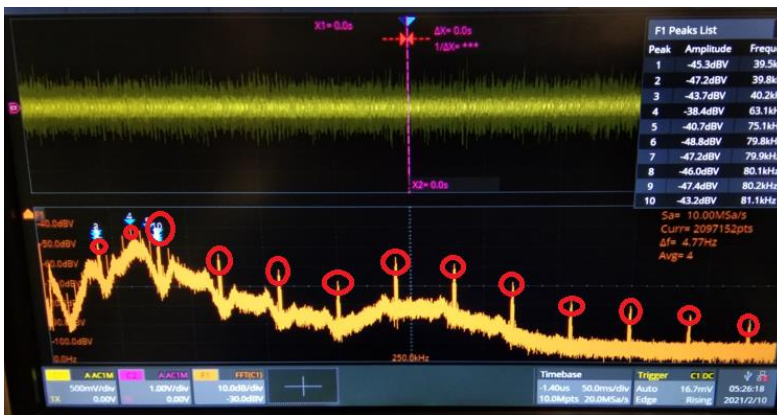
Due to fast Active Front Ends 'hard' switching(several kHz) of modern electrical drives, they trade high efficiency and low THD for high EMI (conductive and radiated as consequence), so there is a additional need of monitoring voltage/current/near EM field of superharmonics (2kHz/3.2kHz - 150kHz) , conducted EMI (150kHz-30MHz) and radiated EMI (CISPR 22 regulation)

CISPR Class A Conducted EMI Limit		
Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15 - 0.50	79	66
0.50 - 30.0	73	60
CISPR Class B Conducted EMI Limit		
Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15 - 0.50	66 to 56*	56 to 46*
0.50 - 5.00	56	46
5.00 - 30.0	60	50
CISPR Class A 10-Meter Radiated EMI Limit		
Frequency of Emission (MHz)	Field Strength Limit (dBµV/m)	
30 - 88	39	
88 - 216	43.5	
216 - 960	46.5	
above 960	49.5	
CISPR Class B 3-Meter Radiated EMI Limit		
Frequency of Emission (MHz)	Field Strength Limit (dBµV/m)	
30 - 88	40	
88 - 216	43.5	
216 - 960	46.0	
above 960	54.0	

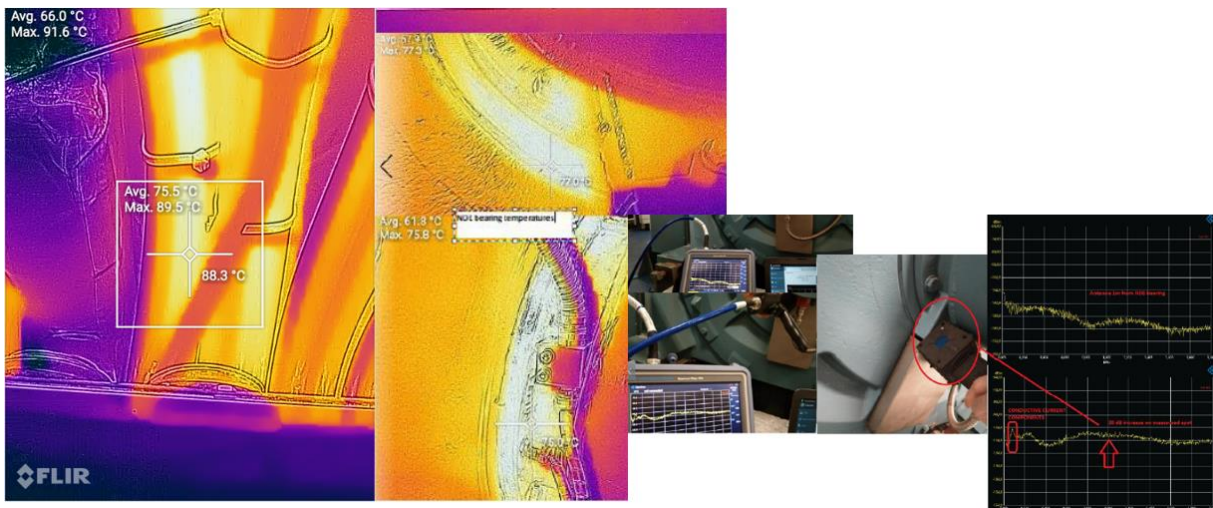
Additional equipment needed are Digital Storage Oscilloscope (triggered by PMU) with high voltage probes and rogowski clamps , spectrum analyser with calibrated antenna and thermographic camera.



Example of fast switching AFE conductive EMI spectra and occurrence of 40kHz harmonics: drive producers trade regulated 'low' harmonics/THD (DC to 3.2kHz) for 'unregulated' superharmonics and EMI.



Effects of hf conductive currents on cable heating (skinn/eddy currents) and NDE isolated bearing hf micro arcing currents evaluation by thermographic method.



Drive originated EMI/conductive currents injection in echosounder signal cable



Voltage notching (phase to phase commutation short circuit)



Electrical network resonance oscillations (amplified by added EMI filters)

