EMI Immunity of Accumetrics Digital Telemetry

Background:
Telemetry systems used for torque and strain based measurements on drive shafts often operate in areas where interference from external signals can threaten the acquired data. Modern digital telemetry provides great advantages in EMI robustness over earlier analog FM telemetry systems. A government EMI lab susceptibility tested an Accumetrics AT-4400 single channel 16 bit telemetry system; this is a summary, with comments, of that lab report.

Test Methodology:
The AT-4400 system was placed in an RF shielded anechoic test chamber and subjected to a radiated electric field. The general methodology employed was consistent with Method RS103 of MIL-STD-461E, although the tests were not used to conclude compliance. The equipment under test was mounted above a copper topped test bench and their instruments provided with 120 VAC power. The telemetry rings, transmitter and receivers were located a distance away from the interface units, the distance varying by the length of interconnecting cable provided. All associated cables were routed along the front of the ground plane. The output signal from the interface unit was also routed along the ground plane and fed through the setup panel to an oscilloscope located in an adjacent antechamber. An oscilloscope located outside of the chamber was used for monitoring the output and assessing the nature and degree of any interference noted. The data telemetry signal was derived from a shunt calibration signal applied to a full bridge strain gaged shaft.

The electric fields were generated by signal generators producing a sinusoidal carrier that was modulated by a 1 kHz square wave. This signal was then amplified and fed to various field-generating antennas. The resultant fields were measured via a closed loop field sensing system that monitored and maintained the fields at or above the minimum levels required for this test. If susceptibility was noted, the field levels were reduced to determine the threshold levels. If necessary the modulation was removed to determine its effect on the systems as well.

The testing was done from 10 kHz to 100 MHz. From 10 kHz to 30 MHz the polarity for the fields was vertical (a single polarity is specified for this range in RS103). Above 30 MHz, the only polarity used was horizontal, which coincided with the routing of the systems cables.

Accumetrics Model AT-4400

The Accumetrics AT-4400 System was a fully functional demonstration unit installed with a telemetry clamp-collar transmitter and stationary pickup for induction power and data transfer mounted above a steel plate to a strain gaged shaft. The plate rig was oriented vertically for this testing.

Testing was performed on the Accumetrics system at 10 V/m meter, modulated as indicated above. From 10 kHz to 30 MHz, it exhibited no signs of susceptibility at fields of 10 V/m. Field strengths were increased until some distortion was observed. At frequencies between 100 –500 kHz, minor distortion was observed at field levels in excess of 25 V/m; the distortion levels were assessed as not severe enough to invalidate the digital output readings, despite the RF interference coupled onto the output signal.

The noise observed in frequency ranges below 30 MHz was no greater than 45 mV (on a 7 V signal), so that resulting data error was less than 0.64 % (0.45% of the full scale 10V output). From 30 – 100 MHz, some distortion of the output signal was noted on the line at field levels at or near 10 V/m. The worst distortion was noted at 93.6 MHz, where the level of distortion at this specific point would have been enough to give false output readings. It was noted that this was above the frequency of any significant noise source generation that was expected to be encountered in actual operation.

The system was tested with 24 feet of exposed RG58 signal cables and unshielded strain gage inputs. (Note: the AT-4400 receiver was also exposed to the EMI, whereas often it is located at a distance from other noise sources.) It was strongly believed by both the lab and Accumetrics that the use of basic EMI hardening (conduit for the cables, with the receiver remotely located) would significantly improve the EMI results.

Legacy Analog FM Telemetry

An analog FM telemetry system was also tested, and was found to have significant problems with basic functional operation at EMI levels much lower (1V/meter typically) than levels successfully endured with little effect by the Accumetrics AT-4400.

Conclusions

The Accumetrics AT-4400 system performed well in the presence of radiated electric fields below 30 MHz. It was not subject to large errors at any frequency below 30 MHz.

The Accumetrics system performed far better across a wider range of frequencies, and was judged superior in performance to the legacy analog FM telemetry system.

The system appeared to be able to withstand radiated electric field levels expected in close proximity to newly developed high power-level electronic motor drive machinery elements.

---Accumetrics Note:
The AT-4400 is an inductively powered 16 bit digital telemetry system sampling at 26484 samples per second. It is very similar in architecture to Accumetrics' digital multi-channel telemetry series, the AT-7000 systems, and the same EMI susceptibility would be expected.

Accumetrics also uses similar digital telemetry for its ground detection systems (Ground Detection System GDS, and Earth Fault Resistance Monitor EFREM), for the AT-1000 large channel count/ high bandwidth systems. Using battery power, the AT-5000 and AT-7500 systems also digitize on rotor, and transmit digital data that is difficult to disturb with EMI, providing good pickup loop layout is provided.

It has been anecdotally found that Accumetrics digital telemetry systems installed in the field provide excellent immunity to EMI susceptibility (due in large part to the fundamental nature of the data transfer design). We believe that EMI lab testing of any of these systems would demonstrate excellent results, comparable to those demonstrated by the above AT-4400 testing.

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